Institutional Analysis & Research (IAR) engaged in a discovery process, with the support of Computing & Communications Services (CCS), to guide the development of an institution-wide data strategy, to support data-driven decision-making based on accessible, comprehensive, and reliable sources of information for academic and administrative data.

The data strategy program defines a future state for institution-wide data and analytics, including data governance and data management.

* Data can be defined as raw, unorganized facts that need to be processed. Once processed, organized, structured or presented to make it useful, it is called information. Though there is a distinct difference between data and information, the word ‘data’ has been used to be interchangeable in this document to represent both data and information.
User stories included in this document reflect comments made by stakeholders during focus group meetings. Slight editorial revisions have been made to user quotes to ensure clarity and readability.
The Case for an Institution-wide Data Strategy
Current Situation

- U of G is using a cumbersome model for institutional data delivery, reporting and analysis.
- For the most part, distribution of data are through “one-off” reports, multiple extracts, and file transfers directly from source systems.
- Heavily administrative approach to accessing data resulting in a stakeholder “queue” with wait times.
- Data are prevalent, expanding in volume, velocity and variety, and often unsecured.

Effect

- Takes too long to get data for decision-making, and data are often outdated once received (i.e., for the originally intended purpose).
- Creation of hundreds of silo and shadow databases and systems (resulting in data duplication).
- Manual effort for aggregation and data cleaning resulting in longer turnaround times (>50% longer).

Associated Risks and Impact

- Data security and privacy risk.
- Decision-making based on inaccurate, unvalidated, and/or untrustworthy data.
- Inability to track performance and success of programs/services.
- Poor data quality and lacking ‘sources of truth.’
- Operational inefficiencies and redundancies.

“We are creating our own positions in the Colleges to manage our data because we have no other choice.”

“These are critical decisions we are making for the institution, without the necessary information.”

We are creating our own positions in the Colleges to manage our data because we have no other choice.

These are critical decisions we are making for the institution, without the necessary information.
Institutions of higher education are operating in an increasingly complex and competitive environment… due to pressure to respond to global and national economic, political and social change. The decisions required for dealing with these rapid changes are complex and can indeed be made if the vast data sources were made available to those entrusted to make relevant and timely choices.

- Dr. Ben Daniel, Big Data and Analytics in Higher Education: Opportunities and Challenges

**Vision**

**Data that are:**

- Easily accessible
- Readily available
- Usable
- Understandable
- Timely
- Trustworthy
- Consistent
- Standardized

**Ideal State**

*Putting quality data in the hands of decision makers in a secure and timely manner, thus enabling faster, more effective, and evidence-based decision-making at the University of Guelph.*
Benefits of the Data Strategy

Strategic Benefits

- Support University strategic planning and competitive advantage.
- Improve financial performance and planning.
- Determine the impact of University programs/services on student outcomes.
- Provide proactive risk mitigation (identifying students at risk, etc).

Administrative Efficiencies

- Reduce manual processes (e.g., combining spreadsheets, emailing requests for information, etc.).
- Reduce costs in creating and storing ‘new’ data—currently the same data are being collected and stored multiple times.
- Reduce the strain on business area resources, which are currently providing one-off reports/extracts; potential for reallocation of resources.
- Reduce number of reporting systems for sustainability and consistency.
- Reduce system design and integration efforts for better interoperability and exchange.
- Reduce time to develop business requirements for IT projects.

“How many students who applied to U of G as their third choice actually attend here?”

“My assistant counts the number of people in each course and creates a chart for me to let me know how are they tracking.”
"We received data and it was all wrong and didn’t match what we had, likely because we are all using different definitions."

"We’re pulling data from a variety of different places and piecing it together."

**Benefits of the Data Strategy**

**Improved Data Governance and Data Management**

- Improves confidence in data through improved data quality, consistency and standardization (‘single source of truth,’ data dictionary, consistent interpretation of definitions).
- Reduces risk with clear data security, privacy, and data accountability policies (controlling access, use, etc.).
- Increases ability to respond to change and events (e.g., government policy, funding opportunities).
- Provides framework for central data.

**Centrally Harnessing Data**

- Improves availability and access to data by providing ‘one-stop’ and self-service access to data, thus empowering staff and faculty.
- Reduces duplication of data, create a central ‘source of truth,’ reduce shadow systems, integrates local data sets with master data.
- Provides data aggregation across systems, functional areas, and the institution based on business needs.
- Provides timely access to data.
- Enables reuse of data to answer new questions.
- Provides comprehensive insights to strategic questions, with the ability to analyze data that describes all aspects of the subject.
Benefits of the Data Strategy

Potential Cost Benefits

- Better decision-making, for example:
  - Increased student retention, enrolment, and success;
  - Improved financial management; and
  - Improved staff and faculty recruitment and retention.
- Reduced project costs
  - Data governance/management will enable a standardized and quality approach to data and analytics, resulting in less rework on projects, enabling their completion on time and on budget.
- Fewer reporting systems, resulting in less hardware, software, and maintenance costs.
- Staff efficiencies, resulting in human resource cost savings, improved workplace wellness and less absenteeism.
- Improved return on investment (ROI) with self-service data delivery, which can improve ROI by 188% by cutting out manual data manipulation and manual reporting, saving time and reducing errors.
- Operational savings due to new data insights across the institution:
  - Reduced infrastructure costs
  - Sharing technical components
  - Less duplication
  - Lower training costs

“Student flow-through—starting from application rates, to numbers accepting offers, to numbers that show up in September, to numbers that are still here on the 40th class day, to retention rates—is critical to assess demand, and how students are making decisions.”
Current State Analysis & Business Needs Assessment Results
In Scope

All institutional data that are created, stored, or transmitted by (or on behalf of) the University, in the management and operation of teaching, research, learning, service or business activities, AND

- Are important for planning, managing, operating, staffing, documenting, or auditing of one or more major administrative functions; OR
- Are used in an official report; OR
- Are used to fulfill obligations such as compliance, accreditation, government stipulation, and quality assurance; OR
- Are used to derive any element that is outlined above.

Out of Scope

- Data created or used in the conduct of research.

We need to see data about achievement of learning outcomes, student grade data by student, course, and program, so that we can enable student success.
**Evaluation Focus**

The process for building this data strategy plan focused on evaluating:
- The current state of data stores and tools used for reporting/analytics.
- Business needs and priorities of academic and key administrative areas as they relate to data and analytics.
- The approach used by other post-secondary institutions, that were considered to have attained maturity in this area.
- The exploration of potential technical architecture options by utilizing the University’s subscription to Gartner, engaging with Gartner IT research professionals, and utilizing their comprehensive reports.

**Research and Engagement**

The analysis included engagement with the following:
- Broad University stakeholders/groups via:
  - U of G focus groups (27)
  - Multiple one-on-one interviews and discussions (25+)
  - Online feedback surveys
  - Data Advisory Committee input (20 participants, advised on data strategy plan, six meetings from May to November)
- Gartner research professionals for their expertise and extensive research.
- Universities across North America (15 institutions, focusing on those considered advanced in data strategy and governance).
- Best practices and respected resources ([DMBOK](http://dama.org), [dama.org](http://dama.org), [dataversity.net](http://dataversity.net), [Higher Education Data Warehousing Forum](http://Higher Education Data Warehousing Forum)).
Academics and Research as Key Drivers

The analysis process was guided by using an Enterprise Information Framework best practice as outlined by Gartner research with academics and research (business) setting direction for the data strategy. The framework will also be a guide for implementation.

"The data strategy will be driven by our community with a primary focus on the academic side (Colleges). You are our core mission, and if you do not have the data you need to do your jobs—to set up programs and courses, to track progress—then we have more work to do."

- Project Co-Sponsor:
  Karen Menard,
  Assistant Vice-President
  Institutional Analysis & Research
The data strategy will align with the strategic priorities of the University.

Broad stakeholder engagement included mostly senior leadership from the academic and administrative areas that would be most impacted. A full list of University of Guelph stakeholder groups/departments engaged in this process can be found on the IAR website. Stakeholder input was gathered based on questions provided to each group, as outlined on the next page. Participants were also asked to share their top three data/analytics priorities.

Figure 2: Aligned Priorities
Discovery Process

Academic Leadership Focus Group Questions:

• What are the types of reports/information you need for management analysis and decision-making? And for what purpose?
• How are you currently accessing/acquiring the data you need for reporting?
• What is already going on within your organization/college related to data/analytics that we might be able to leverage?
• Do you have any current operational/institutional reporting needs that are not being met today? Any other data challenges?

Administrative Area Focus Group Questions:

• What are your business priorities/needs as relates to data/analytics?
• How are you currently accessing/acquiring the data you need for reporting? What systems/tools are you using?
• Where are the requests to your office for data/analytics coming from? What type of information is being requested?
• How are you currently delivering your reports/data? Which tools are you currently using?
• What is already going on within your organization related to data/analytics that we might be able to leverage?
• Do you have any current data/reporting needs that are not being met today? Any other data challenges?
• Do you have any current policies/procedures in place related to reporting? Please explain.
### Stakeholder Needs Assessment Results

## Academic Areas

### Data Requirements:

- Student enrolment
- Student application/admissions
- Course level/enrolment
- Research
- Partnerships
- Financial
- Human resource/personnel
- Graduate studies
- Scheduling
- Facilities
- External sources
- Awards and scholarships
- Accreditation
- Faculty/academic staff activity
- Student grades/learning outcomes
- Student flow-through

### General Data Needs:

- Real-time information
- Historical trends
- Self-service
- Usable
- Aggregated
- Searchable
- Accurate
- Understandable (context)

### Purpose of Data:

- Quality/program improvement
- Course planning/selection
- Human resource planning/allocation of resources
- Curriculum/program development
- Student recruitment
- Student awards planning
- Institutional space planning
- Benchmarking/performance
- Research support
- Student retention/success
- Financial planning and performance indicators
- Teaching performance/productivity
- Strategic enrolment management
- Research funding opportunities
- Alumni progression
- Learning tool assessment
- IQAP/CPR (Institutional Quality Assurance Process, Cyclical Program Review)

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“We need to know which students are not meeting the minimum threshold of 60% for our course so that we are better able to guide them.”
Stakeholder Needs Assessment Results: Academic Areas

Academic Data Priorities

Data Governance  Retention and Graduation  Finance  Student Enrolment  Resource Management  Research  Course Enrolment  Research Financials  Comparative Data

Student Flow-through  Asset Management  Facilities  Learning Outcomes  Survey Data  Scholarships and Awards  Data Access  Technology

Data Security  Budget  Human Resources  Data Quality  Accreditation  Research Partnerships

Faculty  Alumni  IQAP  Staff

Figure 3: Priorities for Academic Stakeholders

“I need to see summary data for student, HR, research, & finance in order to measure College performance.”
**Stakeholder Needs Assessment Results**

## Administrative Areas

### Data Requirements:
- Teaching, research, service activity
- Fundraising results
- Endowment results
- Student enrolment
- Human resource data
- Student demographics
- Financial data support

### General Needs:
- Data governance
- Data definitions
- Data quality
- Daily operations data (transactional)
- Data management
- Aggregated/holistic data (student, faculty)
- Better system-to-system integration & data feeds
- External data
- Identity management
- Central support (reporting tools, data analysis)
- Self-service reporting

### Purpose of Data:
- Impact of donations
- Fundraising results and focus
- Evidence-based budgeting
- Auditing government reporting
- Employment equity
- Faculty/teaching staff performance
- Bargaining/negotiations
- Program/service management
- Compliance with AODA (Accessibility for Ontarians with Disabilities Act)
- Risk management

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“Increasing the standardization and consistency of data through a data dictionary would assist our clients in understanding and using data correctly.”
Figure 4: Priorities for Administrative Stakeholders

“ We need clear policies on who can access what student information and for what purpose they can use the information. ”
### Summary of Current State Challenges

<table>
<thead>
<tr>
<th>Data Access</th>
<th>Inefficiencies</th>
<th>Analysis &amp; Reporting</th>
<th>The “Right” Data</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Unable/difficult to acquire data needed to make decisions (variety of reasons)</td>
<td>• Significant manual efforts to deliver reports: emailing spreadsheets, creating, receiving, and distributing extracts</td>
<td>• Multiple analytics and reporting tools being used institution-wide (n=7)</td>
<td>• Data are not being received in timely manner (systems can’t deliver)</td>
</tr>
<tr>
<td>• Only limited staff can access various central systems</td>
<td>• Frequent manual efforts across the institution to combine or aggregate data in Excel, Access or SQL for desired reporting &amp; analytics</td>
<td>• Lack of university-wide tools and reporting/analytics expertise</td>
<td>• Some data are simply not being collected due to:</td>
</tr>
<tr>
<td>• No central repository to store or access data for aggregated reporting (i.e., no institutional data repository or enterprise data warehouse)</td>
<td>• Drain on resources to maintain shadow systems and parallel databases</td>
<td>• Difficulty aggregating and analyzing information obtained from multiple internal areas</td>
<td>• Limitations of systems</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>• Reluctance to even ask the questions to collect the data</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>• Uncertainty regarding what data they should be collecting (questions that may come)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Lack of Confidence in Data</th>
<th>Other Challenges</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Lack of trust in data so reluctance to get data from “the centre”</td>
<td>• Lack of knowledge of data governance (data governance maturity)</td>
</tr>
<tr>
<td>• Lack of metadata—where collected, what it means, how to interpret</td>
<td>• Evidence based budgeting—need evidence to ask for budget, but unable to provide data needed to support</td>
</tr>
</tbody>
</table>
## Summary of Current State Challenges

<table>
<thead>
<tr>
<th>Data Privacy and Security</th>
<th>Business System Issues</th>
<th>Data Quality</th>
<th>Strained Resources</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Lack of policy—who should be collecting data, who should see what data, what actions they can take with the data</td>
<td>• Integrity—lack of confidence in information so academic areas keep their own data</td>
<td>• Lack of standardization and consistency of data (no data dictionary, lack of defined standards for fields in business systems, numbers do not match, no context around data)</td>
<td>• Colleges—limited time and resources to search, compile, analyze—need summary tables, information ‘at their finger tips’</td>
</tr>
<tr>
<td>• Lack of accountability—who ‘owns’ what data, and who should be making decisions around it</td>
<td>• Lack of integration among systems (disparate ERP—Enterprise Resource Planning systems, no large ERP)</td>
<td>• Data duplication</td>
<td>• Administrative areas—spending time creating &amp; distributing reports often as ‘one-off’ requests</td>
</tr>
<tr>
<td>• Confidential data being collected and stored w/o proper protections in shadow systems</td>
<td>• No database built or available to support system reporting (e.g., Colleague uses live system extracts)</td>
<td>• Multiple shadow systems</td>
<td></td>
</tr>
<tr>
<td>• Some data have no responsible person (e.g., who teaches what courses, student diversity data)</td>
<td>• Poor effectiveness of current systems primarily due to age and/or capabilities (e.g., “no idea what numbers mean,” “not sure if you are balancing or not”)</td>
<td>• Same data being collected multiple times across the institution in various business systems</td>
<td></td>
</tr>
<tr>
<td>• Difficult to audit and verify sources of information</td>
<td>• Some business systems are being augmented/customized unnecessarily to achieve reporting needs</td>
<td>• Some units creating their own central data repository (duplicating information from the centre)</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Weak feedback links to improve data quality at the source systems</td>
<td></td>
</tr>
</tbody>
</table>
Current State of Data at the University of Guelph

Based on the results of the discovery process, a high-level illustration of the current state was developed which highlights some of the key data challenges at the University of Guelph.

Source Systems | Data Stores | Reporting Tools | User Access
--- | --- | --- | ---
Numerous source systems, cloud-based & on-premise | De-centralized shadow systems & in-house-built reporting applications (100s) | Limited central data repositories | Multiple reporting/BI tools with no optimization
Disparate ERP systems (HR, Finance, Student) | Manual ETL Processes | System-focused access vs. U of G role-based access
Some customization/integration of source systems to enable aggregated reporting | No Centralized Institutional Data Warehouse | Frequent data aggregation & reporting done manually in spreadsheets | Limited staff access to core central systems

Most reporting is direct from source systems

Lack of Data Governance, Master & Metadata Management, Limited Privacy & Security, etc

Figure 5: Current State Architecture © CCS/IAR - University of Guelph, 2019
There are several opportunities to leverage current data strengths and successes within the organization and beyond. These include:

• Leveraging existing campus data success efforts (unit data mart’s, data governance practices, etc.) (For example, OVC has a six-person decision support team that has identified actionable savings and efficiency opportunities);

• Partnership opportunities (For example, sharing Hadoop/data lake architecture with zoning for other areas, like research, records management, library, other universities, etc.);

• Re-aligning and leveraging existing institutional data talent (staff);

• Leveraging and supporting in-house teaching and resources in colleges (For example, the School of Computer Science faculty and students are involved in big data and data governance research);

• Extend use cases beyond reporting and analytics (data archiving, cold storage, data integration such as standard APIs to serve operational applications, etc.);

• Continue to build on work IAR has started, central institutional data portal—“one-stop” shop for institutional data, expand access to U of G public data (fact book, website), exploration of existing business system data sources; and

• Leverage this data solution as a mechanism to support the migration/upgrade of existing business systems, e.g., mapping data of retiring systems to the new solution, providing an environment for replication and/or archival of business system data.
A Data Advisory Committee met during 2018 to review the data strategy.

Committee Mandate:
Review and provide guidance and input to the development of the overall vision of the data strategy, specifically around data governance and data management.

Chair:
Karen Menard, Assistant Vice-President, Institutional Analysis and Research

Co-Chair:
Dave Whittle, Associate Vice-President and Chief Information Officer

- Zack Baker, Executive Director, Budget and Financial Planning
- Laura Beaupre, Director, Research Analysis & Reporting, Research
- Susan Brown, Professor, College of Arts
- Graham Brown, Assistant University Secretary & Privacy/Judicial Officer, Secretariat
- Malcolm Campbell, Vice-President, Research
- Rozita Dara, Professor, School of Computer Science
- Ray Darling, University Registrar, Office of Registrarial Services
- Cate Dewey, Associate Vice-President Academic, Provost Office
- Amanda Etches, Associate University Librarian, Research
- Michelle Fach, Director, Open Learning & Educational Support
- Heidi Huisman, Manager, Finance & Administration, College of Business & Economics
- Kristin Ingoldsby, Privacy/Judicial Officer, Secretariat
- Melissa Jutzi, Director, Total Compensation, Human Resources
- Lori Kimball, Associate Vice-President, Finance
- Scott Moccia, Information Officer, Ontario Veterinary College
- Vanessa Myers, Manager, Finance & Administration, College of Biological Sciences
- Murray Perkins, Chief Internal Auditor, Audit
- Byron Sheldrick, Associate Dean Academic, College of Social & Applied Human Sciences
- Mary Wells, Dean, College of Engineering & Physical Sciences

Resources:
- Tegan Anselmini, Data & Reporting Specialist, Institutional Analysis & Research
- Ruth Butlin, Director, Enterprise Applications, Computing & Communications Services
- Ann Cesar, Senior Project Manager & Business Analyst, PMO, Computing & Communications Services
- Olesya Kotlyachkov, Data & Reporting Specialist, Institutional Analysis & Research
- Rob Heenan, Manager, Government Reporting & Data Products, Institutional Analysis & Research
Proposed Ideal
Future State
Proposed Ideal Future State

Scope of Future State:

The data strategy will support business needs identified for reporting and analytics and will also support other non-analytics requirements such as:

• Archival and storage of historical data;
• Storage of data as per FIPPA and legislative requirements;
• Storage of both structured and unstructured data; and
• Supply standard data feeds and APIs (application program interfaces) to meet operational requirements.

The ideal future state of data at the University of Guelph would be to provide an enterprise-level data management solution for operations, reporting, and analytics, to ensure institutional data are managed and used as an asset.

Elements Required to Achieve Future State

| 1 | Data governance and data management operating model; |
| 2 | Organizational model for data roles and responsibilities; |
| 3 | Modern enterprise data architecture; and |
| 4 | Data reporting and analytics operating model. |
The future vision includes establishing a data governance operating model and data management framework.

Data are valuable institutional assets requiring care and due diligence. As such, providing broader access to data in the absence of data governance policies could pose risk to the institution.

Policy development and enforcement will ensure the proper access, handling, and management of data at U of G. It will also address current inefficiencies, such as duplicated requests for data, redundancies in hardware, software, and personnel resources, and the creation of shadow databases. Policies will also need to address data consumers roles, type and level of data required and associated risks of access at various levels, impact to system performance, and the quality of source data.

Figure 6: Data Governance
**Data Governance and Data Management Operating Model**

**What is Data Governance?**

The capability enabling an organization to determine authority, control, and shared decision-making over management of data assets, including items such as:

- Designated decision-making body;
- Formal data dictionaries and processes;
- Individuals designated as data owners, stewards, etc.;
- Technologies that can enforce data governance; and
- Principles, policies, and guidelines for improving data quality and protecting data.

Institutional Analysis and Research, in partnership with data stewards, will define and lead data governance and data management at U of G, accepting the following responsibilities:

- Leading the creation of an institutional data governance and management policy;
- Leading the creation of an institutional data management framework, based on existing best-practice frameworks (tactical for the policy);
- Leading the creation, storage and maintenance of metadata (glossary, data dictionary, etc.);
- Logging University data stewards, data custodians, etc.;
- Collecting, aligning, and implementing policies from stakeholder groups;
- Assisting with classification of data (sensitivity, value, etc.);
- Providing information and guidance related to data-oriented IT projects; and
- Articulating value and purpose of data governance and data management, as well as information advocacy.

“**If we (Colleges) had access to the data ourselves, we could analyze it ourselves.**”

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University of Guelph Institutional Data Strategy
Data Governance Organizational Model

Figure 7: Proposed Data Governance Organizational Structure
The proposed structures to support data governance are outlined in this section.

**Data Governance Steering Committee**

- Senior leadership responsible for planning and policy development for institutional data.
- Decision-making group responsible for overarching policy approval.
- Responsible for prioritization of data initiatives.
- Committee will include: AVP IAR, CIO, lead data stewards, data management/data governance lead, key business unit heads.

**Data Governance Advisory Committee**

- Provides advice, oversight, and influence over data-related issues.
- Consists of qualified, influential data ‘expert,’ staff appointed from different business and IT units that regularly manage data.
- These individuals must understand data issues and bring their data perspectives to the committee.
## Data Governance and Data Management Operating Model

### Functional Area Working Groups

- Functional (subject area) working groups are proposed, which would align with a University functional data map, and consist of lead data stewards, custodians, and subject matter experts (SMEs) for each of the functional subject areas (Finance, student, faculty, Human Resources, etc.).

- Examples:
  - Open Learning and Educational Support and Registrar working together to align student data.
  - Faculty and Staff Relations and Human Resources working together to align employee data.

- Propose data procedures and standards to data governance committees based on functional/subject area.

- Align business and data perspectives.

- Focus on collaboration to define reporting terms, gathering metadata, build data knowledge for their subject areas as opposed to only their department/unit (i.e., break down silos).

- Focus on policy management, business rules, and data quality.

### Data Consumers

- Individuals who receive data on a regular basis.

- Active participants in setting the definitions for data to ensure usability within their business processes.

- Follow policies on data management and access.

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*If the data was in a centralized data portal, I would know where to look and could access the information I need when I need it.
“There is a richness of data that we don’t have, data which would allow us to dig deeper. Who is doing what research? How many other faculty are doing similar work? This data would help to tell a story and we are not capturing it.”

Data Governance and Data Management Operating Model

Data Stewards

- Individuals who own business accountability for a set of data assets, which includes Lead Data Stewards chosen by functional/subject area (e.g., research, student, finance, etc.).
- The point of contact for questions about the data definitions, use of the data, and are knowledgeable about existing processes and carriers of institutional knowledge about data in their custody.
- Create, manage, and define metadata and definitions.
- Document and guide policies, procedures, and guidelines related to the data in their custody throughout the data life cycle.

Data Custodians

- Persons who own technical accountability for a set of data assets. Often IT-focused staff (e.g., database admins, ETL/integration admins, data system/application admins).
- Maintain data in accordance with the requirements and policies defined by data stewards.
- Protect rights for access, processing, maintenance, storage, protection, destruction, etc.
U of G Data Map

- A data map is a data and business process classification scheme that provides an outline of data governance within an organization.
- An interactive U of G data map would outline the functional area working groups and help direct user queries. Benefits of the data map include:
  - Providing consistency in defining and classifying data;
  - Guiding data users/consumers to the appropriate data representative to discuss questions regarding data governance;
  - Providing interactive and drill-down capabilities for more granular information about data stewardship, custodianship;
  - Helping with setting boundaries related to data accountability and responsibilities, identifying authoritative sources; and
  - Helping to classify business processes.

Figure 8: Example data map

Note: ‘Master data’ are data that overlap between business areas
For internal use only

Data Management Framework

Data management involves the tactical execution of the policies set out via data governance.

Data management is a term that describes the processes used to plan, specify, enable, create, acquire, maintain, use, archive, retrieve, control, and purge data. In other words, it describes an information asset’s complete life cycle.

The development of an overall data management framework, to coincide with data governance, will ensure a standardized approach for each data set identified for tactical development and implementation.

Current frameworks such as those published by dama.org (left) could be used as a starting point to create a U of G data management framework.
Data Governance Maturity Assessment

Data governance implementations can only proceed as fast as the organization’s data maturity allows. There are many maturity assessment tools that can be used to help plan and sustain a data governance program, including assessment of the current state of data governance and setting modest goals toward a future state.

Since the full implementation of a data governance program is multi-year, intermediate states can be used to construct a program roadmap.

The maturity model is made up of levels, with each level describing states of the organization. Continued tracking of results can help measure effectiveness of a data governance program over time.

The maturity assessment tools provide several statements/criteria with which to evaluate an organization’s data governance maturity.

“Data quality would ensure we are able to report official numbers for government and compliance purposes.”
Gartner suggests planning data strategy with “particular attention to maturity indicators one or two levels above your current level of maturity.”

Gartner’s Enterprise Information Management Maturity Model, Gartner ID G00289832

Data Governance Maturity: Preliminary Self-Assessment Results

This graph illustrates the results of our self-assessment of U of G’s data governance maturity using Stanford’s Data Governance Maturity Model Basic Maturity Assessment Score Card.

The University’s overall data governance maturity was self-assessed as between level 0-2 out of a possible 5 for all components of data governance related to capabilities, people, and policies. For example, Formalization of Data Governance People has a score of 1, which equates to “There are no defined roles related to data governance.” A score of 5 in this category would equate to “Data governance organizational schemas are filled as defined, meet regularly and document activities.”

Figure 10: U of G Governance Basic Maturity Assessment—Current State
An Institutional/Central Data & Analytics team is proposed, which would be fully dedicated to the data program and would work collaboratively with other areas across the University as data priorities dictate.

De-centralized supporting resources, roles and skill sets across the institution will be required at various points depending on the data initiatives/projects in progress and especially at the start of the program.

Figure 11: U of G Model for Data Roles and Responsibilities
Centralized Roles and Skill Sets

There are many different types of roles and skill sets required to successfully execute the data strategy at U of G. With the rapid pace of change in the data landscape, both with technology and big data, the positions in big data are continually changing and evolving.

Central Data & Analytics Lead

- Holds a senior role and is often identified as the Chief Data Officer.
- Responsible for driving the overall data strategy.
- Leads overall data and information governance.
- Leads overall business process change to effectively support data needs.
- Champions and communicates the value of analytics, data as an asset, data governance, and data operations.
- Helps overcome cultural barriers regarding the proprietary use of data and adoption of the broader data governance model.
- In some higher education institutions this is the Institutional Research or Institutional Data & Analysis lead.

Data Governance Lead

The Data Governance Lead will be a key liaison between the functional and technical areas.
U of G Model for Data Roles and Responsibilities

- Leads and sustains data governance and data management efforts.
- Leads awareness and training programs for stewardship activities, and analytical and reporting tools.
- Leads the creation of a data management framework (technologies and processes that enable data governance).
- Leads the acquisition of data governance tools as needs dictate.
- Leads user acceptance and quality assurance efforts (ensuring data quality).
- Establishes standards for data stewards related to task execution and communication.

Enterprise Data Architect

The Enterprise Data Architect will work in partnership with technical areas.

- Architects the overall data warehouse and data management solutions.
- Develops and maintains an overall architecture for current and pipeline data that effectively captures, integrates, organizes, centralizes and maintains data.
- Defines strategic data requirements, guides integration of data assets, and aligns data investments with business strategy.
- Guides development across systems, such as common reporting, enterprise application integration and data warehousing initiatives.
- Leads Extract, Transform & Load (ETL) and ELT integration practices and standards.
- Leads data modeling practices.
- Assists with data architecture development (i.e., data staging, data ingestion, data architecture testing, ETL).

The data team may be structured in a fully centralized manner or in virtual way.
**U of G Model for Data Roles and Responsibilities**

### Data Strategy Applications/Tool IT Administration

- Supports and maintain the applications that are acquired for the Data Strategy program, such as Business Intelligence (BI) and reporting tool support, data governance tools, etc.
- Provides application/service design—plan service, implement service, understand business needs for service, plan operating model.
- Configures and supports applications
- Documents, communicates, and trains.
- Provides account and permission provisioning, etc.

### Data Integration Analyst/Engineer

- Responsible for the acquisition, extraction, loading, movement, ingestion, replication, synchronization, etc. of data coming from multiple sources to the data warehousing and data management solutions (modern ETL—data engineering).
- Provides best practices and techniques for achieving consistent access and delivery of data across the institution.
- Automates the manual aspects of data loading, ensuring data quality, etc.
- Works with integration solutions (data visualization, ETL) and with data modeling and IT.
- Responsible for the amalgamation of data from multiple sources, data movement, and big data infrastructure.
U of G Model for Data Roles and Responsibilities

Data Modelers

• Develop data into a structure that is ready for analysis, including testing and maintenance.
• Model data (analytical and operational), creating models of data sets, including for NoSQL.
• Provide context and coherent structure to data.
• Work closely with data integration.
• Prepare and architect data.

Data Analysts

• Interpret data for business insights.
• Evaluate data—running reports, customizing reports, conducting queries, data quality.
• Create data visualizations and dashboards.
• Analyze statistics.
• Provide training to business units on the creation of dashboards, etc.
• May evolve to Data Scientists as data maturity evolves.

Resourcing levels may vary based on demand from institutional priorities.
De-Centralized Supporting Roles & Skillsets

De-centralized supporting resource roles and skillsets across the institution will be required at various points depending on the data initiatives/projects in progress.

**Business Unit and Academic Area Support**

*It is recommended that there be horizontal (business process), as well as, vertical (subject/functional area) experts available.*

- Data Stewards (data governance roles, including data custodians if applicable).
- Business Area Data Analysts (as needed) (Gartner refers to these as Citizen Data Scientists).
- Business Subject Matter Experts.
- Business Process Analysts.

**IT Infrastructure & Services Support**

*Depending on the delivery type and architecture of the enabling technologies chosen and their implementation approach (Cloud, Managed Services, etc.), the following areas of support will be needed at various times throughout the implementation, and during initial startup:*

- Data Custodians (see Data Governance).
- Infrastructure support (data systems, server and administration support, storage, processing, etc.).
Modern Data Architecture

A Logical Data Warehouse (LDW) architectural approach is proposed, that meets the following criteria:

- Agile, scalable, reliable, with the ability to flex based on business needs;
- Modular analytics platform, connect & collect; and
- Provides a self-service approach for business operations and decision-makers.

The proposed warehouse consists of three key components:

1. Data repositories
2. Data virtualization
3. Distributed processing

We will take a cloud-first approach to the implementation with a focus on availability, reliability, scalability and security.

- Project Co-Sponsor:
  Dave Whittle,
  Associate Vice-President and
  Chief Information Officer
Logical Data Warehouse - Technical Capabilities:

- Uses data federation and distributed processing (data federation means aggregating data from distributed data sources/business systems that are providing the original data collection).

- Proposes having a decoupled universal semantic layer that goes across the institution’s business systems, which maps complex data into common business terms. This allows for data abstraction so that data are represented consistently even if business systems are moved or replaced behind the scenes (often delivered using virtualization).

- Employs metadata as a foundational aspect (metadata are information about the data collected—the what, where, why, when, and how—essentially, it helps an organization understand its data).

Data Development Streams

Using a Logical Data Warehouse, there are three complementary streams for data development, depending on the business need including:

1. Data warehousing stream
2. Agile stream
3. Data lake stream
Modern Data Architecture

1) Data Warehousing Stream

The data going through this stream must be accessible, well understood, and trusted. Users will make use of these data for tactical and strategic decisions about the business.

Agreement among users regarding type and use of these data:

- Structured data;
- Data model;
- Assured quality;
- Relevant to variety of users; and
- Historical data for long-range analysis.

Use case: Student enrolment data, both current and historical

2) Agile Stream (Data Virtualization, Agile Development)

This stream provides users with the ability to deal with urgent issues by recombining or adding to other data.

- Fast development.
- Combine data to deal with urgent issues.
- Encourages self-service.
- Primarily utilizes data virtualization and virtual data marts.
- Reuse/augment existing data.
- New data combinations.

The Logical Data Warehouse architectural approach proposes that data and information flow through the appropriate development stream and storage type depending on the use case and requirements.
Modern Data Architecture

3) Data Lake Stream

- Offers users access to new data sources internally or externally.
- Large scale unstructured and structured data.
- Enables agility by storing data until it is needed.
- Access to new data sources.
- Experimenting area.
- Ability to be prepared for unknown/new questions.
- Uses Extract Load Transform not Extract Transform Load, applying schema after requirements and value known.
- Can be used for staging, archival, support for operational applications.
- Data in lake can be classified and zoned as raw, structured, curated, consumer, operational (data serving operational systems, etc.) and/or by area, academic, research, etc.

A modern data architecture may include the use of a data lake, for which the uses cases at U of G would be vast:

- Eliminate data silos;
- Simply store data for some as-yet-undetermined future use;
- As a staging area, prepping for data warehousing, analytics; and
- For historical and archival.

Gartner suggests “Adopt Logical Data Warehouse patterns because they ‘future proof’ your analytical landscape. Design the overall architecture, even if you initially only implement a subset of components.”

Gartner ID G00342254
This graphic was published by Gartner, Inc. as part of a larger research document and should be evaluated in the context of the entire document. The Gartner document is available upon request from https://www.gartner.com/home.

Figure 12: High-Level LDW Architecture
The future state data architecture for the University will look something like this illustration with centralized repositories, data governance, 1 or 2 optimized reporting tools and a universal semantic layer with role-based access.

**Source Systems** | **Information/ Data** | **Data Stores** | **Reporting Tools** | **User Access**
---|---|---|---|---
Source Systems, Cloud & On-premise applications | Unstructured Data | Metadata, Raw Data, Aggregate Data Structured & Unstructured | Reports, Dashboards, Queries, Analytics (optimized) | University role-based access

**Figure 13:** Potential Future State Architecture © CCS/IAR - University of Guelph, 2019
The technology landscape for enterprise data architecture is broad and rapidly changing. The capabilities of the required technologies for U of G are listed below. There are technical solutions available that cover most, if not all of the capabilities required, and these include both cloud solutions and fully managed (on-premise) options.

The technologies should be implemented incrementally based on the use cases and priorities defined, as well as on the natural evolution as the data strategy matures.

**Technical Requirements for U of G Enterprise Data Architecture Solution**

- A central repository for structured and unstructured data.
- Semantic layer (separate layer, sometimes referred to as business interface layer).
- Distributed processing.
- Data analytics and reporting tools (1-2 tools).
- Data governance and data management capabilities.

**Data governance and data management capabilities include:**

- Metadata management ("data about data"),
- Master data management,
- Data integration,
- Data quality,
- Self-service data prep,
- Data modeling, and
- Data security.
Examples of Data Technologies

Note: Not all tools will be needed for initial implementation. Implementation of new technologies will be based on business needs and data governance maturity.

Central Data Repository

Master Data Management

Universal Semantic Layer

Data Integration

Analytics & Reporting Tools

Data Query

Metadata Management (Data Catalogue)

Data Prep & Analysis (Data Science ML)

Data Modeling

Other resources include:

Matt Turck’s Big Data Technology Landscape (Matt Turck, Demi Obayomi and FirstMark Capital) and Magic Quadrant for Data Management Solutions for Analytics (Gartner, February 2018).

Gartner also has many other Magic Quadrants for each capability area that can provide a sense of popular tools on the market.

Figure 14: Technology Landscape - Some examples of popular tools in each domain
The future state for reporting and analytics is an integrated model that is available to a broader stakeholder group. It includes various data sets and addresses reporting needs. Ideally, U of G would implement and support 1-2 reporting tools to be used institutionally, with IAR leading the implementation and training of the selected tools.

For this strategy, and to guide future prioritization of data reporting activities, reporting at the University can be broken into three areas: Transactional, Operational, and Institutional/Strategic Reporting, as illustrated in the diagram on the next page of this report.

### Elements Required to Achieve Future State

#### Data Reporting & Operating Model

<table>
<thead>
<tr>
<th>Transactional Reporting</th>
<th>Operational Reporting</th>
<th>Institutional/Strategic Reporting</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Basic reporting from transactional tables in business systems.</td>
<td>• Reporting required by the operational area management (Colleges/ departments/units) to make decisions.</td>
<td>• Official reporting for government, compliance, funding, rankings, public dissemination, etc.</td>
</tr>
<tr>
<td>• Designed to understand what is going on at this moment, or ‘real-time’ data.</td>
<td>• Used for operational planning and decision-making.</td>
<td>• Often is an aggregation of data across the institution and helps monitor progress toward a specific target (e.g., a performance indicator).</td>
</tr>
<tr>
<td>• Required to run the day-to-day operations.</td>
<td>• Usually run at a point in time and are often summarized data.</td>
<td></td>
</tr>
</tbody>
</table>
Data Reporting & Analytics Operating Model

Current State
- Lack of availability and access to desired reports from stakeholders
- Central portal with limited access to data
- Inefficiency - IAR doing manual effort collecting, cleaning, understanding data
- Lack of standardized and consistent data

Future State
- Delivery of data through data portal/self-service using BI tool
- Summarized and cross-unit/function reporting and analytics, drill-down reporting
- Quality/cleansed data from transactional and operational sources

Report Examples
- Cross-sectional & summarized analysis of information from Transactional and Operational
- Strategic Planning
- Government Reporting
- Accredidation reporting
- Enrolment over time
- Retention Rates
- Internal & External Audit

Current State
- Using Excel & Access/SQL databases
- Some units have built data marts, duplicating central data
- Inconsistent access to systems of record
- Systems used for unintended purposes
- Multiple reporting tools

Future State
- Delivery of data through central data portal/self-service using analytical tool
- Summarized and cross-system reporting and analytics for analysis and insight
- Centrally available data sources with timely access to information

Current State
- Current business system issues (data integrity, data ineffective, time to delivery)
- Multiple reports sent to consumers vs. some self-service
- Some data sharing agreements in place
- Overall lack of integration between systems

Future State
- Consumer self-service for day-to-day reporting needs
- Delivery of data to systems through standardized APIs
- Clear reporting needs from business areas

Figure 15: Data Reporting & Analytics Operating Model
Proposed Implementation Plan
Data Strategy Program
Implementation Approach

A new Data Strategy Program is proposed to enable decision-making and support the strategic goals of the University.

The program plan would be continuously and iteratively defined to ensure the goals and objectives of the program provide ongoing support for the most pressing institutional strategic goals and priorities.

Implementation Core Principles

1. Use-case and business requirements-led approach
2. Iterative, incremental
3. Agile analytics approach: focus on the early and continuous delivery of business value throughout the development life cycle
4. Ensure strategic data, analytics, and governance needs of highest priority are always addressed
5. Aim to ensure every iteration produces at least one new user-valued feature
6. Build platform over time not all upfront (not waterfall)
7. Balance between complexity, value, risk, etc.
8. Acquire > Organize > Analyze > Deliver
Proposed Implementation Plan: Implementation Approach

**Insitutional Strategic Goals Identified**
- The Data Strategy will align with the strategic goals of the institution

**Align Data Priorities to Strategic Goals**
- Program priorities would be of two types:
  1. Delivering data products (dashboards, reports, etc.); and
  2. Maturing data governance
- Prioritization of data initiatives would be based on the needs identified through stakeholder engagement and with guidance from the Data Advisory Committee, and decision-making Data Steering Committee
- A standard framework assessing each initiative based on the value proposition of each by:
  1. Effort
  2. Impact (by mapping to the University Strategic goals and objectives)
  3. Risk

**Develop Program Goals and Objectives (by year)**
- The program goals and objectives would be determined based on the priorities identified
- Program objectives would be SMART (specific, measurable, attainable, relevant, and timely)
- A data governance maturity assessment will be used to guide the data governance objectives

**Develop KPIs (Success Metrics)**
- Key performance indicators (KPIs) will be developed for this program during the agile implementation
- Program will be evaluated over a specified time in relation to identified standards or targets
- These would be linked to strategy and performance and will be based on factors such as:
  - Achievement of use cases
  - Adoption/usage
  - Data quality
  - Reliability of solution, etc.

**Execute (Agile Analytics Projects)**
- Agile execution
- Each project/use case sponsored by Lead Data Steward for area and managed by project manager who works with small team of data stewards, SME, technical staff and business to define and implement the following, as dictates:
  - Business glossary
  - Metadata management
  - Data quality requirements
  - Master data management
  - Data governance
  - Data ingestion/migration
  - BI/reporting needs
  - Conceptual, logical and physical data model
  - Data integration requirements
  - Architecture and design
  - Security and regulatory compliance

Figure 16: Proposed Implementation Plan: Implementation Approach
Organizational Change Management for Data Governance
Implementation Success

The implementation of data governance will be a transformational change for U of G. It involves changes in culture, processes, and policies. It requires that people change the way they think about how data are used and accessed.

The recommended strategy for managing this change will be to:

- Deal with the obstacles to data governance;
- Ensure the program supports strategic objectives;
- Consider the full impact of the change;
- Prepare stakeholders; and
- Engage stakeholders.

Common Obstacles to Data Governance

- Competing priorities
- Lack of cross-unit coordination
- Lack of data governance awareness
- Resistance to change
- Data ownership, territorial issues
- Lack of resources
- Impact on existing resources
- Personnel changes
- Aligning business and IT functions
There will be 3 main implementation road maps that will run in parallel and be aligned to meet the program objectives identified.

**Data Governance Implementation: Foundational & Agile Data Governance and Data Management**

1. Governance roles & structure
2. Identify core technologies to support data governance
3. Training: core and sustained
4. Policies: data governance standards
5. Data governance program

**Technology Implementation: Enabling Technology Based on Business Needs**

1. Future state overall architecture
2. Plan & resources
3. Reporting & infrastructure technologies
4. Data lake planning zones
5. Metadata management

**Data Projects Implementation: Agile Data Projects/Implementation Based on Use Cases**

1. Determine priorities
2. Implement data project #1
3. Implement data project #2
4. Implement data project #3
5. Implement data project #4

These projects may take place concurrently.

Figure 17: Data Strategy Program Implementation Road Map
The Data Strategy at U of G is defined as a program, not a project. While a project is usually chartered to create specified “deliverables” as efficiently as possible, this program will focus on the coordination of several related projects and other activities over time to deliver benefits to the University. It is estimated that the time line for this program to reach a relatively mature state is approximately five years.

Note: An updated time line will be made available throughout implementation on the program website.

<table>
<thead>
<tr>
<th>2017</th>
<th>2018</th>
<th>2019</th>
<th>2020</th>
<th>2021</th>
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<tbody>
<tr>
<td><strong>Centralized Data Portal</strong></td>
<td><strong>Proof of Concept</strong></td>
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<td><strong>Discovery/High-level Planning</strong></td>
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<tr>
<td><strong>Communication</strong></td>
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<tr>
<td><strong>Training: On-boarding for core team</strong></td>
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<tr>
<td><strong>Implementation - Data Projects</strong></td>
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<tr>
<td><strong>Planning (use cases, user stories)</strong></td>
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<tr>
<td><strong>Implementation - Data Governance &amp; Data Management</strong></td>
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</tr>
<tr>
<td><strong>Foundational Data Governance</strong></td>
<td>(data governance committees, tools to support, training)</td>
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<tr>
<td><strong>Implementation - Technology</strong></td>
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</tr>
<tr>
<td><strong>Determine/Validate Future State Architecture</strong></td>
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</tbody>
</table>
Identified Risks

This is a large complex program with many factors that may cause the program to fail to meet its goals.

**Risks of doing**

- Research shows high failure rates on analytics, BI, and big data projects, for a variety of reasons, including:
  - Failure to understand business needs
  - Lack of executive support
  - Failure to address the change needed in culture (transformational change)
  - Inability to make all key data available for central harnessing
  - Resourcing constraints (centrally and de-centrally), with five other large campus IT projects utilizing same key resources
  - Providing broader data access without proper data validation mechanisms in place

**Risks of NOT doing**

- Continued (and possibly increased) vulnerability to data security and privacy compliance
- Sharing of inaccurate information for decision-making
- Continued resource constraints and redundancy of resources
- Decisions made without accurate information
- Perpetuation of shadow IT systems/databases/tools and associated increased costs
- Inability to remain competitive
Risk Mitigation

- Clear business case and implementation approach based on extensive research and stakeholder engagement.

- Program is being proposed based on a strong partnership between IAR and IT with business needs leading the priorities for implementation.

- Data and program governance (PMO checks, creation of data governance is core to the implementation plan—adopt core principles at the start of implementation).

- Culture change—Change alignment plan running in parallel to encourage buy-in.

- Strong support of sponsors and executive leadership.

- Agile iterative implementation approach—reviewing tangible deliverables frequently and adjusting priorities accordingly.

- Adopting technology solutions and architectures that are cost effective, can scale gradually and provide agility to adapt to changing needs.

- Resourcing will be strained in the early stages, but efficiencies should be gained over time with the ability to redeploy from data compilation tasks to data analysis, and through identified business process improvements.

- Some of the required data resources, such as an Enterprise Data Architect, may be difficult to acquire due to market demand. Consulting will be judiciously considered to effectively ensure a modern data architecture approach. The ideal will be training our own personnel in modern data architecture for ongoing sustainability.

- Ensuring proper data management practices are delivered throughout the implementation, so stakeholders understand the data, its proper use, etc.
Recommended Next Steps
### Recommended Next Steps

1. **Begin Implementation of Data Strategy Program**: Future state by outlining 1st-year program objectives (using data maturity assessment) based on strategic program goals identified, validated scope, and prioritized data use cases/projects for implementation (based on the Discovery phase data collected from stakeholders).

2. **Determine Overall Enterprise Data Architecture based on Defined Scope & Develop Technology Implementation plan**. Hire an Enterprise Data Architect to determine and validate the overall data architecture based on the defined scope for the institution and begin to map out a plan for technology implementation which aligns with data priorities.

3. **Data Governance Planning and Implementation**: Hire a Data Governance Lead to implement foundational data governance principles and practices, including establishing some quick wins for data governance and the development of an agile plan for data governance and data management implementation.

4. **Create a Change Alignment Plan**: Given the transformational change involved in this project, with the help and participation of the Data Advisory committee, form an Organizational Change Team to create and execute a Change Alignment Plan which would run in parallel with the program plan.

5. **Identify & Align Data and Analytic Talent** institution-wide and define organizational requirements to implement a new data and analytics operating model.

6. **Conduct an Institution-wide Data Inventory and Assessment to Safeguard Confidential Data** similar to that of Cornell. We recommend that this would be a separate initiative and, since the focus would be safeguarding confidential data, this might best be lead by the IT Security office.

7. **Document Data Life Cycle and Data Flow Across the Institution** in addition to identifying business process ownership. This will help to define how data are captured/created, stored, used, shared, archived, and destroyed, and will enable data governance maturity.
References/Resources

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