A BUSINESS CASE FOR A DATA-DRIVEN DECISION-MAKING TOOL TO SUPPORT THE UNBC RESEARCH ENTERPRISE

by

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Executive Summary

Business intelligence tools allows for data-driven decision-making within organizations using historical events to predict future trends, which is especially valuable when allocating operational resources. As a research-intensive Canadian university, UNBC has seen a significant increase in activities related to supporting the research enterprise, which requires additional resources (human, capital, financial etc.) in order to effectively and efficiently advance the mission of the research community. As outlined in our Annual University Accountability Report, 2018/19 was an incredibly productive year for research with more than $14 million received in support of research. The University has seen a significant increase in the number and breadth of agencies and organizations funding research at UNBC.

The administration of research awards involves both pre-award and post-award processes, which requires responsible allocation of available resources to ensure a sustainable model will be developed to achieve goals outlined by the institution's strategic priorities and build the foundation to reach our goal of a research enterprise generating $25M in annual research revenue. Therefore, using business intelligence tools to utilize historical data to predict the necessary resourcing needs of the institution will allow UNBC to make strategic investments in research and remain competitive on the provincial, national and international stage. Informed decision-making when investing resources are critical to the success of any business.

The goal of my MBA project is to gather critical information to be used in the development a data visualization and forecasting tool that will allow for informed decisions for the allocation of resources necessary to support the research mission at UNBC. The objectives of the MBA project are two-fold, which include the development of the business case for the UNBC data visualization tool (DVT) and also the completion of a design document. The information gathered

from this project will be used in the future (post-MBA) to develop a data visualization tool that will allow for the on-going monitoring of UNBC's progress towards putting in place the appropriate resources to reach $25M in annual research revenue. Specifically, the MBA project will consist of completing a comprehensive business case outlining the "business need" and potential solutions. Secondly, the MBA project will consist of developing a "design document" for an eventual tool that will be used to visualize research funding and labor information to inform business decisions for resource planning for the UNBC research enterprise. This design support system will be used by senior leadership within UNBC to effectively and efficiently make decisions to allocate resources.

Section 1: UNBC Office of Research Services

About UNBC Research

The University of Northern BC (UNBC) has identified their four interdisciplinary strategic research priority areas as (UNBC, Research , 2020):

1. Environment and Natural Resources
2. Community Development
3. Northern, Rural and Environmental Health
4. First Nations and Indigenous Studies

These priority areas are highlighted in the UNBC Strategic Research Plan (SRP) and they, along with other emerging areas of research, build the foundation of the research enterprise at the institution. The major objectives of the plan are:

- *"To strengthen research at UNBC that is of outstanding quality and pioneering in its innovation, especially in strategic interdisciplinary research areas that are of marked importance to our region and similar areas;*

- *To enhance the training of researchers, by increasing the number of graduate students and by providing a highly stimulating research environment for all of our students (undergraduate and graduate) that establishes UNBC as a leader in the integration of research and teaching;*

- *To guarantee our researchers access to superior research resources and infrastructure, and to manage these to ensure their effective and efficient use;*

- *To develop new research relations with communities, businesses, industries, other academic institutions and other partners, regionally, nationally, and internationally; and*

- *To enhance access to the results of our research, through improved knowledge translation, transfer and application, in order to maximize their benefits to society in Northern British Columbia and beyond."* (UNBC, Research , 2020).

Office of Research Services

In order to meet the objectives of the SRP, the Office of Research Services (OR) exists. The core functions of the office are to promote and enhance the success of research by faculty, students, and partners of UNBC (UNBC, Research , 2020). The services provided by the OR intend to foster competitive research programs for faculty belonging to all disciplines and the services fall within six support categories (Table 1).

Table 1. Support Functions of the Office of Research

Support Function	Details
Funding Applications	- Provide advice on sources of research funding - Facilitate research grant proposals - Supply institutional letters of support - Negotiate research contract terms and/or funding agreements
Certifications and Regulations	- Ensure UNBC meets or exceeds all relevant regulatory standards for research - Provide services for research certifications (i.e. ethics, animal care)
Research Infrastructure	Assist with maintaining and growing UNBC's research infrastructure
Partnerships	Facilitate the development of research partnerships with community, industry and government partners at the local, provincial, national, and international levels
Technology Transfer and Knowledge Translation	- Support technology transfer and commercialization of research discoveries - Support the transfer of knowledge and bring science to society
Advocacy	- Manage and maintain relationships with research funding agencies - Engage in high-level advocacy with all levels of government to promote an environment in which world-class research may flourish at UNBC

(UNBC, Research , 2020)

Why data is important to the Office of Research operations

In order to effectively support the research enterprise and stay focused on the objectives of the SRP, the Office of Research team needs to understand the linkage between the operations of the office and how well they support the objectives of the SRP. For the purpose of this report, the Office of Research operations is categorized into three organizational levels: Global; Program/Discipline; and, Individual Researcher. The Global level refers to the high-level, "30,000ft view" of the research enterprise – this is the Vice-President Research level. This level is the perspective from the organizational level. The Program/Discipline level refers to the medium-level, "10,000ft view" of the research enterprise – this is the Director of Research level. This level is the perspective from the program and/or discipline level. The Individual Researcher level refers

to the ground-level, "ground-level view" of the research enterprise – this is the Research Administrator level. This level is the perspective from the individual researcher level. Given that these various levels support the research enterprise in different ways, the data needs of the individuals within each level will vary, as will the data access frequency.

For example, "Global Data" needs could be "how much research funding has UNBC secured in the last 12 months?". This is something a Vice-President Research would be interested in and would request this data once per annum given they are trying to move the enterprise forward at the highest level. A "Program/Discipline Data" need could be "how much research funding has the School of Nursing secured in the past month?". This is something the Director of Research would be interested in and would request this data monthly given they are trying to support the research community and build support programs specific to programs/disciplines. "Individual Researcher Data" needs could be "how much funding has Research A secured over the last month, year, five years?". This is something the Researcher Administrator would be interested in and they would potentially need access to this type of data on a daily basis given they are supporting individual researchers prepare funding applications daily. In addition to needing access to the data examples above, an additional example would be the labor costs associated with these activities. These activities directly tie back to the SRP and also the resources needed to support the enterprise.

Figure 1 highlights the perspectives of the three levels of information needed by the various levels of administrators: global, program/discipline, individual researcher. The colors correspond to the frequency the DVT will be accessed (i.e. blue = daily; green = monthly; yellow = quarterly). The wider the base in the pyramid, the more frequently the data needs to be accessed, and vice versa. The higher up on pyramid corresponds to the scope of the data related to the perspective.

Current Challenge

As outlined in the examples above (more comprehensive Use Cases are described below), the various levels within the Office of Research structure require access to various types of data, coming from various perspectives, with various access frequency needs. The challenge is that there is no system currently available at UNBC that will allow for access to "real-time" data related to funding successes at the organizational, program/discipline and/or individual levels, and needing access on daily, monthly, semi-annually or annual basis does not exist. In order to access this information today would require many labor hours poring over spreadsheets from various platforms to capture the information requested. Additionally, it would not be real-time information due to the current system specifications, which are updated typically on a monthly or annual basis. This is a pain-point for the research office leadership as it makes it difficult to effectively support the research enterprise in a competitive way.

Figure 1. User perspective and user frequency

Therefore, there is a current need to address this challenge as this will save time and resources as compared to the current model.

Section 2: Data Visualization Tools

Business intelligence relies on the use of data visualization tools given their utility to both visualize and analyse data that can support decision-making within an organization (Syen Mohd Ali, 2016). *What is data visualization?* "Data visualization is the graphical representation of

information and data. By using visual elements like charts, graphs, and maps, data visualization tools provide an accessible way to see and understand trends, outliers, and patterns in data." (Tableau, 2020). By using data visualization tools to view and analyze data, organizations can gain important business intelligence information using data that might otherwise not be utilized in any useful way. Given the significant amounts of data that are generated every second, not utilizing the data is potentially a missed opportunity to gain useful insights to the business operation, as well as uses for future predictive and prescriptive modelling.

Where have data visualization tools been used? Data visualization tools have been used in many industries and have become more essential given the drive to manage and interpret large amounts of data being generated daily. The World Economic Forum reports that more than 2 quintillion bytes of data is being produced daily across the globe and in order to make use of the large amounts of data being generated, these tools can provide insights that would not otherwise be done, which can lead to improved decision-making capabilities for organizations (Richardson, 2020). Data visualization tools take various forms of data and presents it in a useful, meaningful way, typically in a graphical or pictorial form that allows for quick interpretation of the data. Cordray noted seven benefits to using data visualizations, including enhanced action to make decisions, enabling the communication of findings in constructive ways, understanding connections between business operations and business outputs, embracing the emerging trends in both business and technology, being able to interact with data effectively, fostering the creation of new discussions, and enhanced uses with machine learning (Cordray, 2017).

What are some emerging trends for the use of data visualization tools? As noted above, data visualization tools are becoming more widely utilized throughout business. For example, with technologies all around us, we have devices that capture data for "environmental monitoring,

infrastructure management, manufacturing, energy management, medical and healthcare systems, building and home automation, transportation and many more", for example, which can supported by the internet of things and therefore requires data visualization tools in order to capture the true value of the data being generated (Suresh, 2020).

In addition to helping businesses make informed decisions, data visualization tools are widely used in the scientific community in order to present large amounts of data or complex data sets in a useful way. Ribarsky and Foley report on the benefits to using data visualization tools to present complex data is ways that can expedite the analysis of the data generated, but that the tools need to be designed with the end user in mind so that visualization software does not require extensive expertise to operate (Ribarsky, 1994). One interesting example is using data visualization tools in the development of neurocritical care informatics. As Schmidt *et. al.* report, this discipline generates a wealth of data, but the challenge is how health service providers can gain valuable insights from the data, which could lead to enhancing the clinical decisions that these professionals are making (Schmidt J.M., 2020).

Data visualization tools are increasingly being used in the academic environment in order to measure student performance given the multiple variable that lead to the success of a student (Etemadpour, 2020). Applications in academia also include research management. Given the large amounts of data produced within the research community, creating visualizations can assist in cleaning data and presenting it that could be made available to the public or to organizations (Dimou, 2014).

Finally, an interesting trend is the use of data visualization tools is in human resources within businesses. Whether it is use in the talent management cycle for recruitment and retention

of employees, or if it is tracking the labor hours within an organization, data visualization tools are being used to extract information from this important area for all businesses (Mrsic L., 2020).

As noted above, the increased generation of data has led to the increased use of tools that allow for useful interpretations of data. Typically, these tools are used when large amounts of data are being generated and this data could lead to intelligent business decisions being made. Emerging areas include the use of these tools in research as well as in human resource management, but very little information within the literature noted the use of data visualization tools in supporting research administration processes and operations, including labor insights.

Section 3: Business Need Prompting this Business Case

Data visualization tools are used in businesses that generate data that could be used to inform decisions, so there is an opportunity for UNBC to capitalize on the use of such a tool. As a research-intensive Canadian university, UNBC has seen a significant increase in research activities that requires additional resources (human, capital, financial etc.) in order to effectively and efficiently support the research community. As outlined in our Annual University Accountability Report, 2018/19 was an incredibly productive year for research with more than $14 million received in support of research. The University has seen a significant increase in the number and breadth of agencies and organizations funding research at UNBC. The administration of research awards involves both pre-award and post-award processes (as outlined above), which requires responsible allocation of available resources to ensure a sustainable model will be developed to achieve goals outlined by the institution's strategic priorities and build the foundation to reach our goal of $25M annual research revenue. Therefore, utilizing historical data to predict the necessary

resourcing needs of the institution will allow UNBC to make strategic investments in research and remain competitive on the provincial, national and international stage.

At UNBC, no such avenue exists to enable research leadership to use historical funding data, linked to the necessary labor resources needed to support the research enterprise. Therefore, we are developing the foundation needed to build the data visualization tool that will allow for real-time, informed decision-making capabilities which will support the success of the research mission at UNBC.

There are many factors, both internal and external that are driving the development of an effective tool that will allow for strategic investing in research at UNBC. Below is a list of key drivers that have initiated the development of the tool, which are linked to the desire to address the business need using a software tool:

- **Competitiveness:** The research landscape is becoming more competitive, so in order for UNBC to increase its footing on the provincial, national and global marketplace, we need to remain competitive. A key factor in this is to understanding where University resources should be invested to maximize the opportunities to set the UNBC research community up for success. Specifically, how can UNBC Research Services, and other supporting units at UNBC develop the appropriate structures to sufficiently support the research community.

- **Policy:** As noted above, UNBC research success continues to grow, therefore, there is an institutional change in the priority and mandate of the research mission – continue to grow and enhance research funding success and also opportunities for UNBC faculty and students to engage in research activities.

- **Efficiency:** operationally, increases in efficiency, effectiveness, and quality of a research support programs at UNBC are critical to maintaining and building off the achievements

of research success. As demands increase on specific resources within the institution, costs associated with said resources need to be considered. For example, understanding what positions and/or technological tools that are essential to supporting the appropriate needs within UNBC will ensure maximal efficiencies are achieved when determining resource requirements and acquiring said resources. It is important for senior leaders to be proactive and anticipate potential operational inefficiencies so they can appropriately prepare.

- **Demographics:** With continued success come a change in the demand for specific research support programs at UNBC. For example, UNBC researchers are becoming more successful at pursuing, and obtaining, large multi-jurisdictional research grants and the research administration resources needed to support these programs of research, both pre- and post-award are specific and extensive. Further, increases in the success around industry-partnered research also requires incremental supports above and beyond, for example, federally-funded research programs. Therefore, understanding how the research demographics are shifting (i.e. who is applying to what funding programs), is a critical piece to determining resource requirements. Another important point to make given that UNBC is a post-secondary institution, the demographics for individuals entering undergraduate degree programs is shrinking, therefore, we are seeing an increase in the number of "mature" students entering graduate school in research-intensive programs which require a specific set of support resources (i.e. funding programs, human capacity) to deliver programming.

- **Politics:** Conducting research and development in the public sector requires institutions such as UNBC to monitor and maintain an understanding of the political landscape given the requirement to adhere to government legislation (i.e. University Act, Tri-Council

Guidelines). Changes in legislation and also the potential changes in government terms every 4 years requires institutions to resource plan that with these considerations in mind.

- **Economics:** As with any business, universities in Canada must follow the economy to determine how and where they should invest their limited resources. Changes in the tax regime (e.g. recent changes in employment taxes in British Columbia) can impact the bottom line of a business. Further, with the ever-growing global economy, international trade and monetary factors play into the decision-making process for institutions as they need to ensure the appropriate resources are in place to, for example, foster relationships with like-minded, international institutions. Additionally, as mentioned above, industry factors play into the considerations for universities. Northern BC is a good example of how changes in the economy (i.e. downturn in Forestry) can initiate sweeping changes to programs offered at post-secondary institutions and also potentially drive the need for increased research and development to diversify the economy and develop value-added wood products. Institutions need to be ready for these economic changes and resource investing tools can offer support for informed decision-making.

- **Technology:** One only has to look at the world around us to see that technology is a key driver for change. This is certainly true in the context of post-secondary research programs. The innovation potential to support the advancement of research programs is vast. Whether it is using software programs to monitor and enhance the research funding application processes or the use of efficient online application processes to graduate programs, technology can offer effective solutions to some of our most challenging issues. Further, changes in the legislation related to technology is evolving at a rapid pace, which requires institutions to consider investing in new areas that were not previously required. A good

example of this here is the need for institutions to develop and implement Data Management Strategies, which include providing technological platforms to researchers where they can safely store and access important research data. Technological upgrades and solutions will require institutions like UNBC to consider new resource investment options.

- **Law:** Research at post-secondary institutions in Canada are governed by Federal and Provincial regulatory bodies. For example, the "*Tri-Council Policy Statement: Ethical Conduct for Research Involving Humans (TCPS2) provides guidance on how research involving humans must be conducted within Canadian jurisdiction. There are minimum support resources that must be put in place in order for institutions to be compliant with what is outlined by TCPS2 and the more research that is being conducted involving humans, the more of a demand on these resources there will be. More generally, laws can impact the operations of an organization.*" Changes in employment law can impact the resources organizations need to acquire and direct towards employee groups. For example, the Employment Standard Act of BC outlines provisions around the minimum wages or benefits that must be offered an employee, therefore, understanding changes that might occur can be useful when resource planning within the organization.

As noted above, there are many drivers that have signalled the need to have an effective resource allocation tool to support a research enterprise at UNBC. Given the multiple factors that can impact the operations of a research enterprise, it is imperative to be highly strategic in resources investment planning and understanding the trends that are occurring both internally and externally can ensure institutions are allocating resources appropriately to "keep up" with the ever-changing landscape.

Given the competitive landscape, UNBC must develop and implement strategy that will result in additional value to the organization. This can only occur with an integrated approach that will coordinate the allocation of resources to the areas of most need (Hitt, Ireland, & Hoskisson, 2016). This business case will focus on the research enterprise.

Scope of this Business Case Analysis

The scope of this investment is the following: build a DVT which will highlight historical/forecasted research income and research administration labor data.

In scope:

Capturing and displaying labor data (research services staff, research finance staff, research contracts staff, human resources staff)

Capturing and displaying research funding data (tri-council, non-tri-council, industry-sponsored)

Out of scope:

Capturing and displaying student enrollment data

Capturing and displaying student services labor data

Stakeholders are a critical piece to the development of the business case for the proposed Data Visualization Tool. It is important for stakeholders to be actively engaged in the business case development process as they help to define the business requirements and the business outcomes. Both internal and external stakeholders play a role in the development and implementation of the DVT so their involvement is vital. It is therefore important to consider what stakeholders will be involved, what their roles will be, and what contributions they will bring to the realization of the investment. The internal stakeholders are the groups of resources from within UNBC affected by the proposed investment.

Stakeholders who contribute to the development of the DVT can be either primary or secondary, with primary stakeholders either directly benefit from a project's efficiency, revenues, or competitive advantage or are those implementing the new project. Further, secondary stakeholders in this case have a dependent relationship with the primary stakeholders (i.e. the primary stakeholders are dependent on information from secondary stakeholders).

Below I describe the stakeholder environment of research administration at UNBC (both internal and external) by considering the types of stakeholders, their specific roles, and their contributions to the realization of the investment.

Primary Stakeholders

Research Office – the Research Services Office at UNBC is the primary stakeholder for the DVT project. The ultimate goal of the DVT is to capture and display both labor and research funding data in an effort to assist in the efficient and effective allocation of research administration resources. It is, therefore, critical that the information supplied by the secondary stakeholders is accurate and complete. Fortunately, the research office has a great working relationship with the various secondary stakeholders. The research office will contribute data related to funding applications received and processed, and also indicate if said applications are successful or not.

Researcher – individuals who will submit data to the system and will use data from the DVT.

Secondary Stakeholders

- Research Finance – the Research Finance Office will provide the Research Services Office research funding data received by UNBC ("actuals")

- Human Resources – the Human Resources Department will provide the Research Services Office with labor data associated with research administrators at UNBC. This data will be historical and current.

- Research Contracts – the Research Contracts Office will provide the Research Services Office with historical data on fully-executed research contracts and research grant/award agreements.

- Information Technologies – Information Technologies at UNBC will be key in assisting with the integration of the DVT into existing IT platforms at UNBC (if, necessary and possible).

Summary of Value Results

Essentially, there are seven potential options that could be pursued (or not) to address the business need. As outlined in Table 2, options include not acting to address the business need, take a hybrid approach, or developing a design support system (DVT in this case) that directly addresses the business need.

Table 2. Potential options and the impact to the business strategy and operations

Option	Impact to business strategy and operations
Status Quo (do nothing)	UNBC would continue to have a critical gap in its resources planning and therefore would not be implementing the most efficient planning methods. UNBC would not have a competitive advantage in the allocation of resources that impact labor planning.
Implementation	Delayed— a delayed implementation would be helpful in the long-term, but may mean that UNBC misses on short-term opportunities. Fiscally, this may be a viable option given that the institution is in a deficit position. Full or Big Bang— this most immediately addresses the business need, but also requires full investment to implement. Phased— to implement the solution over time, and in response to research funding success may enable a affordable option. Also, this would allow for UNBC to be nimble and shift the tool as needed to address the changing business needs.
Service Delivery (Outsource)	This option would require UNBC to outsource the function to address the business need.
Re-engineering	Potentially re-engineering existing processes and/or current applications used by the research enterprise is a potential option. This may require

	some extensive changes in processes or complex agreements with current vendors in order to change existing research services software used at UNBC.
Build	This will require building the solution from scratch. This may be the most expensive option, but could lead to the most effective tool.
Buy	Purchasing the tool from a vendor is an option, but an "off the shelf" option may not fully address the business need.
License	Licensing the tool from a vendor is an option, but an "off the shelf" option may not fully address the business need.

Value Analysis

In order to facilitate making an informed decision to move forward with the UNBC DVT or not, below I provide a Cost-Benefit Analysis of three options: purchase a DVT "off-the-shelf"; build a DVT in-house; and, do nothing (i.e. stick with the status quo).

Costs

The costs associated with purchasing the "off-the-shelf" option is ~$115,000. This includes the labour costs associated with the development and implementation of the software. Back in 2015, UNBC went through the process to purchase a research administration software, Romeo by Process Pathways. This software would track the funding approval process electronically, which was an advancement forward from the previous paper-based approach. Romeo also has the ability to track research funding data, a key component of the proposed UNBC DVT. The challenge with Romeo is that it does not have an interface that effectively displays the funding data, or any other metrics that one may want to track (i.e. # of applications processed). Table 3 displays the costs associated with the implementation of Romeo at UNBC. The challenge with many "off-the-shelf" products is that they do not completely address the need of the user (i.e. in this case, there is no visualization function). Therefore, Romeo would need to be reconfigured in order to allow for this function.

In order to build a DVT "in-house", the costs would be ~$96,000. Existing expertise within UNBC's Computer Science program could be utilized in order to develop the UNBC DVT. The major costs associated with this approach include labour costs for both student researchers and their respective supervisor. These costs are highlighted in Table 3.

Table 3. Costs associated with purchasing "off-the-shelf" DVT

LABOUR	Item	Costs ($)
	Salaries - Overtime	319
	Subtotal	**319**
EXPENDITURES		
	Software Licensing (start-up costs)**	87,416
	Legal Fees	9,814
	Ongoing operations and maintenance	15,000
	Travel - Meeting	1,653
	Conference Fees	1,303
	Subtotal	**115,189**
Total Expenditures + Labour		**115,508**

**Note: $30,000 annual licensing fee required.* (Finance, 2020)

Table 4. Costs associated with building DVT "in-house"

LABOUR	Item	Costs ($)
	Salaries – student researchers	42,000
	Salaries – supervisor	12,500
	Subtotal	**54,500**
EXPENDITURES		
	Software Licensing	25,000
	Ongoing operations and maintenance	15,000
	Legal Fees	1,500
	Subtotal	**41,500**
Total Expenditures + Labour		**96,100**

The third option would be to do nothing and not develop and implement the DVT. Therefore, there would be no direct costs associated with this option, however, the indirect costs could be significant. As noted above, the ultimate purpose of the DVT is to support informed decision-making on the part of senior leaders at UNBC. Without a tool that could assist in the

process, decisions could be made that could utilize resources ineffectively. For example, a new position could be added to the research administration process, but there isn't data to support such a decision.

Benefits

The benefits that are associated with implementing the DVT, both "off-the-shelf" and "in-house" options, include better informed decision-making, better utilization of allocated resources, easier reporting, and reduced labor costs. The "off-the-shelf" option will require an on-going licensing fee, whereas the "in-house" option will only require minimal on-going maintenance associated with data integration, patching, software upgrades, backup, and other maintenance tasks. Therefore, the initial and on-going financial benefit would be realized with the "in-house" option.

Impact on cash flow over time

Given the licensing fee associated with the "off-the-shelf" option, it would have the most negative impact on cash flow over time. Further, given that the Romeo option would need to be reconfigure and also maintained by an external company, labor costs would be significantly higher than going with an in-house option. The status quo option could have the highest impact to cash flow given decisions could be made to allocate resources incorrectly.

Recommendation

UNBC should invest in developing a data visualization tool that will track and display research funding statistics and link labor costs associated with managing the research enterprise. This will improve efficiencies when allocating resources to support research as it will allow management to draw conclusion for the necessary costs to operate the enterprise.

Section 4: Building the Foundation for the Visualization Tool

Process Creation

Research is essential to the development of new knowledge. This new knowledge, developed through the research process, provides a better understanding of the intricacies and interconnections of the world around us. The research administration process facilitates bringing this knowledge to the forefront in order to provide direct benefits to society. There are many steps in the research process, but for the purpose of this paper it can be broken down into two large categories: the research program that generates the new knowledge and the research administration supports essential (and at times mandated) to facilitate the research. The administration of the research requires significant resources given the complexity of the continuum (Figure 2).

Ideation
Generate research questions and identify funding options

Development
Research proposal development

Submission
Submit proposal to funder

Award
Researcher/institution recieves notice of award

Grant/contract management
Meet deliverables outlined in proposals

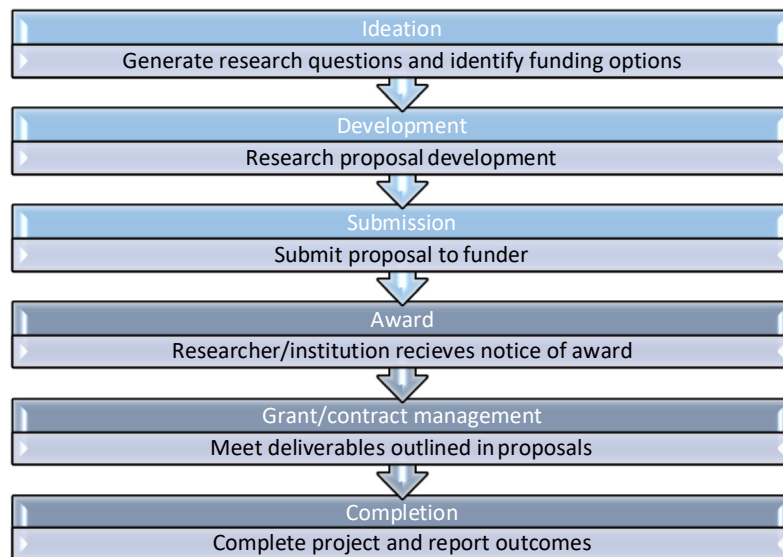| Completion |
| :---: |
| Complete project and report outcomes |

Figure 2. Research administration process. Pre-award (blue); Post-award (purple).

Research administration models across Canadian post-secondary institutions have similar structures with a research services staff who support the pre- and post-award functions as outlined in Figure 2. The post-award functions are supported by either a division of a centralized Research Services office or through a de-centralized model with separate Research Finance and Research

Contracts offices. At UNBC, the model includes a Research Services office that works with Research Contracts to support the pre-award functions, while Research Finance works with Research Contracts to support the post-award processes. It should be noted that there is interaction between all units at all stages of the continuum. Understanding the detailed roles of each actor in the research administration process ensures that we can collect the necessary data to identify areas to enhance support and prepare for future investments as a research enterprise grows.

The research administration process, from an operations management perspective, can be broken down into the "inputs", "outputs", "journey" and "gaps". The inputs include the financial resources, the facilities within the institution, the programs and software that support the process, the support staff, the researchers and perhaps the most important item for the scope of this paper is, the research proposals. The outputs include the services provided by research administration, which includes grant facilitation, partnership building, intellectual property management, research certification support. The finished product of a research proposal and/or grant application is also considered an output. Understanding the key steps of the administrative processes will be crucial to data gathering which will assist in informing decisions around future investments.

Use Cases

In order to appreciate the needs of the UNBC DVT users, three use cases will be described below: one with the Vice-President Research; one with the Director of Research; and, one with the Research Administrator. As noted above, these different actors in the system look at the research enterprise from different perspectives and thus, require different data to fulfil their needs when they operate within the system. Without the UNBC DVT, accessing this information would time not only time consuming and resource intensive, but would result in data that was not "real-time".

"Vice-President Research"

Goal: For the VPR to access global funding trends to compare with competitor institutions, at the provincial, national, international level. Having current research enterprise funding information will assist with advocating for support funding with Senior Leadership within UNBC or with Provincial and/or Federal Governments.

Table 5. Use Case - Vice-President Research

Use case name: Access global funding information		Unique ID: UNBC-VPR
Area: UNBC DVT		
Actor(s): Vice-President Research		
Description: Access to UNBC's global (regional, provincial, national, international) funding trends to compare with competitor institutions.		
Triggering Event: UNBC VPR uses UNBC DVT, enters login information, and clicks **Submit** button		
Trigger type: Internal		
Steps Performed (Main Path)	**Information for Steps**	
1. UNBC VPR logs on to the secure UNBC DVT	UNBC VPR ID, Password	
2. UNBC VPR record is read and password is verified	UNBC VPR Record, UNBC VPR ID, Password	
3. UNBC VPR enters search parameters for funding parameters	Funding record	
4. Current UNBC Funding information is displayed on the UNBC DVT	Funding record	
5. Data is validated on UNBC DVT	Funding record	
6. UNBC VPR requests funding report	Funding record	
7. Funding report is sent to UNBC VPR	Funding record	
Preconditions: UNBC VPR profile is within UNBC DVT; UNBC Funding information is on the UNBC DVT		
Postconditions: UNBC VPR has successfully searched and retrieved the UNBC Funding report		
Assumptions: UNBC VPR has a browser and a valid UNBC DVT user ID and Password		
Requirements Met: Allows UNBC VPR to search, view and report on UNBC Funding information		
Outstanding Issues: Should the number of times the UNBC VPR is allowed to logon be controlled?		
Priority: High		
Risk: Medium		

"Director of Research"

Goal: For the DoR to access program/discipline-specific funding trends to develop new support programs and advocate for areas of highest need (i.e. rapidly growing programs/disciplines).

Table 6. Use Case Table - Director of Research seeking funding information

Use case name: Access funding information specific to programs/disciplines		Unique ID: UNBC-DoR
Area: UNBC DVT		
Actor(s): Director of Research		
Description: Access to UNBC's research subject area trends to develop new programs to support the research community.		
Triggering Event: UNBC DoR uses UNBC DVT, enters login information, and clicks **Submit** bottom		
Trigger type: Internal		
Steps Performed (Main Path)		**Information for Steps**
1. UNBC DoR logs on to the secure UNBC DVT		UNBC DoR ID, Password
2. UNBC DoR record is read and password is verified		UNBC DoR Record, UNBC DoR ID, Password
3. UNBC DoR enters search parameters for funding parameters		Funding record
4. Current UNBC Funding information is displayed on the UNBC DVT		Funding record
5.Data is validated on UNBC DVT		Funding record
6.UNBC DoR requests funding report		Funding record
7.Funding report is sent to UNBC DoR		Funding record
Preconditions: UNBC DoR profile is within UNBC DVT; UNBC Funding information is on the UNBC DVT		
Postconditions: UNBC DoR has successfully searched and retrieved the UNBC Funding report		
Assumptions: UNBC DoR has a browser and a valid UNBC DVT user ID and Password		
Requirements Met: Allows UNBC DoR to search, view and report on UNBC Funding information based on program/discipline		
Outstanding Issues: Should the number of times the UNBC DoR is allowed to logon be controlled?		
Priority: High		
Risk: Medium		

Goal: For the DoR to access availability of overhead funds in order to determine how much discretionary funding the Office of Research can commit as a match on a funding application.

Use case name: DoR to access availability of overhead funds	Unique ID: UNBC-DoR
Area: UNBC DVT	
Actor(s): Director of Research	
Description: DoR to access availability of overhead funds in order to determine how much discretionary funding the Office of Research can commit as a match on a funding application.	
Triggering Event: UNBC DoR uses UNBC DVT, enters login information, and clicks **Submit** bottom	
Trigger type: Internal	

Steps Performed (Main Path)	Information for Steps
1. UNBC DoR logs on to the secure UNBC DVT	UNBC DoR ID, Password
2. UNBC DoR record is read and password is verified	UNBC DoR Record, UNBC DoR ID, Password
3. UNBC DoR enters search parameters for funding parameters	Funding record
4. Current balance of UNBC research overhead is displayed on the UNBC DVT	Funding record
5. Data is validated on UNBC DVT	Funding record
6. UNBC DoR requests overhead report	Funding record
7. Funding report is sent to UNBC DoR	Funding record

Preconditions: UNBC DoR profile is within UNBC DVT; UNBC Funding information is on the UNBC DVT	
Postconditions: UNBC DoR has successfully searched and retrieved the UNBC Funding report	
Assumptions: UNBC DoR has a browser and a valid UNBC DVT user ID and Password	
Requirements Met: Allows UNBC DoR to search, view and report on UNBC overhead information based on successful research funding applications	
Outstanding Issues: Should the number of times the UNBC DoR is allowed to logon be controlled?	
Priority: High	
Risk: Medium	

"Research Administrator"

Goal: Retrieving real-time funding data to assist with preparing research funding application (i.e. include past 5 years of funding for faculty). Often times, researchers are required to list, for example, "5 greatest contributions in the last 5 years". Having access to this real-time data can be extremely helpful in preparing competitive funding applications on short notice, which is common place.

Table 7. Use Case Table - Research Administrator

Use case name: Access funding information specific to programs/disciplines	Unique ID: UNBC-RAdm
Area: UNBC DVT	
Actor(s): Research Administrator	
Description: Retrieving data to assist with funding application (i.e. include past 5 years of funding for individual faculty).	
Triggering Event: UNBC RAdm uses UNBC DVT, enters login information, and clicks **Submit** bottom	
Trigger type: Internal	

Steps Performed (Main Path)	Information for Steps
1. UNBC RAdm logs on to the secure UNBC DVT	UNBC RAdm ID, Password
2. UNBC RAdm record is read and password is verified	UNBC RAdm Record, UNBC RAdm ID, Password
3. UNBC RAdm enters search parameters for funding parameters	Funding record
4. Current UNBC Funding information is displayed on the UNBC DVT	Funding record
5.Data is validated on UNBC DVT	Funding record
6.UNBC RAdm requests funding report	Funding record
7.Funding report is sent to UNBC RAdm	Funding record

Preconditions: UNBC RAdm profile is within UNBC DVT; UNBC Funding information is on the UNBC DVT	
Postconditions: UNBC RAdm has successfully searched and retrieved the UNBC Funding report	
Assumptions: UNBC RAdm has a browser and a valid UNBC DVT user ID and Password	
Requirements Met: Allows UNBC RAdm to search, view and report on UNBC Funding information based on program/discipline	
Outstanding Issues: Should the number of times the UNBC RAdm is allowed to logon be controlled?	
Priority: High	
Risk: Medium	

Data requirements

This business case is outlining the need for UNBC to invest in the development and implementation of a "Strategic Investing in Research Tool", which is ultimately a Data Visualization Tool (DVT) that highlights trends in research success at UNBC and the complimenting resources within the organization needed to support the research enterprise. In

order to develop the tool, one must determine the key requirements that are needed to fully address the business need – a tool that will allow us to analyze a gap in knowledge regarding the resources needed to support a research mandate of $25M in annual research funding. First, we will define the investment by highlighting the business environment (i.e. what is the current state at UNBC when it comes to resource planning for the research enterprise); the business objective and anticipated outcomes (i.e. what is UNBC hoping to achieve by the implementation of the DVT); the business need (i.e. what changes to the current state are required); and, the key requirements (i.e. what information is needed to develop the DVT that will enable UNBC to address and overcome the current state). There are 2 types of requirements: Functional, which are required for the DVT's functionality and include the capabilities, usability, features and operations; and, Non-functional, which will include all of the features not linked to its functionality such as the performance, security and technical specifications.

In order to clearly define what a piece of software is meant to address, and the process related to addressing the need, requirements engineering must be done (Cheng, 2007). The needs analysis outlined above precedes the requirements engineering step, which helps to identify what the system is supposed to accomplish in the environment in which it operates. As Eric Yu highlighted in the article, *Agent-Oriented Modelling: Software Versus the World*, in order for software technology to be successfully applied, the system (or a proposed system) must be understood in the context of the environment that is will operate in (Yu, 2003). Given the "fact finding" nature of developing requirements, there are various ways to complete this important step, which include conducting interviews or surveys, brainstorming, investigative research, reviewing documents or observing processes (Tilley & Rosenblatt, 2017). Requirements for the UNBC DVT were developed by reviewing important documents associated with the funding applications and

also resource planning, in addition to observing the research funding application process (Britton, 2016).

When it comes to research resource planning at UNBC, the institution doesn't fully consider the funding trends and associated resources needed to support the changes in the trends over time. Historical funding data is rarely used to help determine where resources should be allocated. Further, historical labor data is not considered when trying to analyze where to allocate future resources. Therefore, the business objective we are seeking to achieve is to use historical funding and labor data, as well as forecasted data to allow for appropriate resource planning and allocations to support the research missions at UNBC. The business need is to develop the DVT that will present the data described above in a way that will allow for informed decisions to resource plan. The list of example requirements are listed below:

1. "Funding Tracker"

    o Historical research funding data at UNBC

        ▪ Internal vs External

    o Indirect costs of research associated with the funding received

    o Data on the types of historical funding successes (i.e. federal or industry sponsored)

    o Data on the trends of research disciplines

    o Research funding data by individual faculty

    o Research funding data by faculties

    o Applications submitted

    o Patents

2. "Labor Tracker"

   o Historical labor data reflecting how the research enterprise has been supported (both pre- and post-award supports)

   o By department

3. "Funding Forecaster"

   o Forecasting functions to analyze trends

Non-functional:

1. Appearance (user interface)

2. Performance (i.e. real-time data vs delayed)

Assumptions

A list of assumptions associated with the ability to address the key requirements can be found in Table 9.

Table 8. Assumptions associated with key requirements

Assumptions	It is assumed that:	Effects on investment:	Reliability Level: High/Medium/Low
Financial and Labor Data exists	The required data for the key requirements exists	The data is a critical piece for the investment.	High
Financial and Labor Data Availability	The required data for the key requirements will be available	The data is a critical piece for the investment.	High
Data utility for forecasting	The data will have utility for forecasting functions	This is critical given that this will assist in strategic resource planning	Medium
Funding for DVT	The funding to develop the DVT will be available	This is required to move forward	Medium

The assumptions outlined in Table 9 are important to layout given their importance to identifying the key requirements for the DVT. They are critical and if not addressed could compromise the development of the tool and ultimately impact the ability of the business need being met.

Specific constraints can place limits or conditions on the successful development and implementation of the DVT. These constraints are associated with, and have the most impact on the following:

- DVT utility

- Hard deadline

- Predetermined budget

- Subject matter expertise

- Contract provisions

- Privacy or security considerations

Constraints come from both internal and external factors, so it is critical to have capacity to identify constraints in order to avoid or mitigate any challenges in the roll-out of the DVT. Internal factors impacting the development and implementation of the DVT include, but are not limited to, the following:

Resources – having the appropriate resources, both financial and human, to gather the funding and labor data needed for the key requirements of the DVT. Further, these resources will also be needed to implement the DVT within UNBC's systems.

Expertise – subject matter expertise, both for the development and implementation of the DVT.

Business requirements – having the appropriate requirements and also gaining access to these requirements to develop the DVT.

Legal requirements – given there is data being used for the DVT, legal requirements need to be considered. Given that no sensitive data is being collected, there are no legal approvals needed to develop the DVT.

Facilities – UNBC is equip with the appropriate facilities to develop and implement the DVT. External factors impacting the development and implementation of the DVT include, but are not limited to, the following:

- Social factors

- Environmental issues or concerns

- Political reasons

- Economic factors

- Technological issues

There are multiple dependencies identified that relate to the overall business need, the requirements, or the solution. Table 10 highlights how the dependencies are associated with the DVT, specifically in enabling action.

Table 9. Dependencies associated with the DVT

Dependencies		
Dependency	**Element:**	**Is dependent upon [action] from [entity]:**
Data	Generating and gathering	Generating and gathering the financial and labor data is dependent on action from both human resources and finance staff

Now that the system requirements have been established, it is necessary to outline the system entities, which are "a person, place, thing or event for which data is collected and maintained" (Tilley & Rosenblatt, 2017). However, in order to identify the system entities, a data flow diagram (DFD) must be developed during the system analysis phase of the system development life cycle (SDLC). This stage of the development will provide a visual representation of the complex process that the system is meant to support.

Data Flow Diagram (DFD)

In order to fully understand the relationship of the research funding data, and the research support labor data flow, data flow diagrams (DFD) are shown below. DFDs graphically illustrate the general flow of data within the system, which allows the developers to characterize the system processes and how these processes facilitate the movement of data (Kendall, 2014). Kendall and Kendall highlight four key advantages to using DFDs, which include "freedom from committing it to the technical implementation of the system to early, further understanding of the interrelatedness of systems and subsystems, communicating current system knowledge to users through data flow diagrams, and Analysis of a proposed system to determine if the necessary data and processes have been defined (Kendall, 2014). There are four symbols that are used in DFDs which include a double square (entity), an arrow (data flow), a rectangle with rounded corners (process) and an open-ended rectangle that is closed on the left side and open on the right side

(data store). Figure 3 is a context diagram, which illustrates, at a high-level, the flow of data within the system.
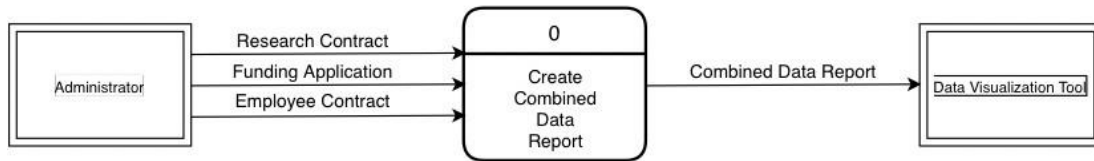

Figure 3. Context Diagram illustrating bird's-eye view of data movement

As noted in Figure 3, data inputs originate with an administrator (or researcher), which is then used to generate an electronic record to be used in the DVT. In addition to the research funding data per faculty, program/discipline and institution as a whole, data on the labor costs associated with supporting the research enterprise is critical to understanding the true costs to operate this business. For example, knowing the labor expenses associated with the number of applications processed within the Office of Research is useful data to determine the trends in the business operations. As noted above, post-secondary institutions in BC are funded by two key revenue streams, Provincial operating grants and tuition revenues. In order to advocate for additional research administration funding to either the province, or to Senior Leadership within the institution, one must have data on the true costs of business associated with labor. The UNBC DVT will capture research administration data associated with managing the research enterprise and will be captured according to Figure 4.
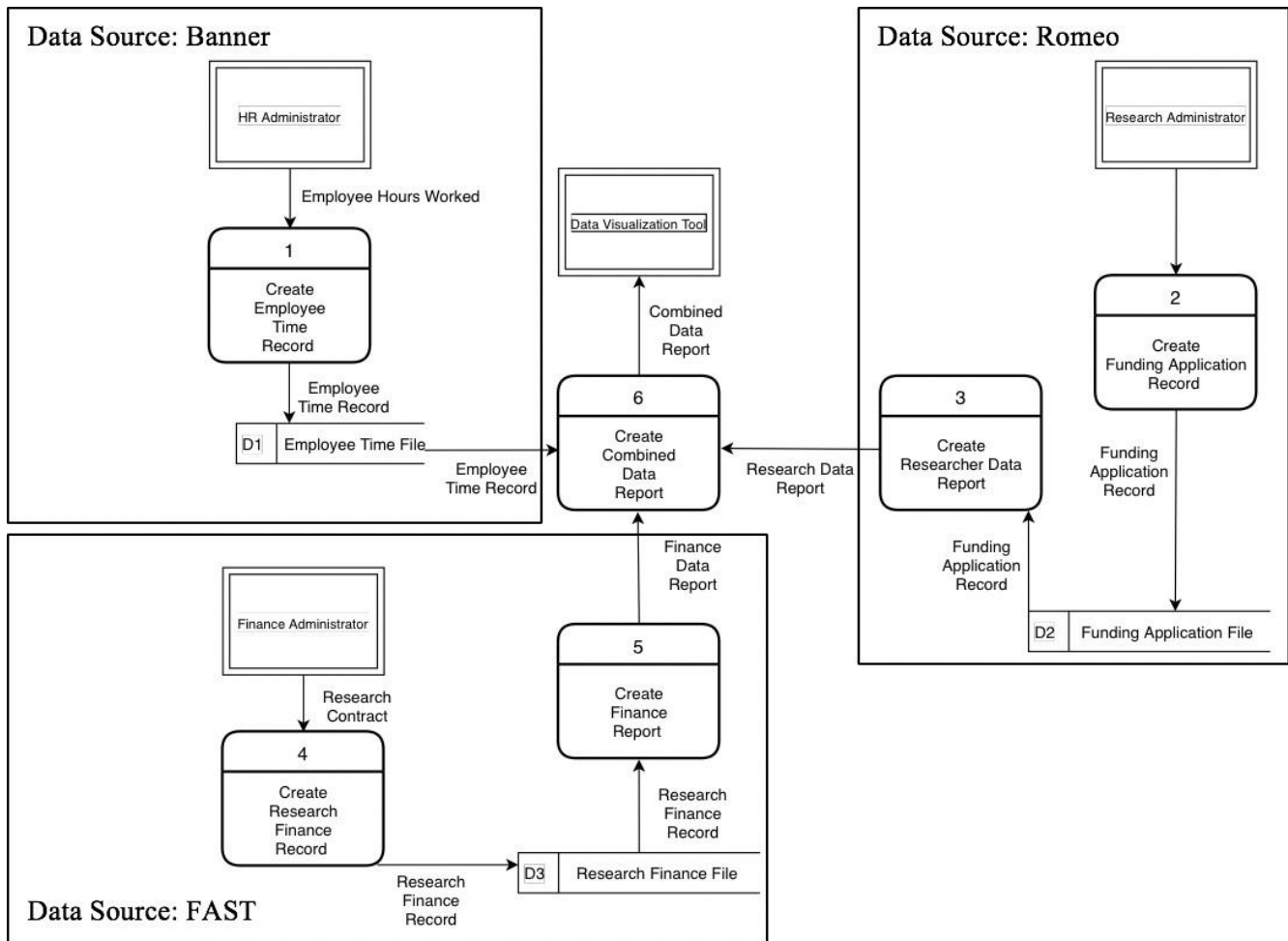
Figure 4. Diagram 0 of data flow movement within the system

Entity-Relationship Diagram (ERD)

As outlined in figures 3 and 4, the UNBC DVT will require data flow between various entities within UNBC. Some of these entities belong to the same operational unit or current customer relationship CRM software (e.g. Romeo, Banner, FAST Portal). Therefore, to gain a better understanding of the relationships between these entities, an entity relationship diagram was produced (Figure 5).

The entity-relationship diagram (ERD) can also be used to show the relationship between important entities within a system. ERD's, according to Chen *et al*., is an effective tool that can assist in the development of databases (Chen, 1976).
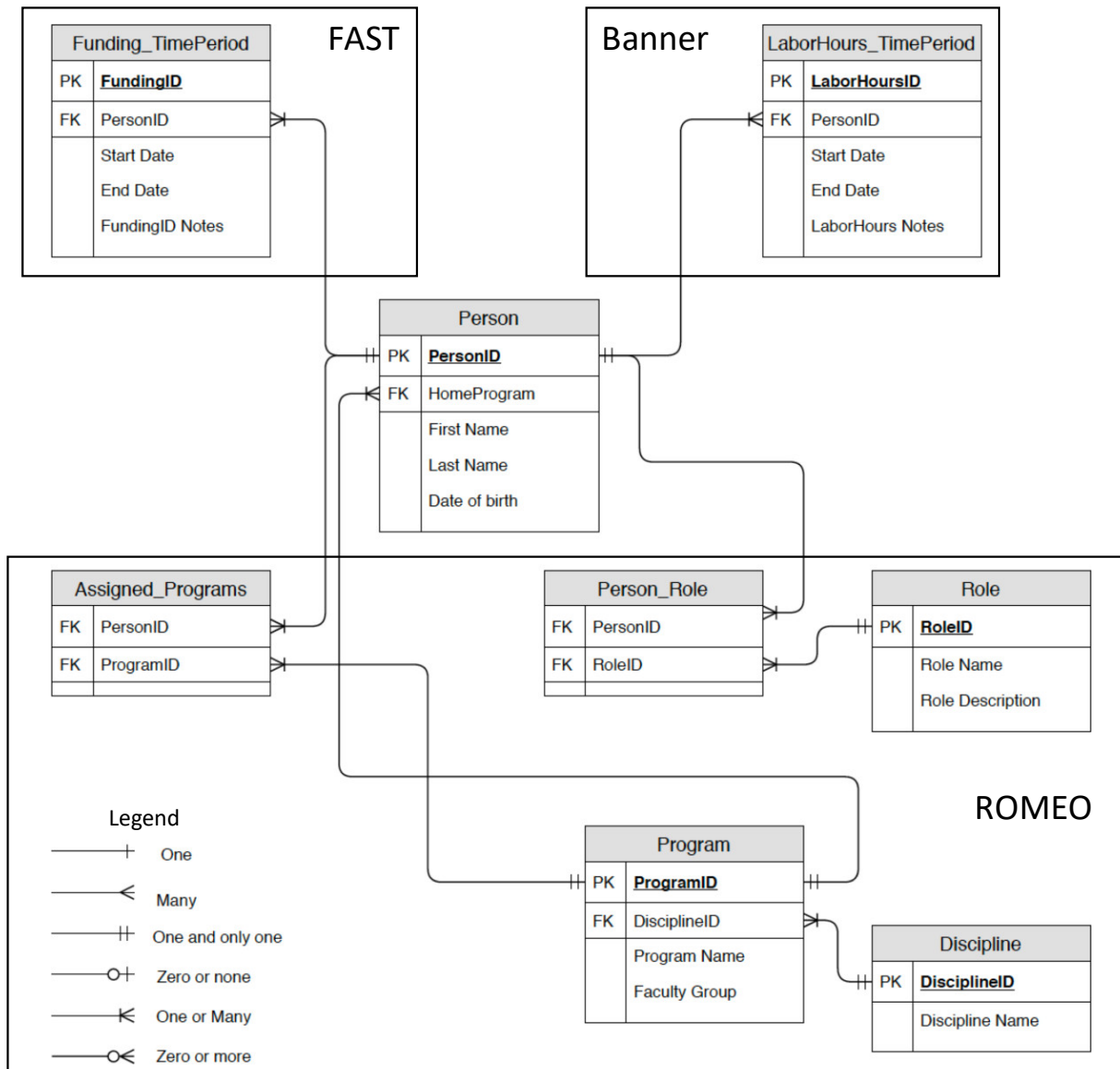
Figure 5. Entity-relationship diagram for UNBC DVT

As illustrated in Figure 5, the UNBC DVT consists of multiple entities that interrelate. In order to understand the flow of the essential data needed for the DVT, the highlights the relationship between the researcher, the discipline they belong to, the academic program they bellow to and the research funding number the researcher has secured for a specific project. From the researcher's perspective, they can belong to one (and only one) program and they program can have one or many researchers. The researcher can belong to one (and only one) discipline, but the discipline can have one or many researchers. In terms of the funding data, the researcher can have

one or many funding numbers, a particular funding number can belong to one (and only one) researcher. This flow of data, with the accompanying rules, is useful for the subsequent DVT developers to understand as this will set the rules for data collection. Details of each entity and also input/output information of data flows are highlighted in Table 11.

Table 10. Entity table

Entity Name	Entity Description	Input Data Flows	Output Data Flows
Researcher	Drafts and submits a research funding application	Research Funding Application	Internal approval notification
Research Administrator	Validates awarded funding	Funding details (amounts, payment schedule etc.)	Actual funding received
Romeo Funding System	Tracks funding application approval process	Application details	Complete funding application history
Data Visualization Tool	Collects and displays funding data	Final research funding data	Historical funding trends for researchers

Function

This section outlines the primary and secondary functions of the proposed Data Visualization Tool.

Primary Function

The primary function of the DVT will be to track and display UNBC Research Funding data, and associated indirect costs of research amounts.

Secondary Function

The secondary function of the DVT will be to track and display the labor resource data associated with the research enterprise.

Tertiary Function

Forecasting both UNBC Research funding growth and the associated research labor data will be a tertiary function of the DVT.

Overview of Forecasting Models

Given that both research funding and the associated labour data can be stochastic (i.e. can be random throughout the year) simple exponential smoothing (SES) is an appropriate method to utilize. Further, given that there is seasonality to the data, Holt-Winters forecasting method is appropriate to complement the SES forecasting (Dotis-Georgiou, 2019). This will ensure that both the random and regular data points will be captured and contribute to the comprehensive forecasting model.

User Interface

The user interface (UI) consists of all the components of the software solution, including the hard- and software, the features of the solution, the appearance of the solution and the "usability" of the solution (Tilley & Rosenblatt, 2017). The UI design is critical to the utility of the solution. If the solution is poorly designed and not intuitive, it may not have any value to the user (Pogue, 2016). Conversely, an intuitive, well-designed interface can provide opportunities for users to realize efficiencies which can assist in making complex business designs. Therefore, it is important that software solution designers have a good understanding of the human-computer interaction (HCI) in which they can build a foundation for a useful, workable solution.

The majority of IT professionals who develop UI's have come to a common conclusion in that there are seven core principles that should be considered when developing an effective UI. Below is a brief description of these principles (adapted from Tilly & Rosenblatt 2017): "Understand the business" – In order for the UI designer to effective create a useful UI, the

individual must understand the core business functions that are at the heart of the need to the business solution. Equally important is understanding how these functions apply to and interact with the various business units within the organization. As noted above, the core functions at the focus of the business solution relate to research administration, both the tracking of research funding data and also the labor needed to support the research infrastructure.

- "Maximize graphical effectiveness" – effectively displaying information in graphical form helps the users easily and efficiently analyze the data being presented. The DVT will use graphs and figures to display historical research funding trends and also the administrative labor that has supported the management of research funds over the years at UNBC.

- "Think like a user" – the designer should understand the point-of-view of the user and "put themselves in their shoes". This means using language and terminology that the end-user is familiar and comfortable with as this will again expedite the data analysis for the user. The UNBC DVT will use common language used within the research community and also research administration in an effort to enhance usability.

- "Use models and prototypes" – gaining feedback from the user during the design process is critical. The designer should work closely with their client to understand how their designs are being received by the end-user and whether they are appropriately addressing the needs of the user. One common methods of gaining feedback is to present prototype designs using "storyboards" which allow the users to visualize the prototype and provide any necessary feedback. At UNBC, the proposed designs will be shared with research administrators and also the Vice-President Research who is the ultimate end-user of the DVT.

- "Focus on usability" – as mentioned above, usability is key and will determine if the system has been effectively designed. It is important to ensure that all the tasks, commands and communications between end-users are built into the system. At UNBC, the critical research administrative units will be included in the design prototyping phase to ensure the users will utilize the tool effectively.

- "Invite feedback" – system design can be a dynamic process that does not need to end once the product is operational. Instead, soliciting feedback on how to improve, using agile development, will ensure the product is always advancing to further suit the needs of the user.

- "Document everything" – for future designers, prototype documents should be kept. Also, interactions with the end-users should be added to the designer's notes and retained for future trouble shooting efforts, as necessary.

In addition to considering the 7 principles of user interface development listed above, the UNBC DVT interface will align with the multiple reporting requirements that the University must report on for both internal and external purposes. For example, the VPR must report to Senate and the Board of Governors on the progress and success of the broader research community at UNBC. In terms of reports to Senate, information could include research award applications applied for and awarded based on per Faculty Member, Program and/or College. As UNBC transitions to the five-faculty model, these reports could include by Faculty as well. The Board of Governor reports tend to be at the higher level, for example, UNBC's total research funding success in the last quarter, last year or five-year trend. Both Senate and Board reports also could include the number of applications processed by the research administration staff and the current staff compliment that is supporting the research enterprise at UNBC. Regarding external reporting, UNBC must report

to the province and federal government on a regular basis for reports that include annual financial statements, Canadian Association of University Business Officer's reports and/or the Institutional Accountability Report. It is for these reasons that the UNBC DVT must align with these reporting requirements so that pulling research funding and labor data will be efficient and effective.

Below is a mock-up of the UNBC DVT. All the necessary information listed above is easily accessible and will help to resource plan for the research enterprise.
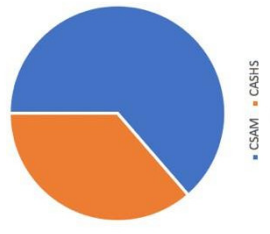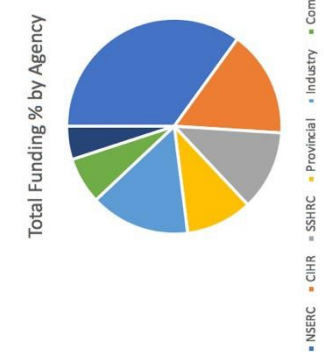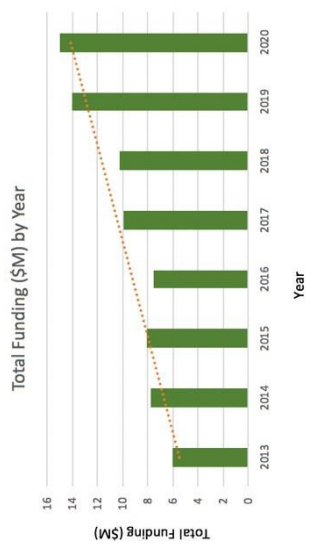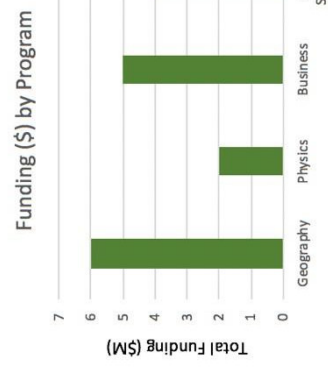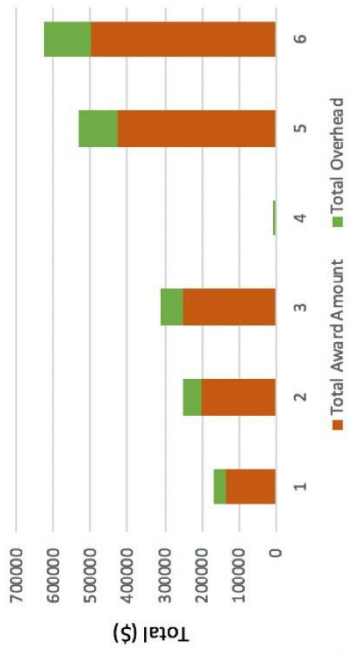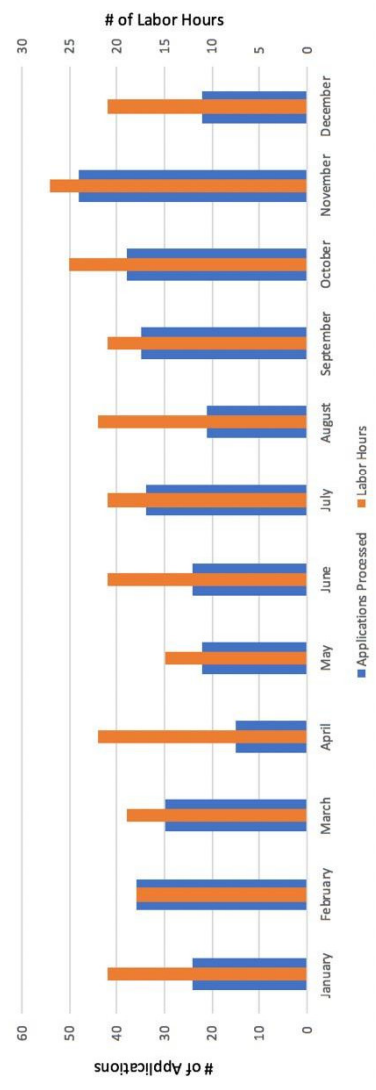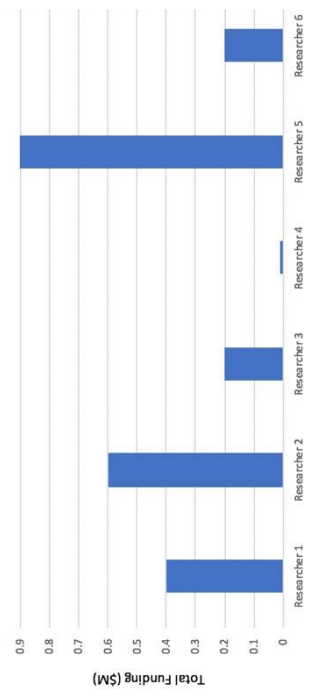
Figure 6. Mock-up user interface of the UNBC DVT

Section 5: Technical Specification (Design Document)

INTRODUCTION

Purpose

This software design document describes the architecture and system design of the UNBC Data Visualization Tool (DVT).

Scope

The scope of this investment is the following: build a DVT which will highlight historical/forecasted research income and research administration data.

In scope:

- Capturing and displaying labor data (research services staff, research finance staff, research contracts staff, human resources staff)

- Capturing and displaying research funding data (tri-council, non-tri-council, industry-sponsored)

Out of scope:

- Capturing and displaying student enrollment data

- Capturing and displaying student services labor data

Overview

This document will begin with a general system overview describing the functional features or the UNBC DVT, why the DVT is needed and also the proposed design.

SYSTEM OVERVIEW

The UNBC DVT will function to capture and display research funding data and labor data associated with the research enterprise at UNBC. For some context, the ever-changing research landscape, coupled with shrinking operating budgets to manage the research enterprise at UNBC requires due diligence for resource planning. The DVT will provide real-time information on the research funding received by UNBC Faculty, Programs and Colleges by funding agency. This data will be coupled with the associated research administration labor hours. The design, as described below, will include various tables and figures to present data in a user-friendly, logical way that will help to inform decision making and also enable easy reporting.

SYSTEM ARCHITECTURE

Architectural Design

The architectural design of the DVT is dependent on various entities that store the data needed to address the business need as outlined above. These systems include Romeo (UNBC research funding that will provide funding numbers by department), Banner (employee records system that will provide the labor hours data) and FAST (UNBC finance software that will provide research funding numbers by researcher and also research overhead numbers). Each of these systems need to communicate with each other as it is critical to share data between applications. However, these systems currently do not "talk" to each other, so middleware will need to be developed in order for the integrate the various platforms (i.e. using pulling data from the various platforms listed above). The ERD highlighted above outlines which individual platform houses the data needed for the DVT.

DATA DESIGN

Data Description

The DVT data will include historical research funding numbers by college, program, discipline, and researcher. The DVT will also capture and display labor data associated with managing the research funding information at UNBC.

Data Dictionary

Below is an alphabetical list the DVT system entities, as well as their descriptions.

Table 11. Alphabetical list the DVT system entities

| Entity Name	Entity Description	Input Data Flows	Output Data Flows
Data Visualization Tool	Collects and displays funding data	Final research funding data	Historical funding trends for researchers
Research Administrator	Validates awarded funding	Funding details (amounts, payment schedule etc.)	Actual funding received
Researcher	Drafts and submits a research funding application	Research Funding Application	Internal approval notification
Romeo Funding System	Tracks funding application approval process	Application details	Complete funding application history

HUMAN INTERFACE DESIGN

Overview of User Interface

The user interface is designed to make retrieving and visualizing research funding and labour data easily accessible for the user.
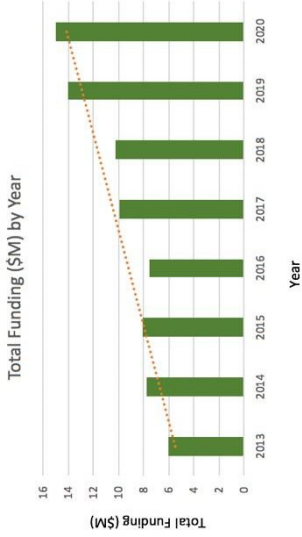
Screen Images
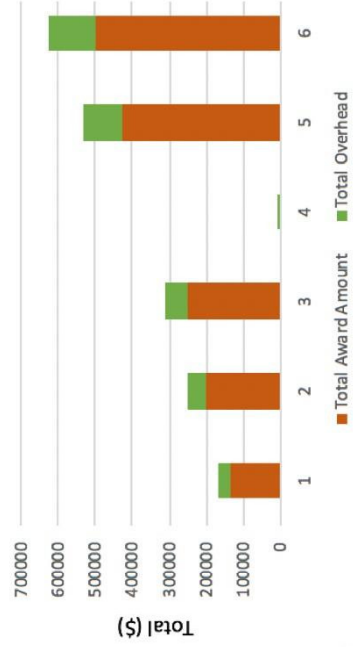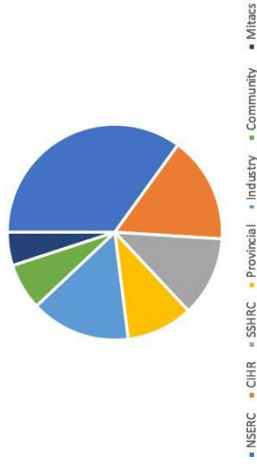
Below are screen images of the DVT.
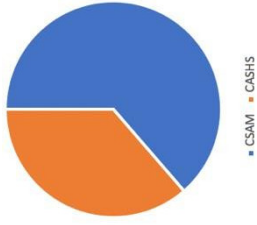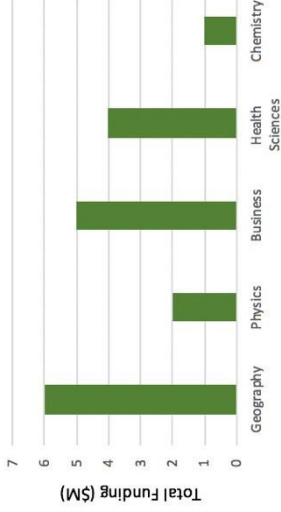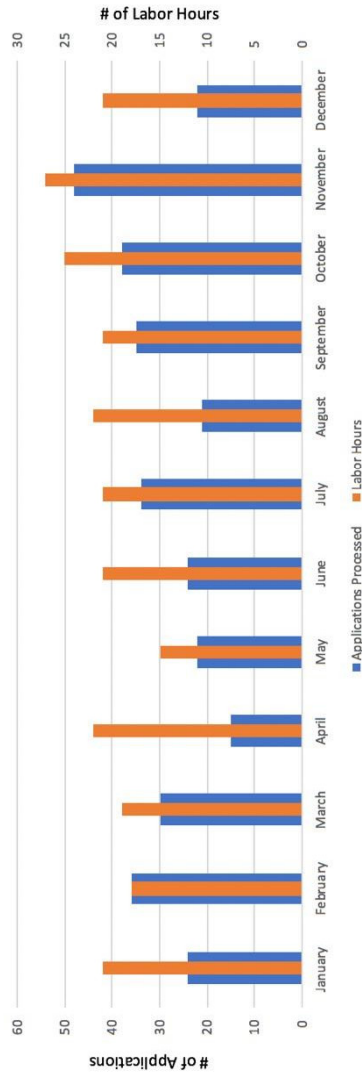
Figure 7. Mock-up user interface of the UNBC DVT

REQUIREMENTS MATRIX

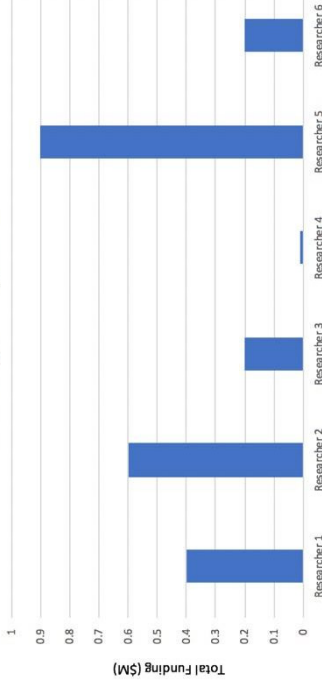Below is a tabular format of the system requirements to show which system components satisfy each of the functional requirements from the SRS. Refer to the functional requirements by the numbers/codes that you gave them in the SRS.

The list of example requirements are listed below:

"Funding Tracker"

- Historical research funding data at UNBC

- Indirect costs of research associated with the funding received

- Data on the types of historical funding successes (i.e. federal or industry sponsored)

- Data on the trends of research disciplines

- Research funding data by individual faculty

- Research funding data by faculties

"Labor Tracker"

- Historical labor data reflecting how the research enterprise has been supported (both pre- and post-award supports)

- By department

"Funding Forecaster"

- Forecasting functions to analyze trends

- Non-functional:

- Appearance (user interface)

- Performance (i.e. real-time data vs delayed

Section 6: Key Learnings

UNBC is a research-intensive university, that has seen a significant increase in research activities that requires additional resources (human, capital, financial etc.) Therefore, utilizing historical data to predict the necessary resourcing needs of the institution will allow UNBC to make strategic investments in research and remain competitive on the provincial, national and international stage. Informed decision-making when investing resources are critical to the success of any business.

Data can be used as a powerful tool to inform decision-making. The research enterprise at UNBC generates significant amounts of data (i.e. funding data, labor data etc.). To strategically invest in resources needed to support the research enterprise, this data can be used to understand the needs of the business. UNBC currently does not have a tool that will facilitate using research enterprise data to inform decisions around resource allocation to support the research enterprise. This MBA project explored the foundational steps to developing the UNBC Data Visualization Tool (DVT) that would allow individuals at various levels of the organization view important data that would inform decision making when allocating resources.

Firstly, a business case was developed. This is an important step that is required prior to making the decision develop the DVT as it must be financially beneficial to the organization, which the business case will reveal. Secondly, an analysis of the DVT requirements was done, followed by a review of the system architecture needs. This document can be used to work with a software developer to create the proposed DVT, which will enable UNBC leadership to have access to a tool that will allow access to important date prior to making decision around resource allocation.

Perhaps the biggest outcome of engaging in this exercise was my learnings around what information needs to be known in order to build or purchase a software tool. Investing in software

to gain intelligence about your business is often quite expensive, so selecting the right software to address a business need is critically important. Often times, I see individuals suggesting they need a CRM, for example, to support their business operations because they "need the data". However, individuals often do not explore the business case, do not fully understand the use cases that would explain how the tool could address the need, or whether the data even exists. This process has changed the way I analyze if an investment:

1. Makes business sense;

2. Will effectively address the business need;

3. Allow access to data, and does this data exist;

4. And, are the current systems compatible with a proposed software tool and if not, can middleware be used to make it work.

This is critically important to know before investing in any software tool.

Understanding all the inputs and outputs of implementing and developing and procuring an ERP system for a large organization is critical. *Why is this so important?* The wave of the future is data and data driven decision-making. Understanding how a piece of software can improve decision-making, can improve effectiveness and efficiencies within the organization's systems and, understanding which one of these solutions that can address the need is critical. There are many examples of large organizations that implement software systems before fully understanding why they're doing it or knowing if the solutions addresses the business need or the answers the questions they are truly asking or if it will provide the organization with the data needed to make decisions. Hundreds of thousands of dollars, even millions of dollars are spent on these systems and if the goal of the organization is to build a sustainable business model, certainly organizations with limited resources, need to be sure that the decision to implement a piece of software has to

make business sense. This was the biggest learning for me. I originally thought I would have a tool I could use, but in fact, I developed a deeper understanding of the process around what it takes to source a piece of software. Understanding use cases, understanding entity relationships within the systems, and understanding what infrastructure the organization has that may need to interact with the new piece of software has be quite insightful.

It's been an incredible learning opportunity for me. When working in healthcare, it seemed as though I was in a meeting every week watching a presentation about a new software solution being developed or implemented, but there was often little clarity on whether the system would address a need. I have also witnessed this in the education sector where I've been part of many meetings about implementing a new CRM and ERP, but there is little clarity around if the proposed systems would address a need. Finally, it is important to know who in the organization should drive the strategy for data collection and analysis and also the system(s) that will be used to create a business intelligence platform. Having the knowledge to source large software systems could potentially save significant resources, which allows an organization to be strategic with their investments. The wave of the future is data and we need software to house data in a single location so that it can be used to inform decisions making. It is critical, however, that the software one chooses will address the needs of the business.

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