Deloitte.

Winnipeg
Water and Waste Department

Water and Waste Department Business Intelligence and Analytics – Phase 1

Future State and Gap Analysis

January 11, 2019

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Executive Summary

Journey to Date

Inputs from current state interviews and future state workshops were combined with Deloitte's industry expertise and best practices to define City of Winnipeg Water and Waste Department's (WWD) future state vision.

09 Divisions | **35** Domains | **25** Interviews | **74** Hours | **33** Stakeholders | **950** Pages | **02** Workshops

Current State Milestones

- Conducted current state workshops comprised of 9 divisions, 33 stakeholders, and 25 interviews
- Collected current state BIA findings across Strategy, People, Process, Data, and Technology domains
- Delivered current state assessment report highlighting current BIA ecosystem, key BIA observations across divisions, and WWD's challenges

Future State Milestones

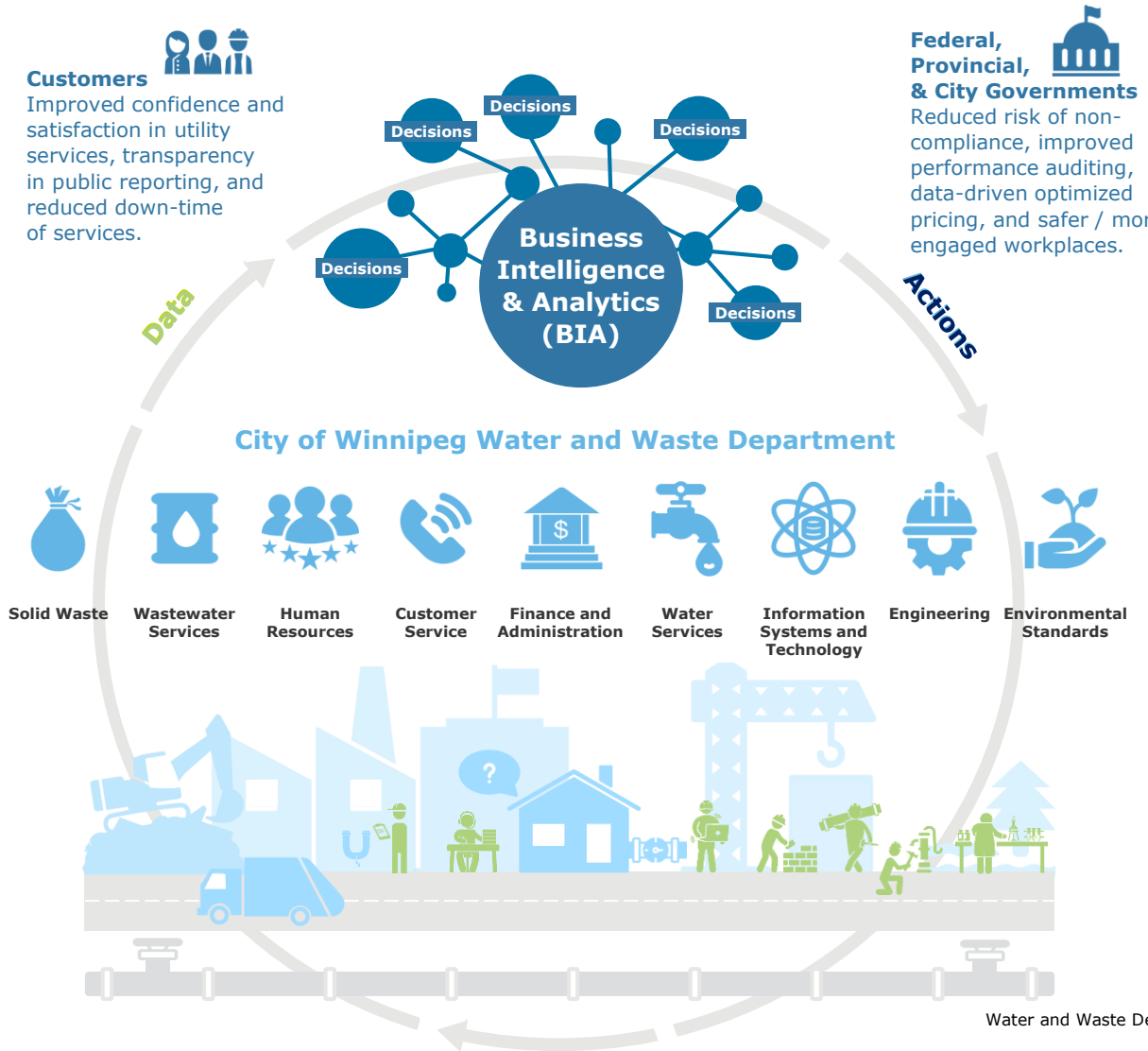
- Conducted an "art of the possible" workshop to introduce new and innovative BIA concepts and ideas for WWD
- Identified and prioritized "crunchy questions" for each division that laid the groundwork for action
- Demonstrated agile techniques and prototypes to increase divisions' understanding of agile delivery processes

Turning City of Winnipeg Water and Waste Department into a Utility of the Future

WWD can leverage BIA to gather insights regarding services offered and make better fact-based decisions to realize synergies, minimize costs, and deliver greater value for customers.

INCREASED REVENUE & COST REDUCTION

- **Reduced maintenance cost** through greater visibility over assets' net worth, depreciation, and insurance and maintenance costing
- **Lowered cost of meeting water demand** by optimizing water pumping and storage operations based on demand forecasts and known input cost factors
- **Better-managed landfills** though efficient landfill client services, contained revenue losses, and price modelling by leveraging historical landfill transaction information
- **Decreased lost revenue** through optimized water meter management
- **Increased late payment recovery** through prediction and preemptive action



OPTIMIZED PROCESSES

- **Efficient and predictive repair, replacement, and maintenance** of assets
- **Reduced safety incidents** with help of insight-driven front-line staff deployment based on safety risk predictors computed through a multitude of data on work orders, past safety incidents, safety inspections, etc.
- **Easier dissemination of water and wastewater quality data** to external and internal stakeholders through self-serve capabilities and enhanced data validation
- **Enhanced technology services delivery** through greater visibility over IT assets, data assets, and investments in technology

IMPROVED SERVICE

- **Minimized disruptions** through leveraging asset information and past breakdowns to reduce unplanned maintenance
- **Ability to predict and preempt customer needs** by analyzing past customer inquiries
- **Increased automation of inquiry handling and processing** by analyzing customers interactions with MyUtilityBill portal

What is the value of BIA to WWD divisions?

Divisions have immediate ideas on what critical business questions i.e., crunchy questions, need to be addressed to optimize performance, improve citizen confidence, and more.

CRITICAL BUSINESS QUESTIONS THAT BIA CAN ANSWER FOR WWD

Water Services
- What is the impact of turning off a water-main valve?
- How do we optimize operations of pumping stations and distribution system assets to minimize the impact of transients?
- How do we prioritize work allocation for Water Services crew resources to maximize benefit (i.e., how do we prioritize between meter exchanges and turn-offs for non-payment and water main repair)?
- What are the collective financial implications of a given work order and how can we leverage this information to forecast future costs/effort?
- How do we reconcile differences between budgeting, HR planning, collective agreements, and financial resource planning?

Solid Waste
- How do we optimize landfill management in terms of guiding services, controlling revenue loss, and modelling pricing?
- How can we predict cart damage and replacement (asset planning)?
- What is the most cost-effective way to record assets (carts) to ensure accuracy?

Engineering
- How do we optimize asset maintenance practices to maximize efficiency and reduce costs?
- How can we predict water main renewal work required beyond 1 to 2 years?

Across WWD
- Are we competitive compared to other utilities?
- How can we drive innovation and leverage technology trends like the "Internet of Things" (IoT) in our strategy and planning processes?
- Can BIA change the service model (i.e., Demand Management / Elastic Supply)?
- How do we provide a consistent customer experience?
- How do we enhance monitoring of compliance?
- How to use data to drive best practices for council decisions?

Customer Service
- What proportion of Utility Billing Center calls have been diverted to the MyUtilityBill portal?

Human Resources
- How do we reduce incidents and injuries to improve health and safety at the workplace?

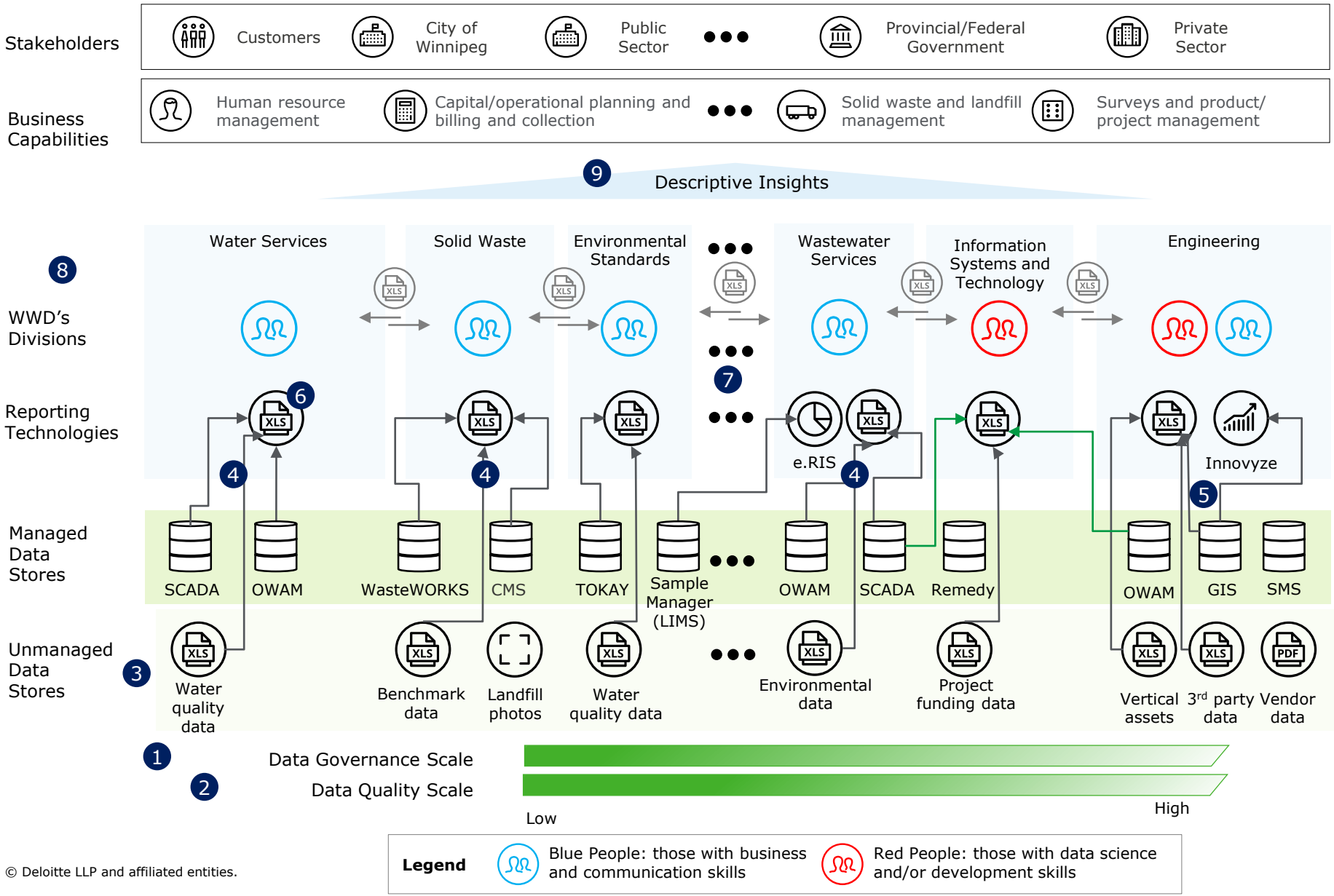
Information Systems and Technology
- How can BIA insights help with capability planning?
- How can we measure success and feed back actual costs for future estimates?

Environmental Standards
- How do we ensure data is sent to end users efficiently in a usable and meaningful format?

Wastewater Services
- How can we use asset information (including maintenance) in conjunction with external influences (e.g., climate) to make optimal decisions?
- How do we go from >50% to 0% unplanned maintenance?
- How do we prioritize maintenance efforts?
- How can we predict and avoid dry weather overflows?
- How do we track and prioritize media and councilor requests?
- How can we improve spending tracking to ensure alignment to budget?

Finance and Administration
- Can we predict customer payment behavior, i.e., which customers will fall in arrears?
- How do we optimize meter population?
- How can we identify unaccounted water including its theft (based on factors such as water consumption, meter age, and inspection date)?
- How can we consistently develop our cost of service rates process (thereby making the process less subjective and less ad hoc)?
- How can we improve water meter reporting accuracy (consumption)?
- How do we ensure we are billing for all services provided?

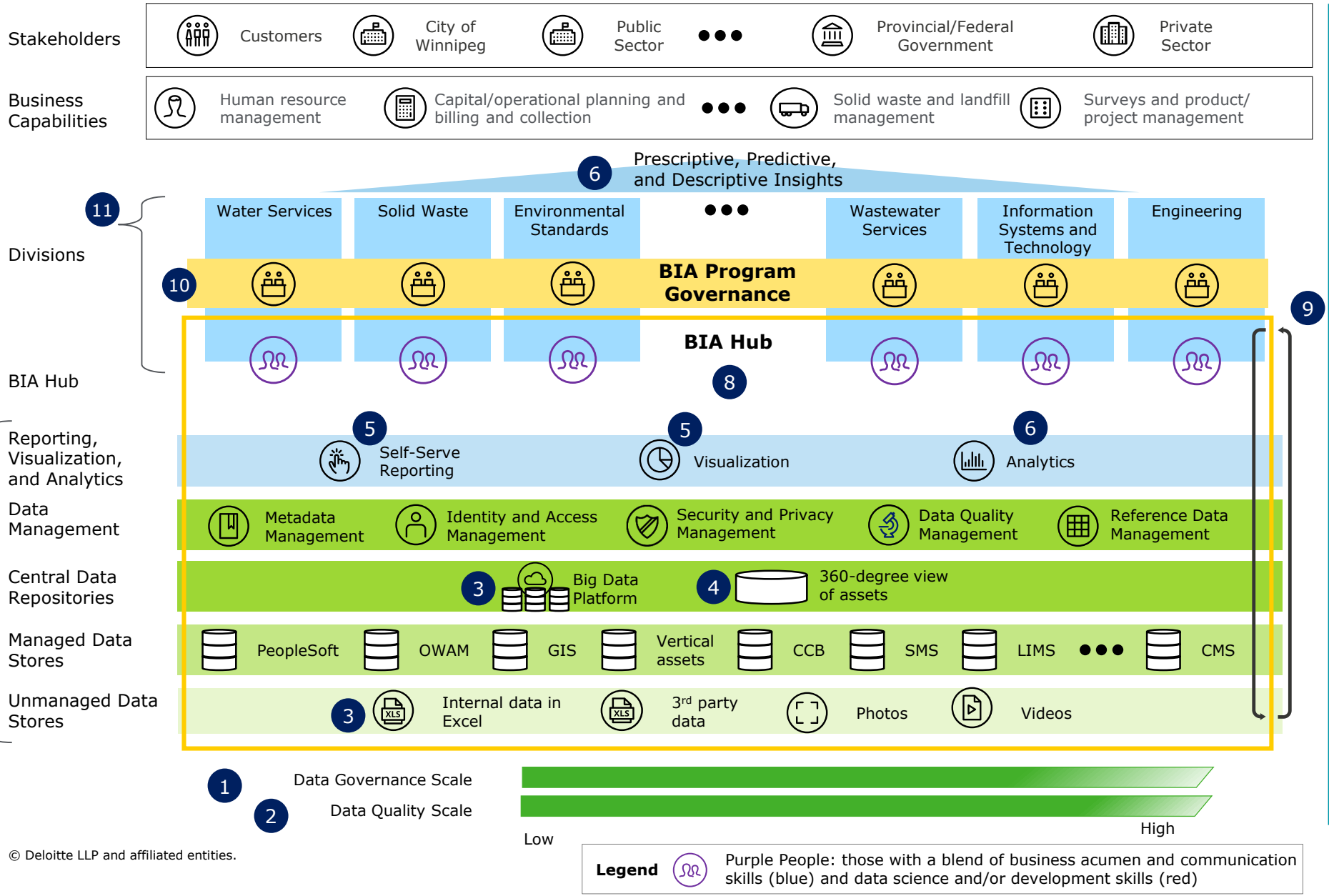
WWD's Current State BIA Model Canvas



1. Lack of a mature **data governance program** leads to inconsistent management of data assets.
2. Absence of **data quality management capabilities** leads to a lack of trust in data and requires significant manual effort for data cleansing.
3. Critical datasets such as vertical assets are stored in **unmanaged data storage** limiting reporting, audit control, and version control capabilities.
4. No **central data repository** to link and share data and generate meaningful insights.
5. Absence of a **360-degree view of assets** impacts WWD's ability to make critical high value managerial decisions.
6. No **self-serve reporting** tool is being leveraged for end-users to extract insights.
7. No **BIA reference architecture** to guide technology alignment with respect to business capabilities.
8. No formalized **BIA program governance** present to escalate issues, meet technology and talent needs, and deliver BIA initiatives effectively.
9. Given BIA gaps in foundational data management capabilities, it is challenging for WWD to generate **predictive analytical insights**, limiting its ability to use insights to reduce costs, optimize operations, or enhance services.

Note: *The challenges listed above are not in order of priority, but rather follow sequential/logical ordering.*

WWD's Future State BIA Model Canvas

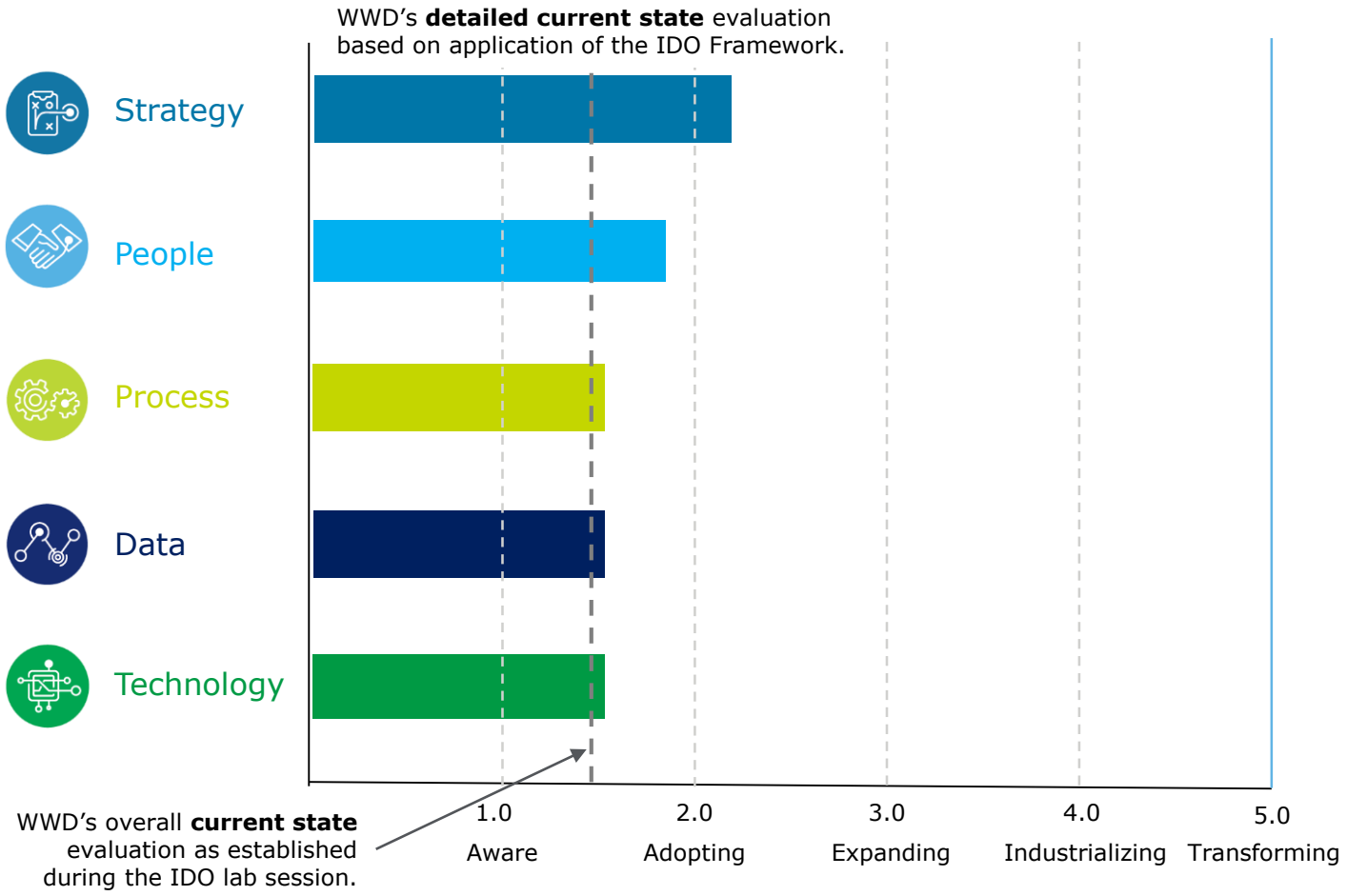


1. Majority of data stores, based on their significance and analytical usefulness, are brought under a **data governance** (DG) program.
2. **Data quality** (DQ) metrics are defined and periodic checks are conducted, resulting in higher quality of the data overall.
3. A **Big Data platform** is leveraged to link and share data, and to exploit data for generating insights. The **number of unmanaged data stores are continually being reduced** through the implementation of the BIA solution and supporting digital initiatives. However, continued organic growth in digital assets is increasing the volume of unstructured data generated.
4. WWD has a complete **360-degree view** of its assets, enabling it to use analytics for capital planning, asset maintenance, insurance costing, and for other high level business decision-making.
5. Modern **self-serve reporting and visualization tools**, along with clean and labelled datasets, enable staff to create their own reports.
6. WWD is able to generate insights using **analytics tools**.
7. WWD has designed a **reference architecture**, enabling it to make timely and coherent technology design choices.
8. WWD has established a BIA Hub in a **Hub-and-Spoke operating model**, enabling divisions to efficiently deliver BIA projects, harness BIA talent (purple people), and realize synergies. This operating model can serve as an archetype for other city departments to replicate.
9. WWD is able to deliver BIA projects efficiently using an **agile methodology.**
10. WWD has established **BIA program governance**, providing a means for balancing efforts while also serving as a forum for raising and reconciling roadblocks.
11. Leadership and staff alignment has been facilitated through regular **change management** activity during the transition from current state.

WWD's Current State Maturity Across IDO Dimensions

Cross-divisional support for BIA promotes Strategy and People scores, but overall the department is held back broadly across the remaining dimensions due to the lack of an industrialized BIA team, the absence of a central data repository, and other factors.

CURRENT STATE BIA MATURITY



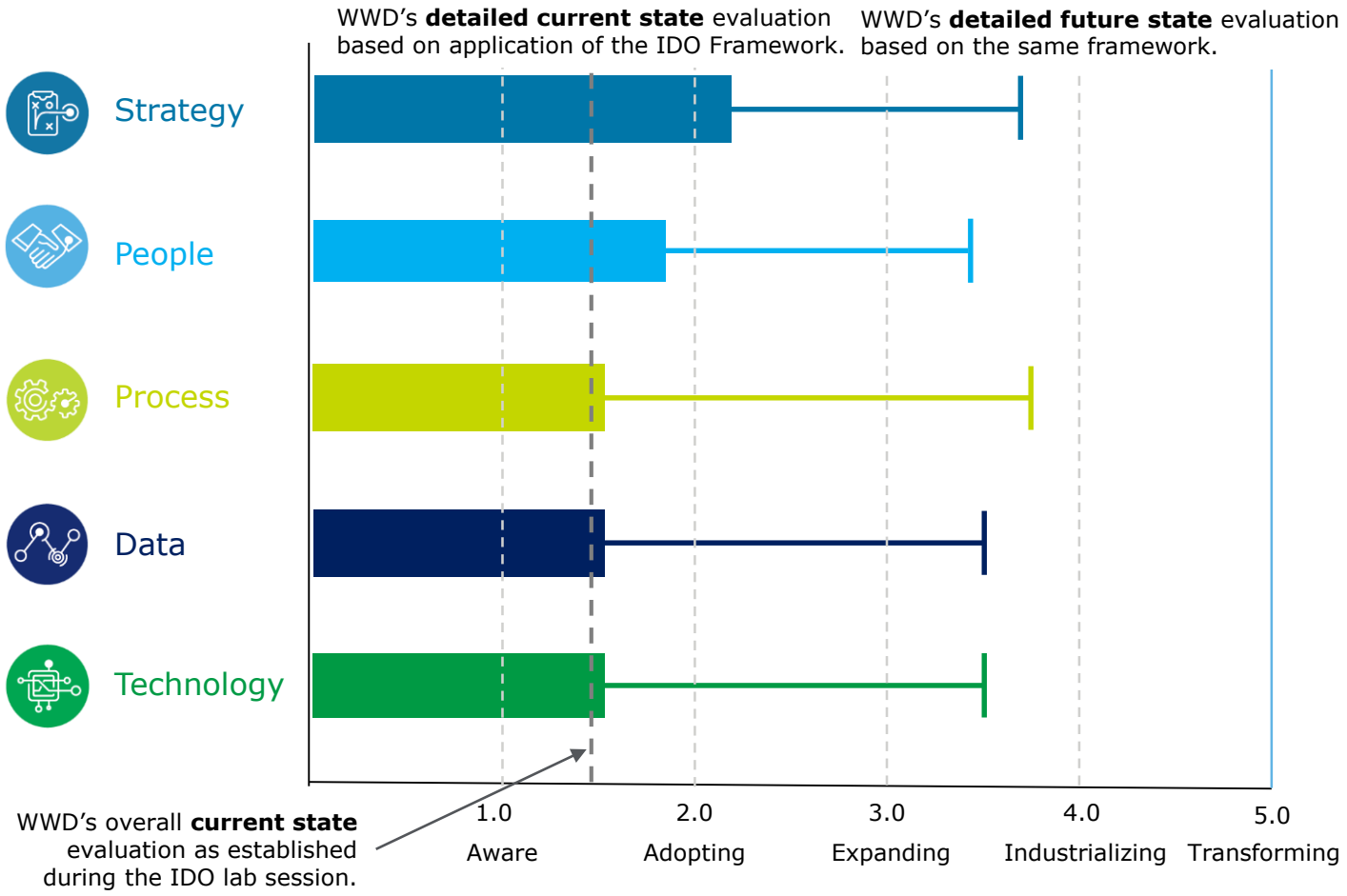
KEY OBSERVATIONS

- WWD has take some initial steps with the completion of the Enterprise Strategy, where BIA was a key initiative.
- Some of the divisions are executing innovative pilot projects.
- WWD currently follows a dispersed BIA operating model that enables divisions to prioritize their individual needs well, but creates inefficiencies and inhibits WWD from exploiting cross-division synergies.
- WWD lacks resources for new BIA technologies such as Big Data, predictive modelling, visualization, etc.
- Although some WWD resources are trained in change management and WWD employs change management tactically in IST projects, WWD could leverage it more broadly to affect technology driven change in business capabilities.
- WWD lacks overarching governance for BIA projects and activities.
- IST employs hybrid-agile processes for delivery of some projects, but staff members across WWD do not use agile practices to deliver BIA projects and activities.
- WWD lacks a central data repository to link and share data and generate insights.
- WWD does not have a mature data governance / data quality program.
- WWD does not have a common set of BIA tools, although IST is leading divisions to work together to implement common reporting tools.

WWD's Future State Maturity Across IDO Dimensions

WWD will need to invest across all five IDO dimensions – the process dimension requiring the greatest investment – to realize its future state vision.

FUTURE STATE BIA MATURITY

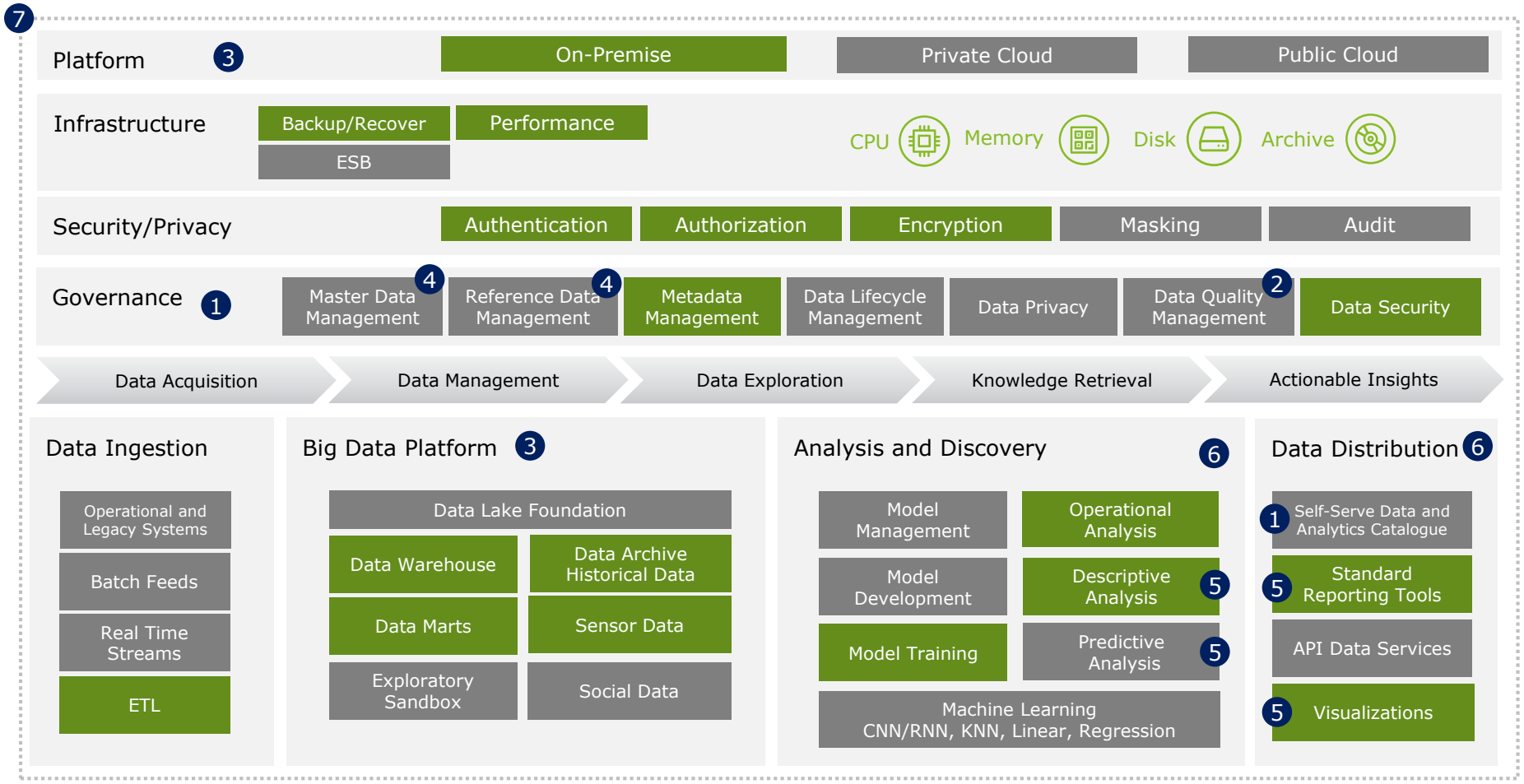


FUTURE STATE PRACTICES

- Key stakeholders across WWD divisions are aligned with the BIA vision and are supportive of BIA initiatives.
- Decisions with respect to BIA people, process, and technology are made with all divisions in consideration, championed by a BIA lead.
- WWD has implemented an organization design that most effectively leverages analytical resources.
- BIA needs (i.e., capabilities and skills) are broken down at the lowest level and proactively embedded into hiring and talent development strategies and process.
- WWD has an industrialized team that builds BIA projects across divisions.
- Opportunities for BIA projects are identified and prioritized using a formal analytics intake process.
- Well-defined BIA program governance is established at WWD, enabling staff members to raise and triage issues and conflicting priorities.
- BIA projects are executed using a consistent and repeatable process that encourages innovation and quick time to value.
- Data is being stored, linked, shared, and exploited for insights using a Big Data platform and a suite of BIA tools and technologies.
- Data stewardship is fully implemented. Data quality tools and processes are standardized and actively used.
- WWD has a well established vendor ecosystem and delivery model, aligned with WWD's BIA goals.

WWD's Future State Architecture

A shared data ecosystem, aligning technology with business capabilities.



O U T C O M E S

1. Majority of data stores, based on their significance and analytical usefulness, are brought under a **data governance** (DG) program.
2. **Data quality** (DQ) metrics are defined and periodic checks are conducted, resulting in higher quality of the data overall.
3. A **Big Data platform** is leveraged to link and share data, and to exploit data for generating insights. The number of **unmanaged data stores have reduced** due to installation of the platform and digital initiatives (though the volume of unstructured data has increased).
4. WWD has a complete **360-degree view** of its assets, enabling it to use analytics for capital planning, asset maintenance, insurance costing, and for other high level business decision-making.
5. Modern **self-serve reporting and visualization tools**, along with clean and labelled datasets, enable staff to create their own reports.
6. WWD is able to generate insights using **analytics tools**.
7. WWD has designed a **reference architecture**, enabling it to make timely and coherent technology design choices.

Available or partially available

Missing in Current State

Recommendations for Realizing the BIA Future State

All 5 IDO dimensions were considered in outlining the 11 distinct recommendations to support and strengthen WWD's position as the Utility of the Future.

No.	Recommendations	Impacted IDO Dimensions				
		Strategy	People	Process	Data	Technology
1	Adopt a **"Hub-and-Spoke"** operating model to provide a department-spanning BIA strategic vision, institutionalize a BIA team (i.e., BIA Hub) supporting the divisions, and directly address the present technology and talent gaps.	✓				
2	Implement overarching **BIA program governance**, via a two-tier committee structure, to provide a means for balancing efforts while also providing a forum for raising and reconciling roadblocks.			✓		
3	Implement a **Big Data platform** to lay the foundation for connecting all sources with the end user, promoting self-serve reporting, driving greater visibility of data, facilitating data sharing, and enabling analytics capabilities.					✓
4	Establish a **data quality program** for developing trust in data assets, reducing associated risk and costs, and improving overall operational efficiency within the domain of BIA.				✓	
5	Implement a **data governance program** to enable divisions to share their datasets, develop trust in the data and insights, and produce a formal structure to govern the datasets.			✓	✓	
6	Implement **self-serve reporting and visualization capabilities**, train end-users, and provide high quality, labelled datasets to democratize data and foster a data-driven culture.		✓			✓
7	Implement **master data and reference data** capabilities to ensure WWD is equipped with a 360-degree view of its assets for use in analytics, is able to control data quality, and can reduce its data management overhead and risk of poor data quality in general.				✓	
8	Develop, maintain, and deliver on a pipeline of **analytics use cases** (i.e., crunchy questions) by leveraging analytics tools to enable WWD to derive meaningful and actionable insights about business operations from data and, correspondingly, make better fact-based decisions.	✓				
9	Develop a **BIA reference architecture** to enable quick, consistent, and timely solution design and reduce maintenance overhead.					✓
10	Adopt a systematic approach for delivery via an **agile framework** catered to BIA that will help WWD garner support for the initiative, reduce exposure to risks, and observe more efficient delivery of the program and its components.			✓		
11	**Manage change** for successful implementation of the BIA vision, ensuring that stakeholders are involved and engaged from the beginning, challenges are exposed and planned against, and the message of a department committed to its BIA vision is reinforced.	✓	✓			

Options for management consideration for BIA Capability Rollout

Multiple options were analyzed for the implementation approach, taking into consideration strategic alignment, impact to divisions, and other metrics that will impact WWD's ability to successfully achieve its future state vision.

OPTIONS

1 Full capability implementation through **multiple use cases (i.e., crunchy questions) within a single WWD division.**

2 Full capability implementation through **multiple use cases** from a **few selected divisions**, and thereafter scaled to other divisions.

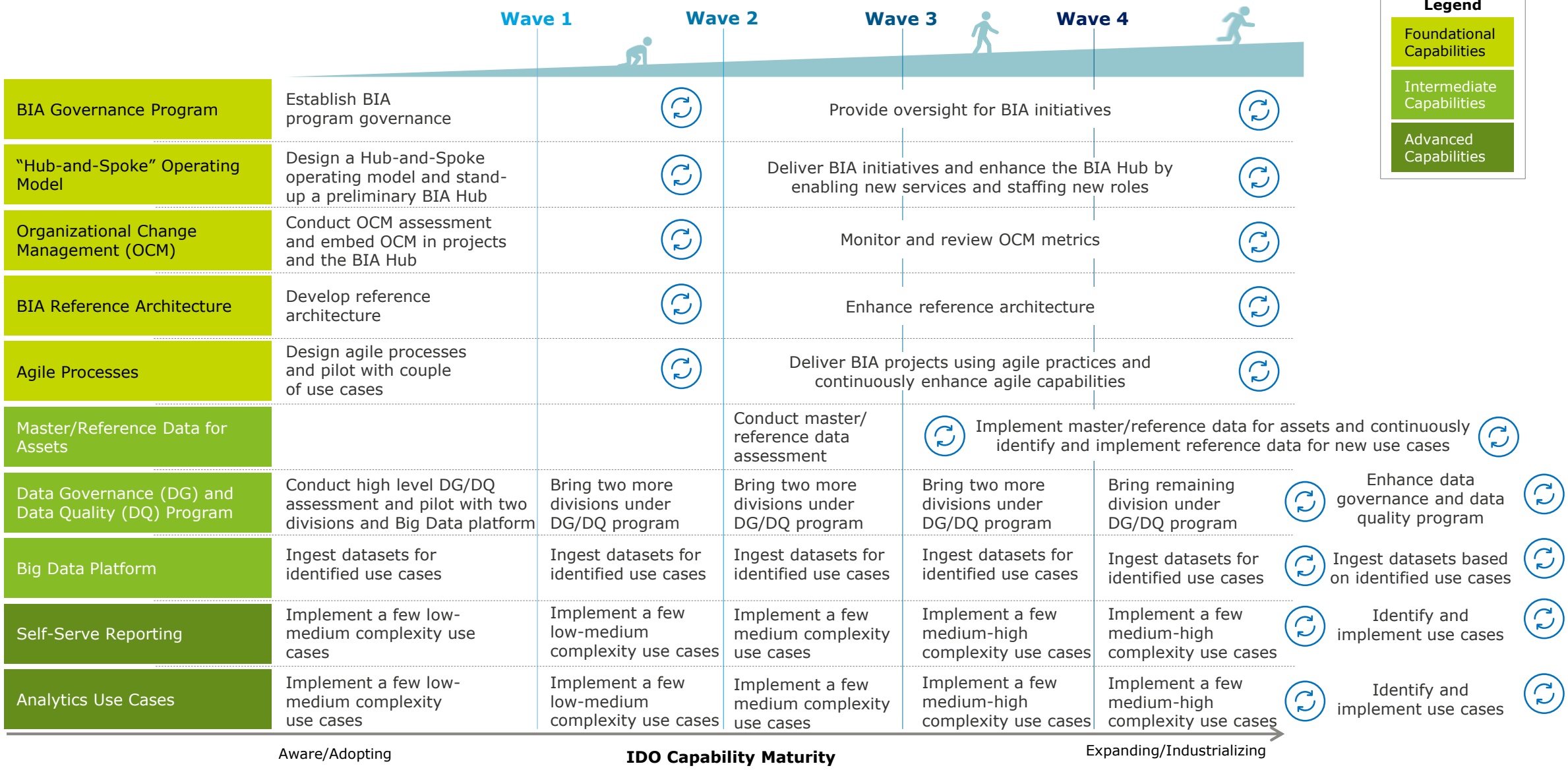
3 **Full scale capabilities implementation up front**, thereafter applied to all use cases, with capabilities iterated upon as needed.

Category	Criteria	Option 1	Option 2	Option 3
Strategic Alignment	Addresses strategic priorities identified during assessment	High	High	Low
	Scalable for other initiatives across the City/WWD	Medium	High	Low
Impact on divisions	Stakeholders impacted	Medium	High	Medium
	Flexibility to mitigate risk	Medium	High	Low
	Range of use cases / business decisions supported	Medium	High	Low
Gaps Closed and Future State Capabilities Enabled	Data and technology	Medium	High	High
	Operating model	Medium	High	High
Benefits Realization	Ease of implementation	Medium	Medium	Low
	Cost effectiveness	Medium	High	Low
	Time to value	High	High	Low

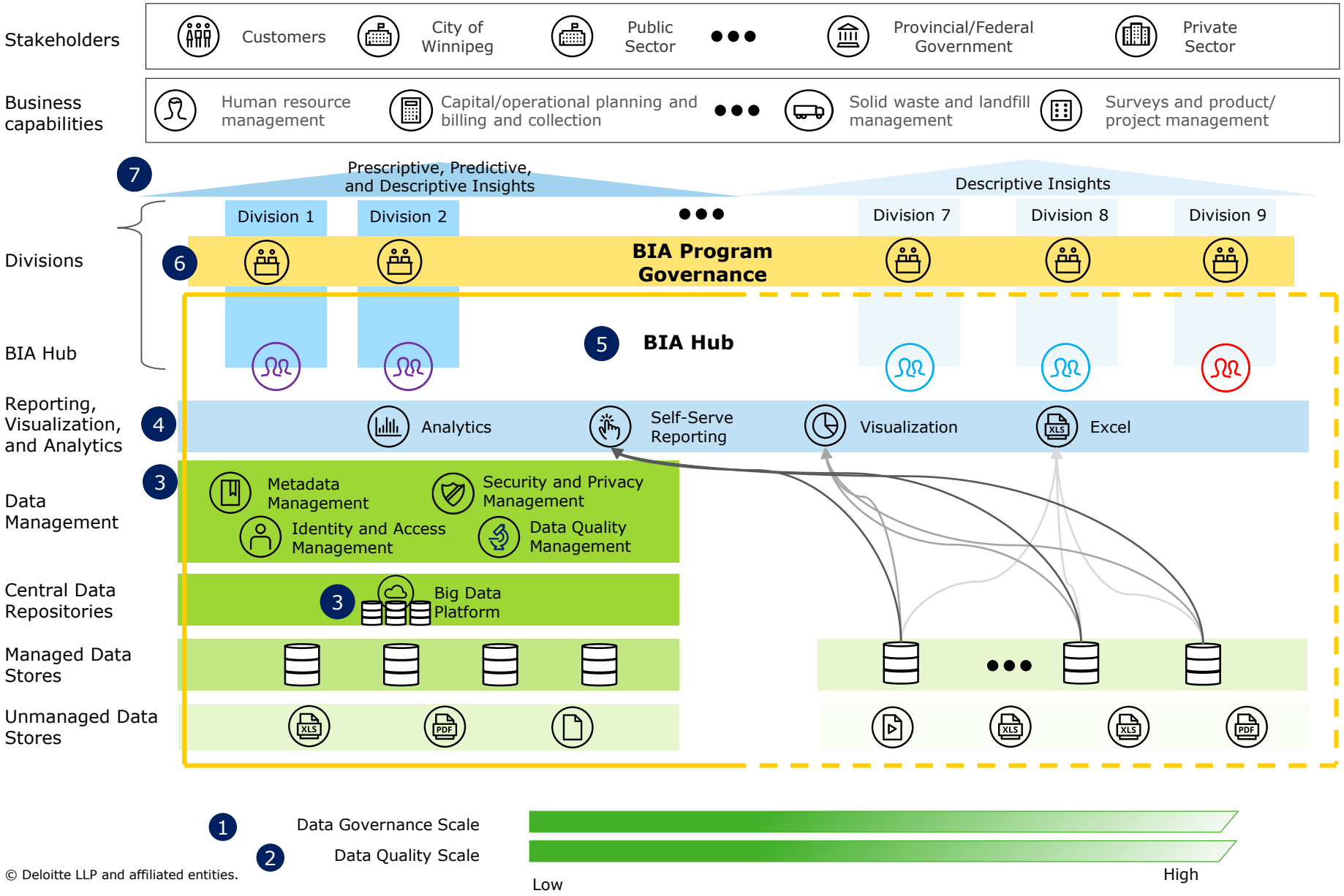
RECOMMENDATION: **OPTION 2**

For WWD, Option 2 is most suitable, allowing the department to start small, learn from experiences, and scale across WWD in a sustainable manner. Option 3 requires significant up-front investment and planning, while by comparison Option 2 would enable WWD to invest incrementally in capabilities instead and thus achieve tangible analytical insights over a shorter period of time. Option 2 conversely trumps Option 1 by offering greater breadth of impact with respect to the department, garnering better buy-in and support early in the program. Option 2 also affords better ability to scale BIA for other initiatives across the City.

Approach for Phase 2 - BIA Implementation



WWD's BIA Model Canvas at Conclusion of Wave 1



1. Two divisions and the Big Data platform are brought under the **data governance program**.
2. Data quality for the two initial divisions' data sources and the Big Data platform is monitored against data quality dimensions, with quality itself incrementally improving.
3. A **Big Data platform** is instantiated for initial use cases, which will eventually serve as the foundation for rest of the department.
4. A **self-serve reporting tool** is used for creating reports for selected use cases. Users external to the use cases are able to leverage the tool for existing reporting needs as well.
5. A preliminary **BIA Hub** – with active participation from the two initial divisions as **spokes** – is established, supporting initial BIA use cases and helping WWD develop and utilize **agile** processes.
6. A **BIA program governance** group, with representation from across divisions, is established. The group provides direction for implementation of initiatives on the BIA roadmap and monitoring associated progress.
7. WWD is able to generate **predictive and descriptive insights** to enable initial use cases.

Blue People: those with business and communication skills

Red People: those with data science and/or development skills

Purple People: those with a blend of business acumen and communication skills (blue) and data science and/or development skills (red)

This Approach will Empower BIA Champions, Triggering a "Ripple Effect" for Change

While recommendations apply wholly to the department, divisions with an innate interest in a particular capability can support and champion specific recommendations as their primary advocates, and leverage the BIA Hub to make these capabilities "positively contagious".

The Human Resources, Customer Service, and Finance and Administration divisions, in collaboration with the hub-essential Information Systems and Technology division, will advocate for the BIA Hub, analytics, Big Data platform, and self-serve reporting. Their advocacy will create ripples across the department and generate stakeholder buy-in for execution of rest of the BIA roadmap.

CS
FA
IST
HR

Thanks to data science capabilities in the **BIA Hub,** we are providing safety predictors to supervisors by linking datasets in the **Big Data platform** and creating insights using **predictive analytics.** These insights are enabling them to manage deployment of resources in the field based on associated risks.

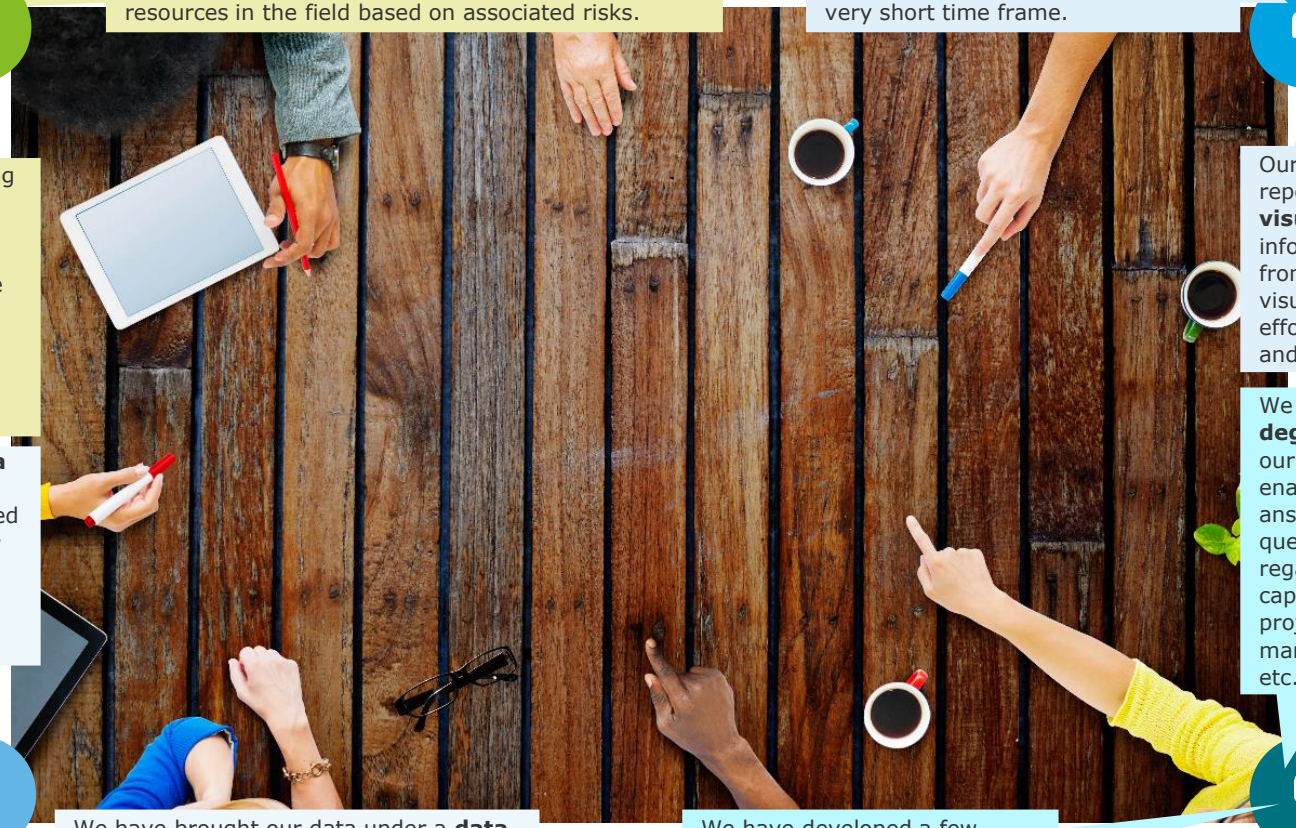
As opposed to providing static reports, we are providing safety data and insights to the WWD divisions and the City via a **self-serve reporting** tool, such that datasets can be sliced and diced precisely as required.

We create multiple user-tailored dashboards and reports on a regular basis by using a "consistent and repeatable" **agile process** that provides us with tangible value in a very short time frame.

Water Services
Wastewater Services

Water Services and Wastewater Services will advocate agile analytics processes and visualizations capabilities for others to adopt, leveraging multiple managerial and operational dashboards as examples.

Our dashboards and reports employ advanced **visualizations** thanks to information architects from the BIA Hub. These visualizations reduce our effort for understanding and conveying insights.



Thanks to our **data quality program**, we provide validated lab results to other divisions and regulators in a lot less time than before.

Environmental Standards and Solid Waste will be able to identify data quality issues, rectify high priority issues and label their datasets, encouraging others to follow.

SW

Environmental Standards

We have brought our data under a **data governance program** and standardized and labelled data sets, enabling self-serve capabilities.

We have a **360-degree view** of our assets, enabling us to answer crunchy questions regarding capital planning, project management, etc.

We have developed a few **reference data repositories** that can be leveraged by other divisions in WWD.

Engineering

The Engineering division, with a 360-degree view of its assets, will be championing its master data and reference data. The capabilities developed in this project can be leveraged for creating a citizen-centric digital platform at city-level.

Recommendations

Recommendation 1 | Driving the BIA Vision and Forming a Dedicated BIA Team

Adopting a "Hub-and-Spoke" operating model will help provide key BIA strategic vision for the department as a whole and serve to integrate and share BIA capabilities.

BUSINESS CHALLENGE

The City of Winnipeg Water and Waste Department (WWD) follows a dispersed operating model, where BIA talent resides in silos within divisions. Such a model allows the divisions to prioritize their own needs, but it constrains the divisions' staff members from collaborating with each other, gain synergies, and implement cross-division projects. In addition, the divisions lack overarching BIA vision, staff, and skillsets for meeting their existing BIA needs.

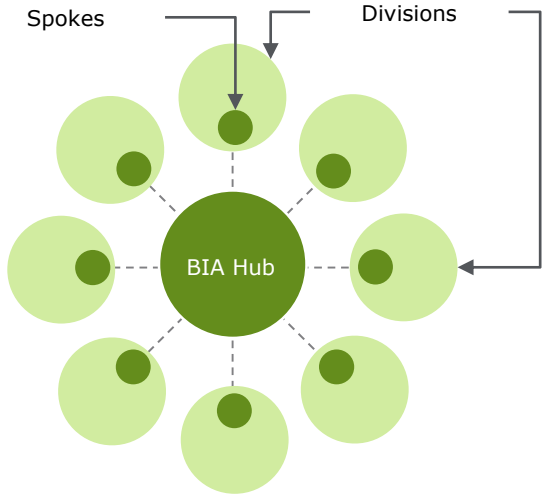
RECOMMENDATION 1

Implement a "Hub-and-Spoke" operating model

Implement a "Hub and Spoke" operating model, where the Hub (i.e., the BIA Hub) will be a central virtual entity that will be primarily responsible for fulfilling the BIA mandate at WWD. It will manage and enhance the BIA strategy and governance, centralize data asset management, deliver advanced analytics use cases, and enable key technology capabilities.

Spokes will exist within divisions and will be responsible for descriptive analytics, visualizations and dashboard development capabilities, and integrating BIA community, leveraging a facilitator and a dotted relationship to the Hub.

The BIA Hub operating model will serve as an archetype for other departments in the City to leverage and adopt. In addition to leveraging operating model design, City departments can also learn from successes achieved and challenges faced in implementation of the operating model.



BUSINESS OUTCOMES

- **Provides and delivers on the BIA strategic vision**
- **Establishes a formal BIA team** recognized by all other divisions, as both the guiding group as well as point of contact for all BIA-related efforts
- **Organizes and fills technology and talent gaps**, defining future goals and providing an area and means for growth
- **Strengthens spokes' BIA capabilities**

Strategy | People | Process | Data | Technology

Recommendation 1 | Plant and Grow

The operating model should start in fundamental form, with emphasis on vision and minimum/ essential BIA capabilities, scaling over time in-line with use case roll-outs.

K E Y A C T I V I T I E S

- Design the Hub-and-Spoke operating model (i.e., structure, roles, etc.) and its integration with the department.
- Staff 1 to 1.5 resources in the BIA Hub's* Competency Center/BIA Project and Portfolio Management (PPM) to deliver foundational capabilities.
- Establish spokes for divisions that are identified for Wave 1.
- Leverage external vendors to implement Wave 1 projects.
- Towards the end of Wave 1, staff 0.5–2 resources across *Data, Analytics, and Technology Services Centers in the BIA Hub to manage use cases and internal demand.

- Review and refine the operating model based on learnings from Wave 1.
- Staff additional resources in the *five areas of the BIA Hub to manage wave 2 and 3 use cases and internal demand.
- Onboard additional WWD divisions.
- Leverage external vendors to implement Wave 2/3 projects.
- Develop a plan for establishing internal delivery capability for some of the Wave 4 use cases.
- Divisions will be able to hire internally as spokes, once the BIA hub has matured and if there is significant priority / specialized requirements with in the division.

- Review and refine the operating model based on learnings from Waves 2 and 3.
- Onboard remaining WWD divisions.
- Establish internal delivery capability, and deliver some of the use cases internally, whilst leveraging external resources to deliver the balance of use cases.

B E N E F I T S

- Lean and sustainable operating model implemented
- Foundational BIA Hub comprising in-house and 3rd party resources established
- WWD stakeholders engaged

- BIA Hub further matured to meet internal BIA needs
- Majority of divisions engaged and brought under the new operating model
- WWD's internal resources adept at modern BIA technologies

- Internal BIA delivery capabilities established
- All of WWD divisions engaged and brought under the new operating model

Wave 1 — *Waves 2 to 3* — *Waves 4+* →

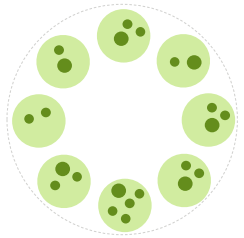
** Please refer to Slide 22 for breakdown of the BIA Hub.*

Recommendation 1 | Comparison of Operating Models

Of the five archetypical operating models, WWD currently operates under the most de-centralized variant – the dispersed model – but based on its configuration and future needs it should adopt a model oriented more centrally towards the middle of the spectrum.

De-centralized ⟷ **Centralized**

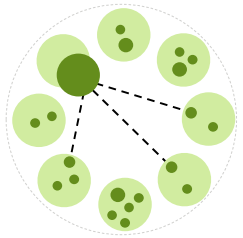
Dispersed Model



BIA talent is spread across different divisions

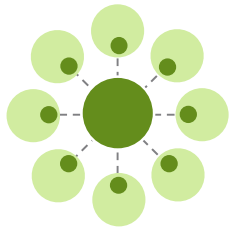
Current

Functional Model



BIA talent is primarily located in the divisions dominating BIA activity

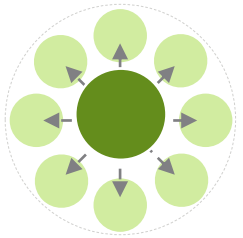
Hub and Spoke Model



BIA talent resides in divisions, but their activities are coordinated and supported by a centralized BIA Hub

Target

Consulting Model



BIA talent is centralized but assigned to work on projects throughout the organization through a chargeback system

Centralized Model

BIA talent form a division serving the entire department

S U I T A B I L I T Y

For distinct divisions with independent analytics needs

- Allows for full divisional control and tailoring of analytical methods
- Leads to duplication of efforts and resources
- Does not offer cross-divisional synergies

For organizations with a core BIA-oriented division in place

- Enables required BIA support for divisions, but primarily in an ad-hoc capacity
- Suitable only if additional divisional analytics needs are minor and not burdening for the BIA group
- Limits ability to expand BIA work into other divisions that could benefit, leaving them with limited BIA support

For large, diverse organizations with a variety of BIA needs and issues

- Keeps BIA talent close to their division while collectively providing support for BIA development
- Ensures some broader BIA vision and capabilities exists for the department
- Restricts control of the BIA Hub over decentralized BIA resources (i.e., the spokes), such that divisions remain in charge of their staff

For organizations with infrequent but large, diversified BIA needs

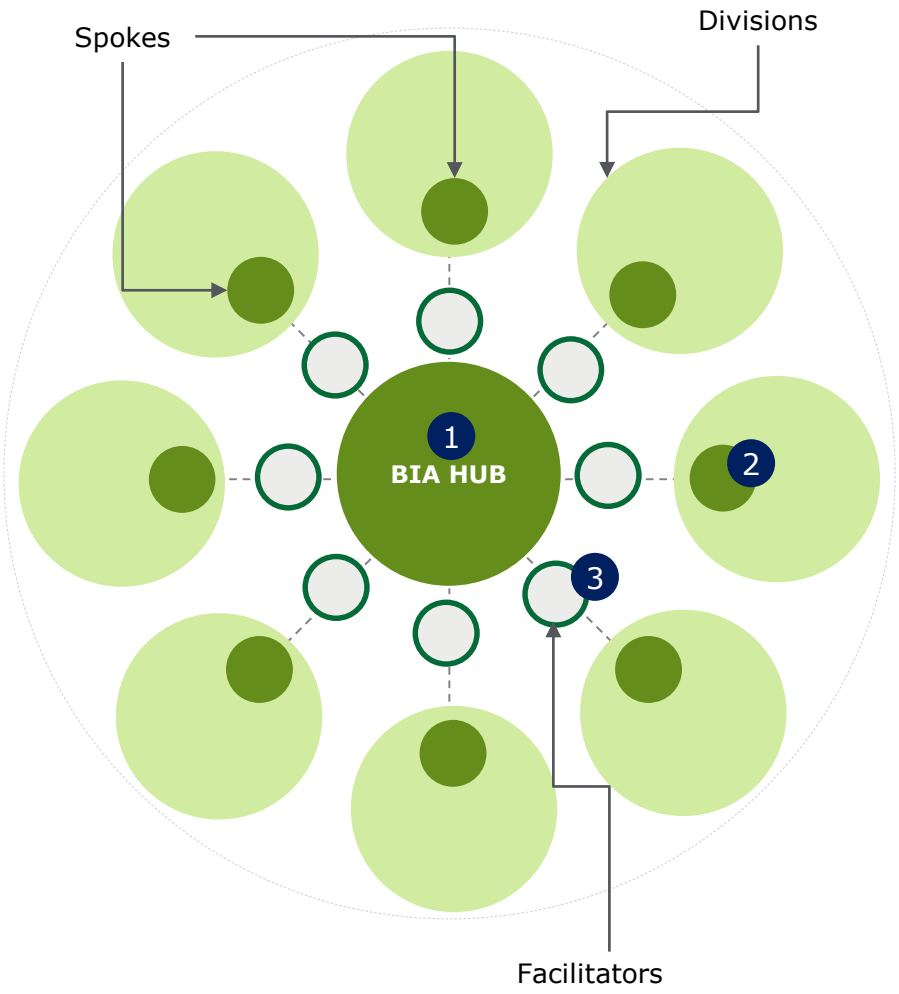
- Enables cost recovery through a chargeback system
- Shifts focus of BIA work to the divisions willing to pay, not necessarily to areas of most strategic importance to the department

For when a dedicated BIA practice is justified for the greater business

- Enables easier cross-functional project working, sharing of ideas, innovation, and standardization of tools
- Enables deployment of analysts to projects with strategic priority
- Requires robust operating model implementation to ensure the BIA group to be detached from the divisions and operate with less understanding of their needs

Recommendation 1 | Overview of the "Hub-and-Spoke" Operating Model

The BIA Hub will manage and enhance WWD-wide BIA strategy and governance and centralize key BIA functions, whereas the spokes will embed descriptive analytics capabilities within the division and coordinate with the BIA Hub through the Facilitators.



1 A **'virtual' BIA Hub** manages and enhances the WWD-wide BIA strategy and governance and centralizes data asset management, advanced analytics, and key technology enablement capabilities.

2 **BIA 'spokes'** embed descriptive analytics capabilities in the divisions and integrate the BIA community through dotted reporting relationships to the BIA Hub.

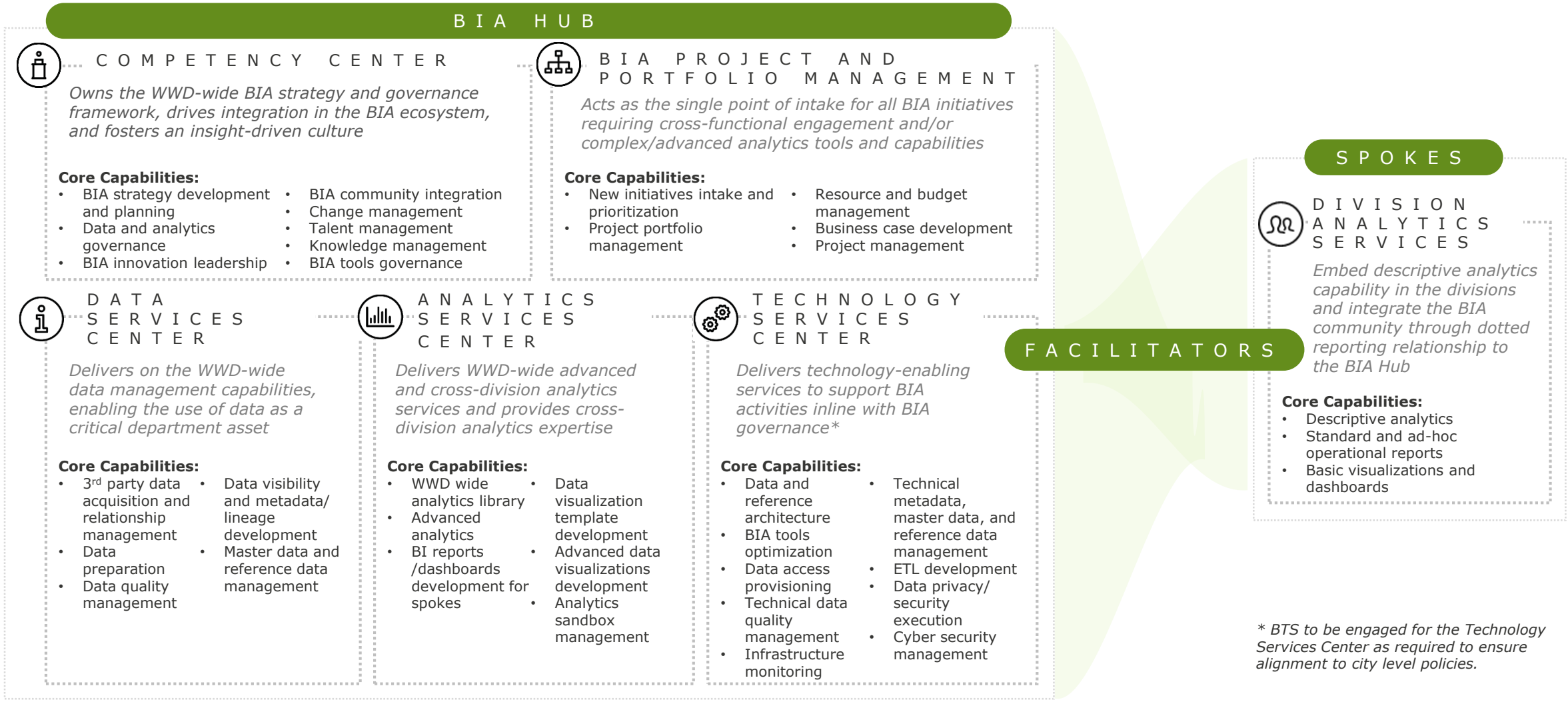
3 A **facilitator** acts as the bridge between the business and the 'Hub', supporting the divisions and BIA Hub to make the best use of BIA capabilities to further WWD's goals.

ROLE MANDATES

- The **BIA strategic vision** will be driven by the BIA Hub.
- End-to-end **data management and governance** for all data sources will be driven by the BIA Hub, with some of responsibilities assigned to the spokes.
- **Advanced analytics** will be the primary responsibility of the BIA Hub, with an aim to enable some of these capabilities within specific spokes based on their needs and maturity. As the program matures, divisions can hire spokes with strong BIA capabilities to address high volumes or specialized project needs within the division.
- **IST functions critical to enabling BIA** will be integrated into the BIA Hub. It can be a dotted line relationship initially, integrating further as the size of the BIA Hub grows.
- A **Project Management Office (PMO) in the BIA Hub** will act as a single point of intake and prioritization for BIA initiatives. The PMO will setup regular checkpoints with the divisions to triage the projects.
- A **facilitator** – the key point of contact for the spokes – will act as bridge between the spokes in the divisions and the BIA Hub.
- The BIA Hub will be responsible for **training spokes to develop self-service capabilities** and understand how to utilize the catalogue of data available.

Recommendation 1 | BIA Hub and Spoke Capability Model

Strategic and core BIA capabilities will be centralized in the BIA Hub, supporting spokes across divisions to develop their own reports, draw on the hub's advanced capabilities, and promote and foster collaboration in the community of practice.



** BTS to be engaged for the Technology Services Center as required to ensure alignment to city level policies.*

Recommendation 2 | Defining, Prioritizing, and Strategizing BIA Efforts

Program governance will help guide BIA efforts in alignment with overarching business objectives while simultaneously (via the BIA Hub) providing a forum to raise and reconcile roadblocks.

BUSINESS CHALLENGE

Absence of central governance affects the ability of WWD's BIA users and project members to escalate BIA project and BIA issues, collaborate on BIA efforts, and fulfil BIA talent and technology needs.

RECOMMENDATION

Institute a BIA program governance

Implement a two-tier governance model, where the first tier – the BIA Management Committee – will include representatives from the BIA Hub, IST, and other divisions, and will be chaired by the IST Manager. The second tier – BIA Executive Committee – will be comprised of WWD's Leadership. The BIA Management Committee will oversee the BIA strategy, project portfolio, and operations, whereas the BIA Executive Committee will strategically guide the BIA ecosystem to align with the overarching BIA strategy.

As other departments in the City formulate their BIA strategy and operating model, the BIA program governance will serve as an archetype for them to leverage and adopt.

BUSINESS OUTCOMES

- **Achieves a platform for raising concerns** for roadblocks and cross-division BIA efforts
- **Ensures alignment to WWD's BIA vision** at a broader level than the BIA Hub itself (i.e., at the highest levels of the department) weighing-in on BIA strategy, governance, and investments
- **Provides a central forum** to establish common guidelines and standards for business case development, execution, measurement, and shared services, and reduces duplication of the foundational capabilities across divisions
- **Provides a means for the BIA Hub to direct the spokes** to align with the BIA strategy and address their technology and talent needs

Strategy | People | Process | Data | Technology

Recommendation 2 | Building a Dedicated Team

The BIA Committee should stand-up with as few as 1 to 2 representatives from the BIA Hub, as activities will be highly-focused to start, and should expand over time based on priorities and needs.

K E Y A C T I V I T I E S

- Establish a foundational BIA Management Committee that will initially be responsible for governance of the capabilities implemented in Wave 1.
- Achieve representation of 1 to 2 BIA Hub resources – in addition to the IST Manager – with active participation from the divisions involved in Wave 1 use cases, privacy and risk representatives, and other necessary IST members.
- Engage with WWD leadership through existing channels.

- Review and refine the BIA Management Committee's membership, responsibilities, and engagement model inline with Wave 2 and 3 needs.
- Formalize the BIA Executive Committee and consider direct representation from the BIA Hub at this level committee.

- Review and refine the BIA Management Committee's membership, activities, and engagement model inline with the governance needs of Wave 4 and beyond.
- Include a BIA Hub representative in the BIA Executive Committee.

B E N E F I T S

- Implementation of a lean and sustainable BIA program governance for issue escalation, strategic guidance, and learnings transfer

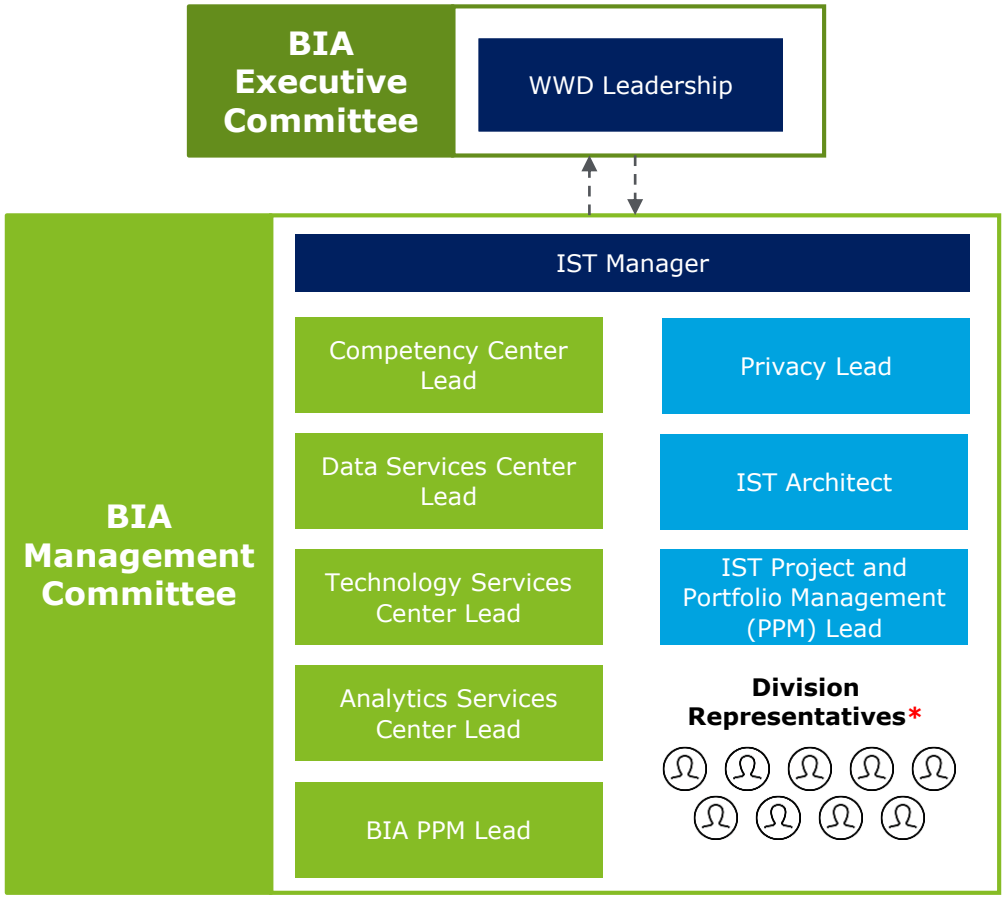
- Enhanced BIA program governance

- Matured BIA program governance
- Increased visibility of BIA capabilities, activities, and future needs at WWD leadership level

Wave 1 — *Waves 2 to 3* — *Waves 4+* →

Recommendation 2 | Overview of the BIA Management Committee

The BIA Management Committee will be the tactical group managing the BIA strategy, project portfolio, and operations, whereas the BIA Executive Committee will provide strategic guidance and resolve inter-division conflicts.



Note: *Initially the BIA Executive Committee won't require direct representation from the BIA Hub, but as the Hub matures further, the competency center lead should be added to BIA Executive Committee.*

BIA EXECUTIVE COMMITTEE MANDATE

- Review WWD's BIA strategy
- Provide strategic guidance to the BIA Management Committee
- Resolve inter-division priority conflicts
- Align WWD's BIA efforts with those of the City

BIA MANAGEMENT COMMITTEE MANDATE

- **Strategy**
  - Formulate and approve WWD's BIA strategy
  - Approve BIA architecture and governance changes
  - Review and align with plans for IT Infrastructure & IT security, and Process and IT Management capabilities portfolio and roadmap
- **Project Portfolio Management****
  - Provide input for the coordination of prioritization efforts at the leadership level
  - Discuss issues, trends, and progress for BIA projects
  - Project Go/No-Go decision-making
- **Operations**
  - Discuss and approve BIA policies affecting the processes in managing BIA activities with leadership's involvement / direct approval as required
  - Regularly review the process performance metrics from the governance dashboard, identify division issues, and support the BIA Hub and its spokes in defining an action plan
  - Serve as an information sharing forum and discuss cross-division issues
  - Review recurring or critical data issues and progress on key deliverables and milestones
  - Review BIA talent, technology, and capabilities needs across divisions
  - Impact and risk analysis from a data security and privacy and regulatory compliance perspective

** Division Representatives are delegates of any level to communicate two-way interests/prioritization.*

*** Existing budget approval process will be used for seeking budget approval for BIA projects.*

Recommendation 3 | Centralizing and Unifying WWD's Data Assets

A Big Data platform will lay the foundation for connecting all sources with the end user, driving greater visibility of data, facilitating governance over BIA, and enabling advanced analytics capabilities.

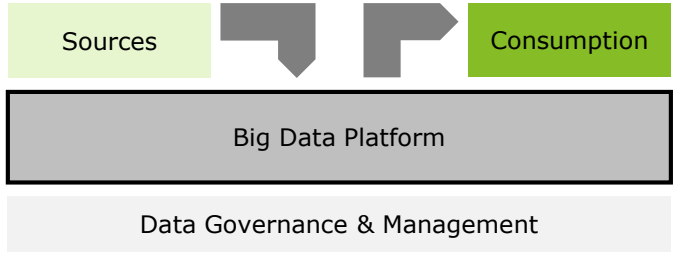
BUSINESS CHALLENGE

At WWD, staff members lack the ability to link datasets together, limiting depth of analysis, affecting the ability to share data across departments, foregoing connectivity with third-party data sources, and creating report and analytics governance issues.

RECOMMENDATION

Implement a Big Data Platform

WWD presently lacks consolidation of its various data sources and BIA applications, resulting in a suite of limitations and hindering further BIA development. A Big Data Platform would serve as the fundamental BIA platform to expand on BIA capabilities.



More than merely a central data storage system, the platform represents a collection of tools and processes that brings data together and enables capabilities such as advanced analytics, visualizations, processing of unstructured datasets, data cataloging, access control, metadata storage, and more.

Other departments within the City can use the platform to access WWD's datasets, share their own datasets with WWD, and leverage lessons learnt during platform implementation to establish their own Big data platform.

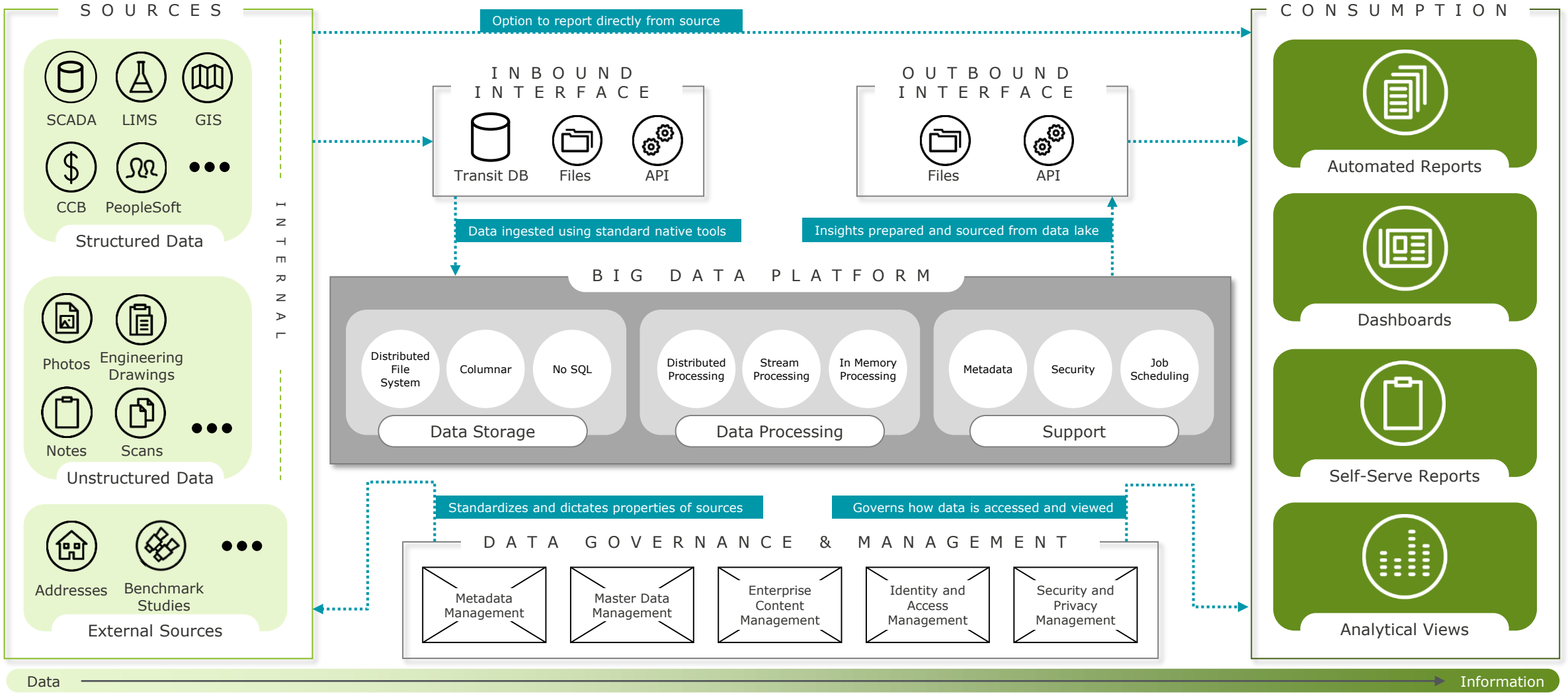
BUSINESS OUTCOMES

- **Provides means for greater depth and breadth of analytics** through horizontally extensible processing capabilities and co-located structured, unstructured, and semi structured datasets (including data which is at present stored in unmanaged sources)
- **Allows for incremental infrastructure development** based on changes in data and processing requirements
- **Facilitates governance** as attention can be focused at the centrally stored dataset, which is more critical to WWD's decision-making than other datasets, resulting in a trickle-down effect on all data assets
- **Simplifies joining and extending data sets** as all data is co-located, reducing further interfacing needs
- **Drives data democratization and self-serve capabilities** by providing end-users with easy access to data and the ability to create reports, dashboards, and visualizations

Strategy | People | Process | Data | Technology

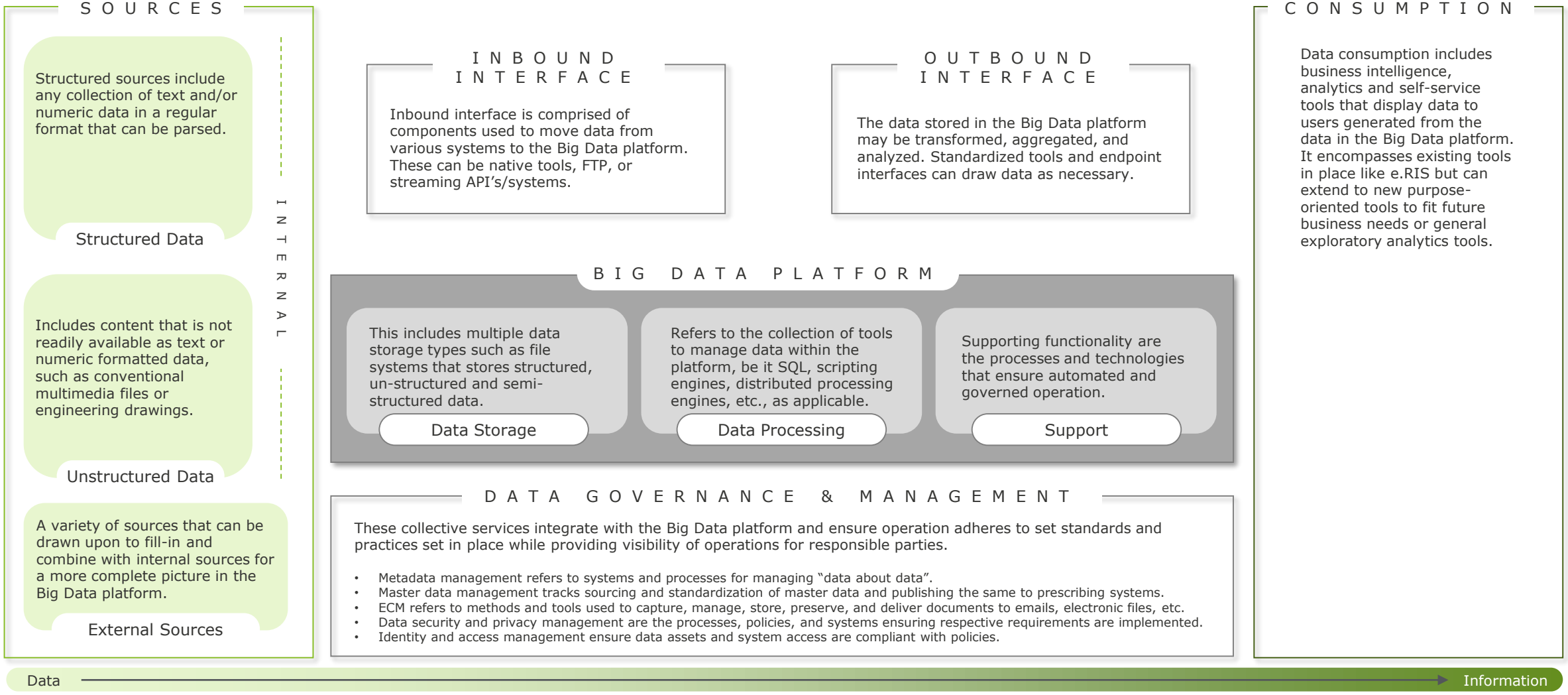
Recommendation 3 | Overview of a Big Data Platform in Practice

The platform effectively connects a variety of sources to multiple forms of user consumption, with the platform itself exercising data storage, processing, and facilitating support elements.



Recommendation 3 | Descriptive View of the Big Data Platform and its Components

The platform will enable a number of core foundational capabilities. Some of its key components are outlined below.

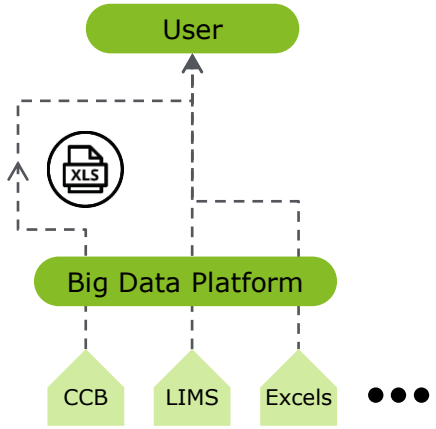


Recommendation 3 | Drivers Promoting a Big Data Platform

Five key value drivers make the Big Data platform a foundational and necessary component of the overarching BIA program.

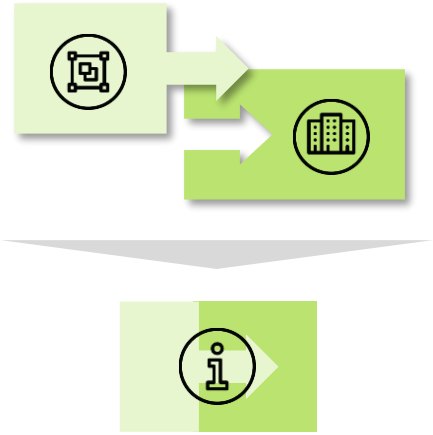
Self-Serve Data Access

A Big Data platform builds-in access to data sources and provides storage for intermediate analytics and reporting results.



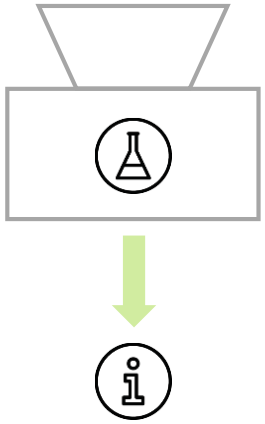
Linking Data

Co-located sources can easily be combined to synergistically drive more insights.



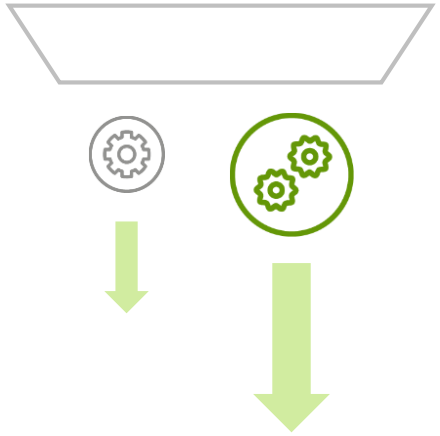
Sandboxing

Zoning for different use cases, like "sandboxing", offers managed areas to interact with data.



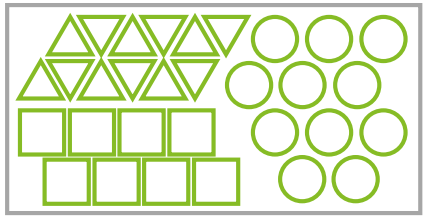
Scalable

Pooling hardware means embedding capability for high-throughput data processing.



Flexible Data Storage

Only one system is necessary to store a variety of different data types together.



DETAILS & EXAMPLES

- A Big Data platform provides the ability to aggregate data from across sources that are associated with driving useful insights, offers better visibility of data, allows users to save intermediate results, and stores unmanaged, 3rd party, and reference data, making data more readily accessible.
- For instance, relevant LIMS data can be stored in the platform, and made available for self-serve access.

- The platform can enable linking of different types of datasets sourced from multiple data stores, increasing breadth and depth of analytics.
- Linking of safety data from PeopleSoft, data from WCB, work orders from OWAM, training data from SmarterU, and 3rd party weather data can increase the quality of safety insights generated by providing a holistic view on safety, risks associated with types of work, training requirements, and more.

- As opposed to collecting a variety of individual files and then managing the tracking and storing of said files, a sandbox offers a clean, simple, and non-persistent way (if necessary) to complete exploratory analytics.

- A Big Data platform can be designed to allow for distributed processing, enabling economies of scale in processing power.
- Infrastructure can be scaled incrementally, based on data/analytics needs, reducing costs for WWD.
- The current fidelity of data can be improved accordingly, allowing even greater depth of insights to be gained.

- From unstructured to structured, streaming to batch, all data can be hosted together.
- Such a platform also supports "schema-on-read" which means any content can be stored and eventually parsed/structured as necessary.

Recommendation 3 | Scaling Piecemeal

The Big Data platform can start with minimum infrastructure and capabilities, expanding vertically and horizontally over time in-line with the defined architecture and identified use cases.

K E Y A C T I V I T I E S

- Leverage BIA reference architecture (i.e., recommendation 9) to setup a Big Data platform.
- Establish and test connections between the Big Data platform and WWD's existing data stores, visualization tools, analytics tools, and other peripheral technologies.
- Continuously setup and test Big Data technologies required for implementing Wave 1 use cases.
- Store selected unstructured data in the platform.

- Continuously review Big Data infrastructure and scale it (i.e., add further nodes) based on requirements of Wave 2 and 3 use cases.
- Continuously setup and test Big Data technologies required for implementing Wave 2 and 3 use cases.
- Identify and store unstructured data (e.g., videos, photos, etc.) in the Big Data platform.

- Continuously review Big Data infrastructure and scale it (i.e., add further nodes) based on requirements of use cases identified for Wave 4 and beyond.
- Continuously setup and test Big Data technologies required for implementing use cases identified for Wave 4 and beyond.
- Identify and store unstructured data (e.g., videos, photos, etc.) in the Big Data platform.

B E N E F I T S

- A lean Big Data platform established with minimum upfront costs
- Big Data platform is integrated with rest of the BIA technologies
- Costs of storing unstructured data are lowered

- Additional Big Data capabilities implemented

- Majority of Big Data capabilities implemented

Wave 1 — *Waves 2 to 3* — *Waves 4+* →

Recommendation 4 | Increasing Trust in Data

Establishment of a data quality program will help establish trust in data assets, reduce risks and associated costs of acting on decisions made on incorrect data, and improve overall operational efficiency within the domain of BIA.

BUSINESS CHALLENGE

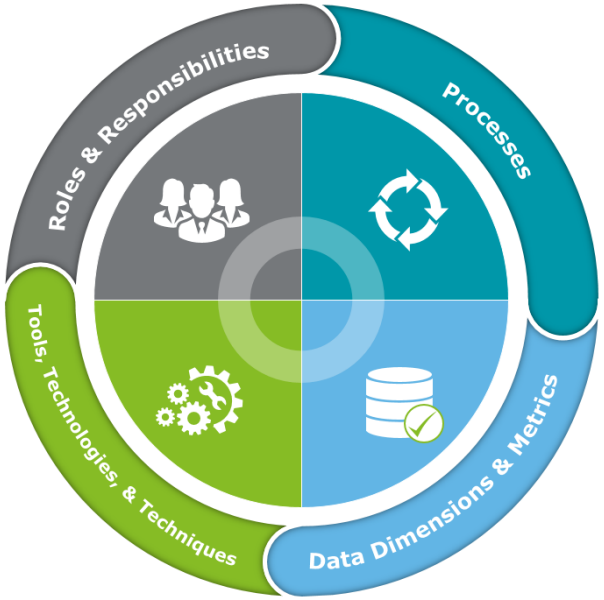
Absence of a data quality program to ensure trust and integrity of datasets results in a range of limitations with respect to furthering overall BIA efforts, from low confidence in the data to ineffective and inconsistent ways for coping when poor data quality issues arise.

RECOMMENDATION

Implement a data quality program

Data quality refers to both the characteristics associated with high quality data and to the processes used to measure or improve the quality of data.

Alongside processes for sustaining quality, this would extend to dimensions and metrics used to bound and define quality, tools and technologies for facilitation and automation, and finally the definition of roles and responsibilities to govern what parties are involved and how the effort is divided.



BUSINESS OUTCOMES

- **Increases trust in data** resulting in better adoption and support of BIA efforts overall
- **Reduces risk and cost** associated with data quality by enforcing rules and establishing controls to maintaining set quality requirements
- **Improves organization efficiency and productivity** with defined checks and workflows for managing overall data quality issues and associated actions

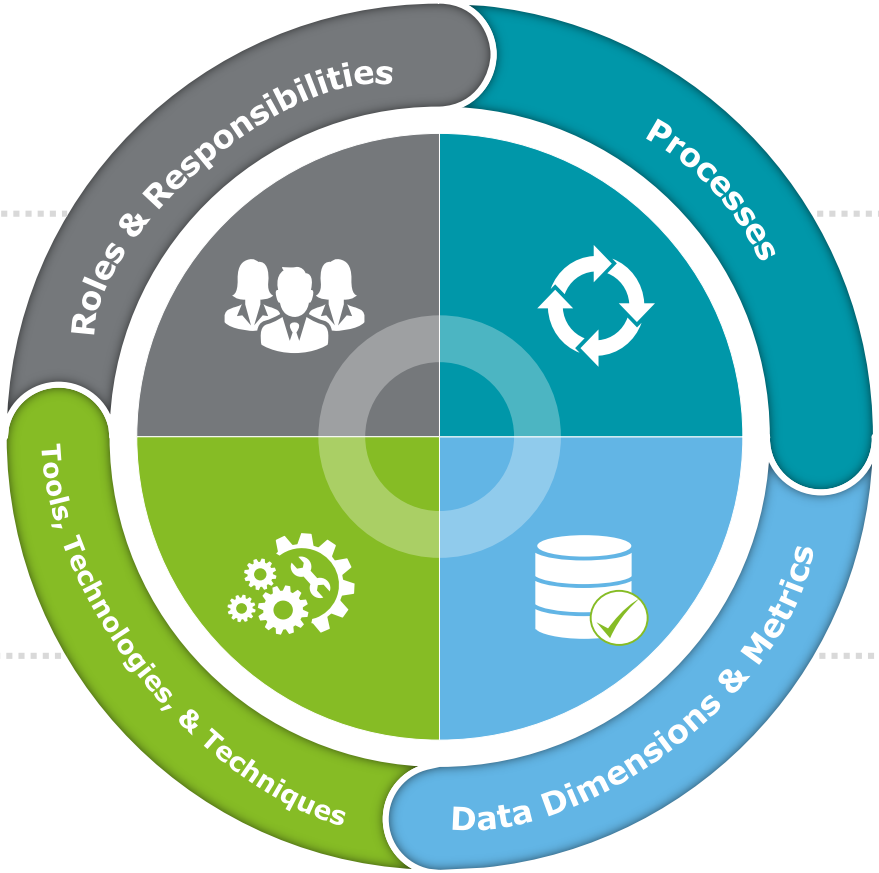
Strategy | People | Process | Data | Technology

Recommendation 4 | Overview of the Data Quality Framework

A data quality framework ensures a methodical approach to measure, maintain, and improve data quality (refer to Appendix A for further detail).

Defines responsibilities, rights and accountability of key roles (e.g., data quality specialist, data stewards, etc.) in the management of the data quality

Addresses the automation needs that are required for an effective data quality management program through tools, technologies, and techniques such as data profiling tool, data querying tool, statistical profiling control technique, and others



Ensures that all critical activities (e.g., data quality requirements definition, data quality monitoring, etc.) are executed in a prescriptive manner to enable effective data quality control and management

Assesses the quality of data, particularly the data's health against the 7 dimensions (e.g., accuracy, completeness, etc.), to serve its purpose in a given context

Recommendation 4 | Managing Data Quality

Beyond fundamental role and process establishment in alignment with initial data governance efforts, data quality will be an incrementally-defined BIA component.

K E Y A C T I V I T I E S

- Conduct a high level data quality (DQ) assessment, including defining roles and responsibilities, designing processes, reviewing tools/technologies/techniques, and defining data dimensions and metrics.
- Roll out the data quality program for use case defined datasets and respective WWD divisions identified for Wave 1 by gathering requirements and implementing and executing DQ checks and reporting.

- Roll out the DQ program for the datasets and respective WWD divisions identified for Waves 2 and 3.
- Review and refine existing DQ processes, policies, techniques, metrics, and data quality rules.
- Continuously monitor data quality of the datasets under the data quality program and remediate issues.
- Review technology needs and procure accordingly.

- Roll out the DQ program for the remaining datasets and WWD divisions.
- Review and refine existing DQ processes, policies, techniques, metrics, and data quality rules.
- Continuously monitor data quality of the datasets under the data quality program and remediate issues.
- Review technology needs and procure accordingly.

B E N E F I T S

- A lean and sustainable data quality program established
- DQ of identified data storages established and respective corrections identified and executed based on their priorities
- Improved data quality for Wave 1 critical datasets realized

- DQ checks, processes, policies, tools/technologies, and metrics reviewed and refined to reflect current needs
- Improved data quality for Wave 2 and 3 critical datasets realized

- DQ checks, processes, policies, tools/technologies, and metrics reviewed and refined to reflect current needs
- Improved data quality for most of the WWD critical datasets realized

Wave 1 — *Waves 2 to 3* — *Waves 4+* →

Recommendation 5 | Establishing Data Standards, Policies, Best Practices, and Rules

Lack of a well-defined data governance model impedes the ability for WWD divisions to share datasets reliably.

BUSINESS CHALLENGE

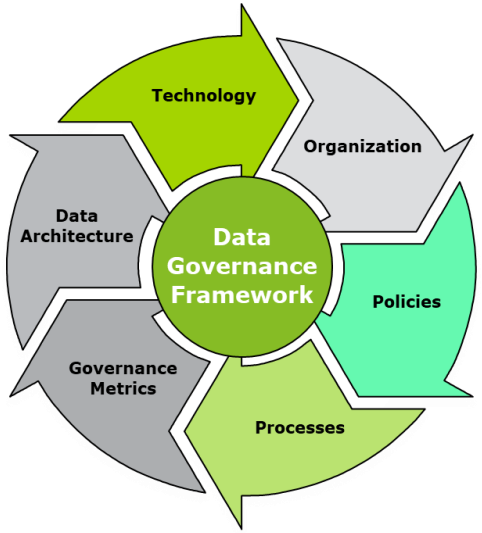
Although data ownership at a high level is defined amongst divisions, there is no central data governance in place that establishes standards, policies, best practices, and rules for use of data and provides visibility over data assets.

RECOMMENDATION

Implement a data governance program

Data governance is the collection of decision rights, processes, standards, policies, and technologies required to manage, maintain, and leverage data assets as an enterprise resource. The governance spans across 10 disciplines of data management (e.g., metadata management, data quality, etc.).

WWD should implement a data governance program that encompasses adoption of an appropriate organization model, definition of policies, processes, and governance metrics against selected disciplines of data management, data architecture providing visibility over data assets, and technologies to operationalize data governance.



BUSINESS OUTCOMES

- Enables consistent, central, and governed storage/use of data
- **Streamlines and democratizes access** to critical data
- **Improves data sharing** across divisions
- Drives **confidence in data-driven insights** from trustworthy and reliable data
- Facilitates further **monitoring and improving** of data governance through a stewardship view

Strategy | People | Process | Data | Technology

Recommendation 5 | Detailed View of a Data Governance Framework

A comprehensive data governance program spans across six focus areas that WWD can invest in to govern selected data management disciplines (refer to Appendix B for further detail).

Technology provides solutions to enable data governance capabilities.

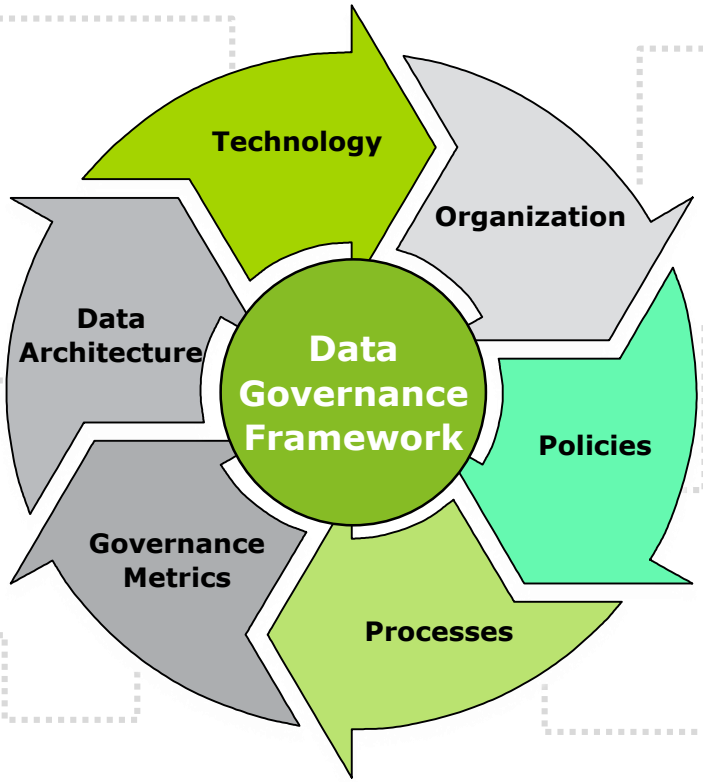
Organization defines the network of resources to deliver governance capabilities.

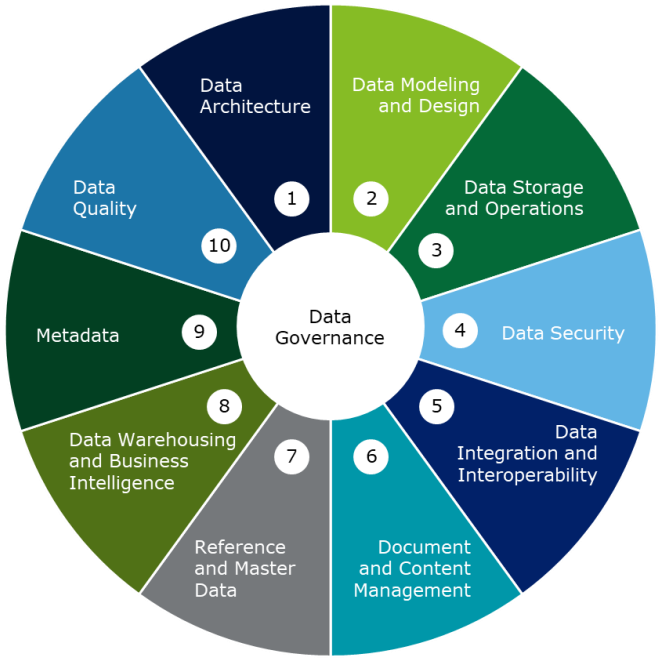
Data architecture includes business and information model and a metadata dictionary.

Policy refers to guidelines and principles to enforce data governance processes.

Governance metrics establish measures to monitor performance of enterprise data.

Processes establish guidelines on management of routine data governance tasks.





Fundamental Data Management Capabilities (as defined by Data Management Association (DAMA))

Recommendation 5 | Sustainably Growing Data Governance

Data Governance should grow organically addressing and incorporating components as necessary, and only at the level-of-detail necessitated, becoming elaborated over time.

K E Y A C T I V I T I E S

- Conduct a Data Governance (DG) assessment, including defining the operating model, designing the processes, policies, metrics, and high level data architecture, and reviewing technology needs.
- Roll out the DG program for the datasets and respective WWD divisions, identified for Wave 1, by standing up the operating model, designing detailed data architecture components (e.g., data dictionary), and implementing DG process, policies, metrics, etc.

- Roll out the DG program for the datasets and respective WWD divisions identified for Waves 2 and 3.
- Review and refine existing DG processes, policies, data architecture components, and metrics.

- Roll out the DG program for the remaining datasets and WWD divisions.
- Review and refine existing DG processes, policies, data architecture components, and metrics.

B E N E F I T S

- A lean and sustainable DG program established
- Improved visibility and control over Wave 1 critical datasets realized

- A lean and sustainable DG program established
- Improved visibility and control over Wave 1 critical datasets realized

- The DG program is extended to all of WWD divisions
- Improved visibility and control over the majority of the WWD critical datasets realized

Wave 1 — *Waves 2 to 3* — *Waves 4+* →

Recommendation 6 | Putting BIA Capabilities in the Hands of End Users

Implementing self-serve reporting capabilities can help foster a data-driven culture throughout the organization by democratizing data.

BUSINESS CHALLENGE

WWD's end users lack self-serve capabilities to produce reports and analytical insights which increases their dependency on IST, affects their ability to produce advanced reports, and increases the time and effort that they require to create reports and insights.

RECOMMENDATION

Implement self-serve reporting capabilities

Due to lack of self-serve reporting tools, development of reports requires considerable effort across divisions. Manually intensive processes are followed to compile reports leading to decreased employee productivity and increased risk of data quality related issues.

Self-serve reporting allows non-IT professionals to be more independent in accessing and working with data even if they don't have a background in statistical analysis, business intelligence or data mining. In addition, business users can be empowered with more timely, meaningful and flexible analytical capabilities to produce data-driven insights.

APPROACH

WWD needs to procure a (or set of) self-serve reporting tool(s) that is compliant with its business needs, is easy to use, and is interoperable with WWD's IT landscape. Once WWD procures and installs the desired tool(s), it needs to provide end user training and establish support for achieving department-wide adoption of the tool. WWD needs to continuously evaluate the need for to change/add new tool(s) with the arrival of new use cases, as warranted.

BUSINESS OUTCOMES

- Facilitates **easier access to data** for business users through self-serve capabilities
- Enables **generation of deeper insights** from data by arming users with toolsets that allow data visualization and data manipulation
- Improves **flexibility for business users**, enabling them to create personalized reports for the questions they are seeking answers to
- Improves **productivity for business users** through use of self-serve tools that shorten the time required for data preparation

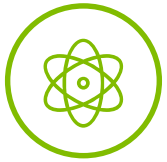
Strategy | People | Process | Data | Technology

Recommendation 6 | Overview of Self-Serve Reporting

Self-serve reporting tools should be selected based on assessment of key functionalities, broadly defined by eight categories.

Data Discovery

Searching, sampling, profiling, cataloging data assets and tagging data for future exploration and pattern detection



Data Transformation

Blending data, filtering data based on selected data attributes, computing based on user requirements, and augmenting data

Data modelling/Structuring

Providing support for logical models and logical data structures, and discovering relationships among data source attributes

Mobile Access

Accessing data, reports, and dashboards on mobile/tablet devices

Data Preparation

Harmonizing disparate data sources to provide unified datasets for analysis, managing data life cycles, and maintaining data quality

User Collaboration

Sharing data source connections, sharing queries, sharing datasets, and publishing/sharing models

Data Visualization

Preparing and designing business user-oriented, visual, and interactive data views such as charts, graphs, maps, and dashboards

Predictive Analysis

Extracting information from data sets to determine patterns that inform future outcomes and trends

Recommendation 7 | Improving Visibility and Availability of Assets

Adopting master and reference data management capabilities will ensure that WWD is equipped with a 360-degree view of assets for use in analytics, help control data quality, reduce overhead of data management in general, and minimize the risk of poor data quality.

BUSINESS CHALLENGE

Divisions across WWD have expressed the need for having a complete view of their assets to answer key business questions such as "What assets does the department own?", "When should WWD replace its assets?", "Which assets have been draining WWD's budgets the most?", and "How should WWD optimize use of its assets?". In addition to answering these questions, the divisions would like to provide a consistent answer for public inquiries and optimize their operations.

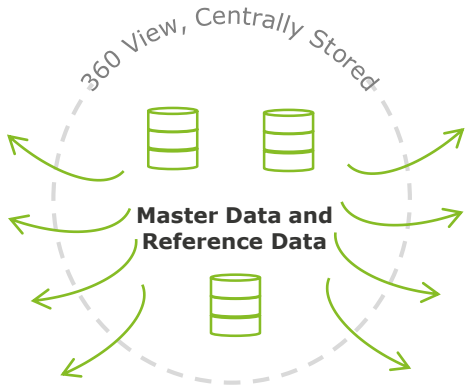
RECOMMENDATION

Implement Master and Reference Data Management (M/RDM) capabilities

Master data and reference data both satisfy the role of centralizing data that serves BIA needs across WWD divisions. A master data system will enable WWD to centralize its asset data which is currently stored in multiple systems (e.g., GIS, Excels, etc.) and link this data with various other relevant datasets (e.g., work orders in OWAM). This system will provide the department with a 360-degree view of its assets in the process.

Reference data capabilities, which are fundamental to master data implementation, will cater to WWD's needs beyond master data such as customer address information.

Master data management is a complex and critical capability in an organization's data landscape. Once WWD implements master data capability for "Assets" data entity, the City can leverage the experience and expertise developed in-house, to deliver a citizen-centric master data solution.



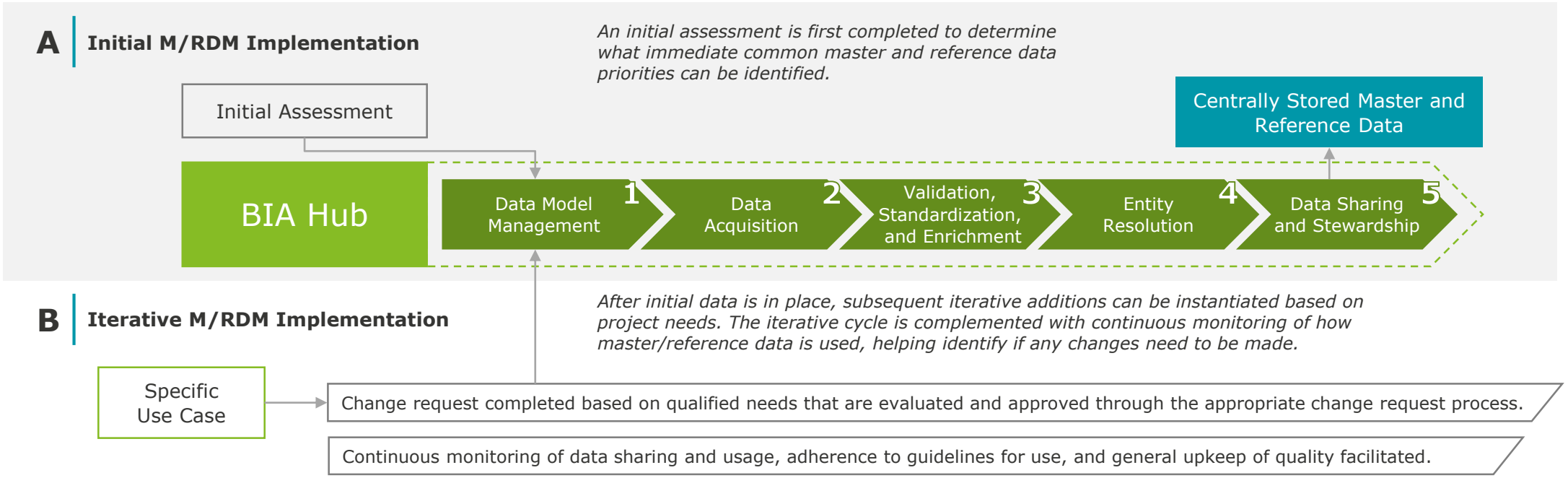
BUSINESS OUTCOMES

- **Provides a 360-degree view of all assets** for access and use
- **Promotes good data quality** by minimizing opportunities for data redundancy
- **Reduces overhead of data management** by centralizing shareable assets together
- **Minimizes risk** of incorrect data usage or data escaping quality
- **Enables analytics use cases** (e.g., predictive maintenance) that answer some of WWD's high value crunchy questions

Strategy | People | Process | Data | Technology

Recommendation 7 | Basic Approach to Integrating Master and Reference Data

An initial assessment helps integrate a first-pass collection of master and reference data, with additional sources integrated as required as part of the BIA Hub-managed M/RDM process.



1 A model for the data must be defined, accounting for and consolidating the needs of relevant stakeholders. The corresponding architecture for storage and access should be considered at this early stage.

2 Data acquisition extends beyond concerns for addressing integration to the underlying considerations of assessing data quality, completing data profiling, and establishing responsibility for monitoring and upkeep.

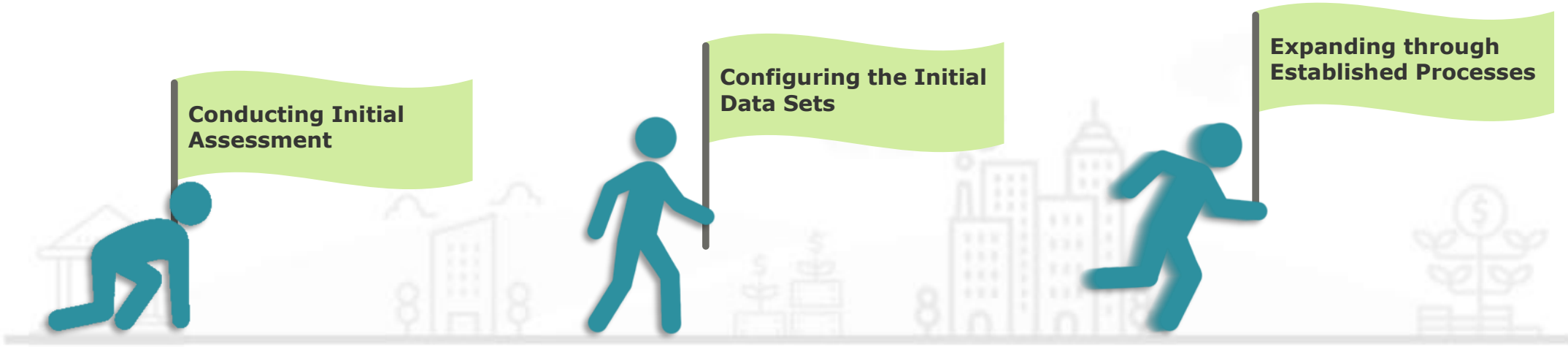
3 The three activities respectively address checking data is correct and passes quality criteria, ensuring data adheres to established standards and formats, and expanding attributes to enrich data (e.g., via source properties, date of entry, etc.).

4 Entity resolution entails matching and merging records to consolidate the "truth"; activities include reference preparation, reference resolution, identity management, and relationship analysis.

5 Much of the data management process in this context can be algorithmically managed (i.e., automated), but stewardship must nonetheless be defined to provide oversight, respond and review needs, and raise concerns as necessary.

Recommendation 7 | Progressive Incorporation of Master and Reference Data

Master and reference data will be incorporated in two ways: first, by an overall initial assessment with the long-term BIA vision incorporated, and second by use case driven needs.



K E Y A C T I V I T I E S

- Develop context/understanding and reusable frameworks for addressing MDM.
- Leverage use cases to generate justification and buy-in for the R/MDM effort.
- Conduct an initial master data and reference data assessment for "asset" data entity (to determine immediate common master and reference data priorities), assess data and implementation challenges, and define a high level implementation plan.
- As part of the initial assessment, identify master and reference data processes, policies, standards, and the operating model.

- Implement a master data and reference data solution for "asset" data entity.
- Establish processes, policies, standards, and required operating model to standup and maintain the master data and reference data solution.

- Continue implementation of the master and reference data solution.
- Establish a change request process, inline with existing processes, to allow additions or changes to the master and reference data.
- Identify additional reference data use cases beyond the ones for "asset" data entity.
- Leverage the change request process to add additional datasets to the master and reference data solution.

B E N E F I T S

- Master data and reference data priorities identified
- Key risks associated with implementation of the master data solution identified

- Multiple BIA use cases (e.g., data-driven capital planning for assets, data-driven asset repair, etc.) enabled
- In-house expertise and knowledge for future master data (e.g., citizen-centric master data solution for the City) and reference data projects attained

- Additional BIA use cases enabled
- Single source of truth for additional datasets established through reference data implementation

Waves 1 to 3 — *Wave 4* — *Beyond Wave 4* →

Recommendation 8 | Driving Insights and Informed Business Decisions

Developing and leveraging advanced analytics capabilities will help WWD drive value from the data available to them, supporting its divisions and the department overall to execute its operations better and make more informed business decisions.

BUSINESS CHALLENGE

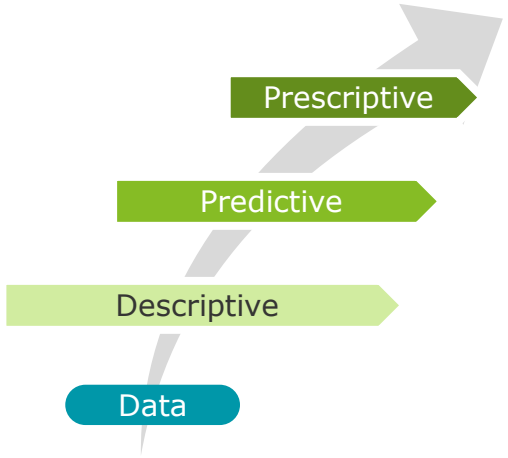
WWD currently employs limited analytics capabilities, forgoing the potential value that can be extracted from its data assets to support business activities and decision-making.

RECOMMENDATION

Develop analytics capabilities

The effort and emphasis on building the foundations of a BIA program – from a Big Data platform to data governance – is to set the stage for advanced analytics capabilities.

The implementation of such techniques will rely on prioritization, but will span the breadth of divisional interests including process optimization, predictive maintenance, cost containment and education, annual budgetary planning, and more. Implementation of such use cases will act as catalyst for BIA aspirations of other City departments.



APPROACH

Building upon use cases (i.e., the crunchy questions) identified during this assessment, continuously identify and prioritize additional analytics use cases, deliver them incrementally using agile processes, operationalize them, and communicate their value to continue the momentum.

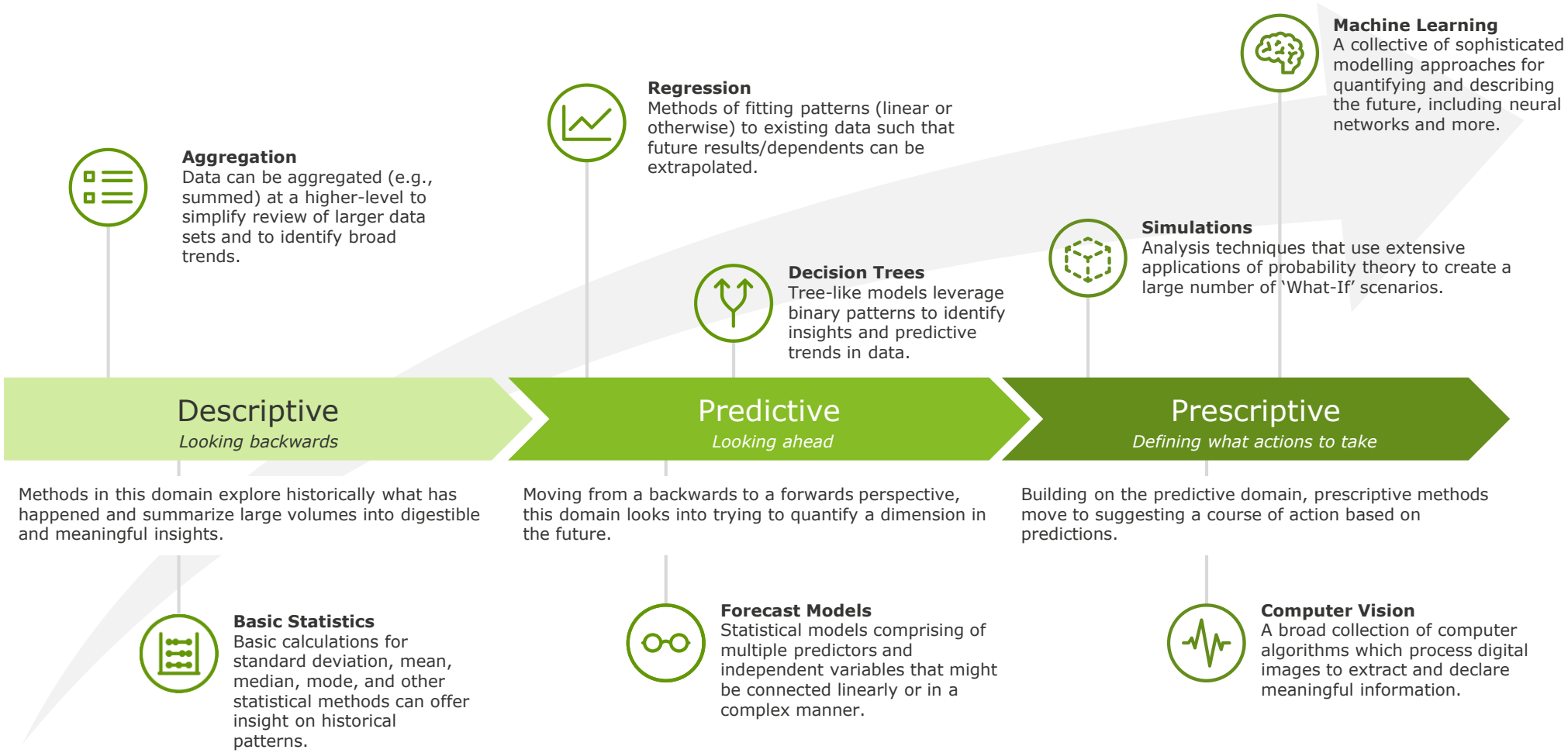
BUSINESS OUTCOMES

- **Capitalizes on the wealth of data present**, which would otherwise be underutilized without a BIA program, to make insight-driven business decisions, lower costs, optimize operations, improve compliance, and create a positive impact on citizens
- **Develops a better understanding of operations today** through greater application of descriptive methods
- **Develops an insight-driven culture** as opposed to gut-based by demonstrating value of analytics across the department

Strategy | People | Process | Data | Technology

Recommendation 8 | Overview of Advanced Analytics Capabilities

Analytics capabilities broadly fall into three categories – descriptive, predictive, and prescriptive – ranging incrementally in both value added and complexity/sophistication of approach.



Recommendation 8 | Key Business Questions from IDO Lab

During the IDO lab, key business questions were discovered as potential areas of interest for BIA application, organized by the type of value generated.

Cost Reduction

- How can we consistently develop our cost of service rates process (thereby making the process less subjective and less ad hoc)? *(Finance and Administration)*
- How do we optimize operations of pumping stations and distribution system assets to minimize the impact of transients? *(Water Services)*
- How can we identify unaccounted water including its theft (based on factors such as water consumption, meter age, and inspection date)? *(Finance and Administration)*
- How can we predict cart damage and replacement (asset planning)? *(Solid Waste)*
- How do we prioritize water services crew resources to maximize benefit (i.e., how do we prioritize between meter exchanges and turn-offs for non-payment and water main repair)? *(Water Services)*
- How can we use asset information (including maintenance) in conjunction with external influences (e.g., climate) to make optimal decisions? *(Wastewater Services)*
- How do we optimize asset management practices to maximize efficiency and reduce costs? *(Wastewater Services, Engineering, and Water Services)*
- How can we improve spending tracking to ensure alignment to budget? *(Wastewater Services)*
- How can we predict water main renewal work required beyond 1 to 2 years? *(Engineering)*

Revenue

- Can BIA change the service model (i.e. Demand Management / Elastic Supply)? *(Across WWD)*
- Can we predict customer payment behavior, i.e., which customers will fall in arrears? *(Finance and Administration)*
- How do we optimize landfill management by guiding services, controlling revenue loss, and adjusting the pricing model? *(Solid Waste)*
- How do we optimize meter population? *(Finance and Administration)*
- How do we ensure we are billing for all services provided? *(Finance and Administration)*

Impact on Citizens

- How do we provide a consistent customer experience? *(Engineering)*
- What proportion of Utility Billing Center calls have been diverted to the MyUtilityBill portal? *(Customer Service)*
- How do we track and prioritize media and councilor requests? *(Wastewater Services)*
- How can we predict and avoid dry weather overflows? *(Wastewater Services)*
- Are we competitive compared to other utilities? *(Across WWD)*
- How can we measure success where success results in less direct data? *(Across WWD)*

Strategic Alignment

- How can we drive innovation and leverage technology trends like the "Internet of Things" (IoT) in our strategy and planning processes? *(Across WWD)*
- Are we a service or a business (related to changing level of service, e.g., reduction of work hours)? *(Across WWD)*
- How do we go from >50% to 0% unplanned maintenance? *(Wastewater Services, Engineering, and Water Services)*
- How to use data to drive best practices for council decisions? *(Across WWD)*
- How can we measure success and feed back actual costs for future estimates? *(Information Systems and Technology)*

Capability/ Talent

- How can BIA insights help with capability planning? *(Information Systems and Technology)*
- How do we reduce incidents and injuries to improve health and safety at the workplace? *(Human Resources)*

Compliance/Reporting

- What is the impact of turning off a water-main valve? *(Water Services)*
- What are the collective financial implications of a given work order and how can we leverage this information to forecast future costs/effort? *(Water Services)*
- How can we improve water meter reporting accuracy (consumption)? *(Finance and Administration)*
- How do we enhance monitoring of compliance? *(Water Services, Wastewater Services, and Environmental Standards)*
- How do we prioritize maintenance efforts? *(Wastewater Services)*
- How do we reconcile differences between budgeting, HR planning, collective agreements, and financial resource planning? *(Water Services)*
- How do we ensure data is sent to end users efficiently in a usable and meaningful format? *(Environmental Standards)*
- What is the most cost-effective way to record assets (carts) to ensure accuracy? *(Solid Waste)*

Recommendation 8 | Key Business Questions Prioritization Map

A prioritization map is essential for distilling key business questions into what has value, what's complex, and thus answering what should be targeted as initial BIA efforts.

1 How can we measure success where success results in less direct data? *(Across WWD)*

2 Are we competitive compared to other utilities? *(Across WWD)*

3 How do we optimize landfill management by guiding services, controlling revenue loss, and adjusting the pricing model? *(Solid Waste)*

4 How can we consistently develop our cost of service rates process (thereby making the process less subjective and less ad hoc)? *(Finance and Administration)*

5 How can we drive innovation and leverage technology trends like the "Internet of Things" (IoT) in our strategy and planning processes? *(Across WWD)*

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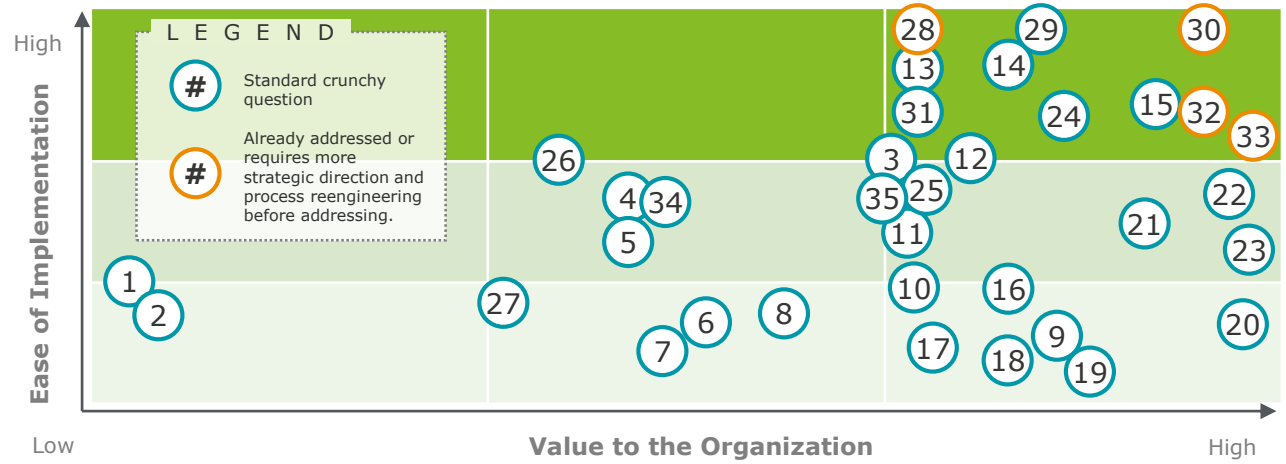

11 Can we predict customer payment behavior, i.e., which customers will fall in arrears? *(Finance and Administration)*

12 How do we prioritize water services crew resources to maximize benefit (i.e., how do we prioritize between meter exchanges and turn-offs for non-payment and water main repair)? *(Water Services)*

13 How do we optimize meter population? *(Finance and Administration)*

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16 How can we predict cart damage and replacement (asset planning)? *(Solid Waste)*

17 How can BIA insights help with capability planning? *(Information Systems and Technology)*

18 How to use data to drive best practices for council decisions? *(Across WWD)*

19 Are we a service or a business (related to changing level of service, e.g., reduction of work hours)? *(Across WWD)*

20 How can we use asset information (including maintenance) in conjunction with external influences (e.g., climate) to make optimal decisions? *(Wastewater Services)*

21 How do we go from >50% to 0% unplanned maintenance? *(Wastewater Services, Engineering, and Water Services)*

22 How do we optimize asset management practices to maximize efficiency and reduce costs? *(Wastewater Services, Engineering, and Water Services)*

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34 How can we predict water main renewal work required beyond 1 to 2 years? *(Engineering)*

35 How do we ensure we are billing for all services provided? *(Finance and Administration)*

Recommendation 9 | Structuring Development and Aligning to the Future State

Development and adherence to a BIA reference architecture will reduce the level of effort for future development, reduce the challenge of governance, and minimize the risk of technology and strategy misalignment in pursuit of the future state.

BUSINESS CHALLENGE

At present, WWD does not have a BIA reference architecture that prescribes a set of BIA tools and technologies for enabling divisional capabilities, resulting in unmanaged implementation with downstream consequences such as added cost and difficulty of BIA governance. This challenge, if not addressed, could have significant implications during implementation of the Big Data platform, which comprises of a multitude of technologies.

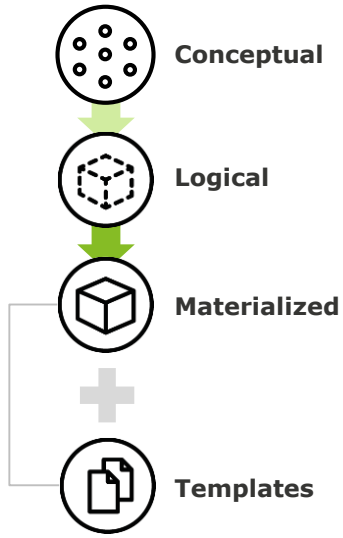
RECOMMENDATION

Define the reference architecture

A reference architecture will help clarify and communicate the future state vision in both technical and business terms by laying out both the design (at varying levels of technical-specificity) and templates for modification/ development of the Big Data platform and associated BIA tools.

APPROACH

Develop the BIA reference architecture by leveraging the tool assessment conducted in this BIA strategy. In the BIA reference architecture, continuously incorporate lessons learnt and make amends to address emerging needs.



BUSINESS OUTCOMES

- **Improves development cycle time** by leveraging best practices and established template workflows and by reducing potential duplication of effort
- **Simplifies governance**, reducing corresponding overhead
- **Reduces risk** of incompatibility from either a technology or strategy / future state alignment perspective

Strategy | People | Process | Data | Technology

Recommendation 9 | Structuring a Reference Architecture

The reference architecture is captured and made explicit through appropriate documentation.

Communicates business context and key drivers that clarify and support the BIA vision. From basic elaboration of BIA itself to details of the challenges and guiding principles of design that have led to the definition of the reference architecture.

An intermediate symbolic view that describes the technology/solution-agnostic conceptual form of the high level architecture. This perspective not only outlines the individual components but also the inter-relationships across to illustrate the flow of control between them.

Defines template and common use cases adhering to the constraints of the architecture described. From extending access at the consumption layer with additional tools to augmentation of the enterprise platform, such scenarios will ensure compatibility and alignment of all future changes.

Describes a capability-based view of the architecture that addresses the preceding business drivers. Defined in the context of the aspirational future state, capabilities provide higher-level abstraction of intended functionality (over logical and technical views) making it easier to understand the relationship to strategic business objectives.

The lowest-level view that is solution-specific and explicit to the finest level of detail required. The granularity can become as fine as the file system itself for specific hardware to the choice of partitioning or other specific technical implementations and corresponding justifications.

Recommendation 10 | Building BIA Incrementally through Quick Wins

A systematic approach to deployment via an agile framework catered to BIA will help the department garner support for the BIA program, reduce associated risks, and observe more efficient delivery of the program and its subcomponents.

BUSINESS CHALLENGE

Using conventional and linear delivery cycles, WWD will struggle with the overall implementation of a large-scale BIA deployment, facing-off against large investments, slow return on investment, and low visibility (and therefore observing limited buy-in) of the initiative.

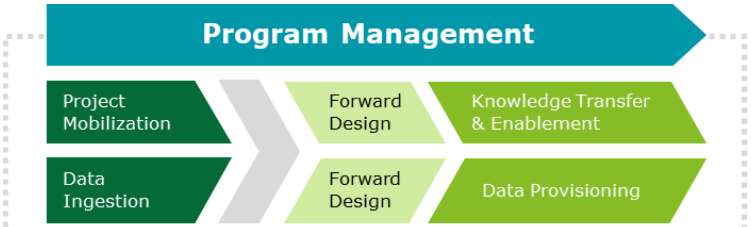
RECOMMENDATION

Adopt agile BIA delivery processes

An agile approach emphasizes the use of sprints to realize delivery in smaller, more frequent cycles as opposed to the conventional single large cycle. WWD can leverage a BIA-specific framework for the overall deployment and individual initiatives within.

APPROACH

Leverage a vendor to deliver early use cases using an agile approach and have them facilitate knowledge transfer back to the team. In Wave 4, design agile processes and designate resources to facilitate delivery. Augment existing staff to enable agile coaching in initial internal delivery. Add a scrum master to BIA hub and continue to deliver use cases in agile fashion.



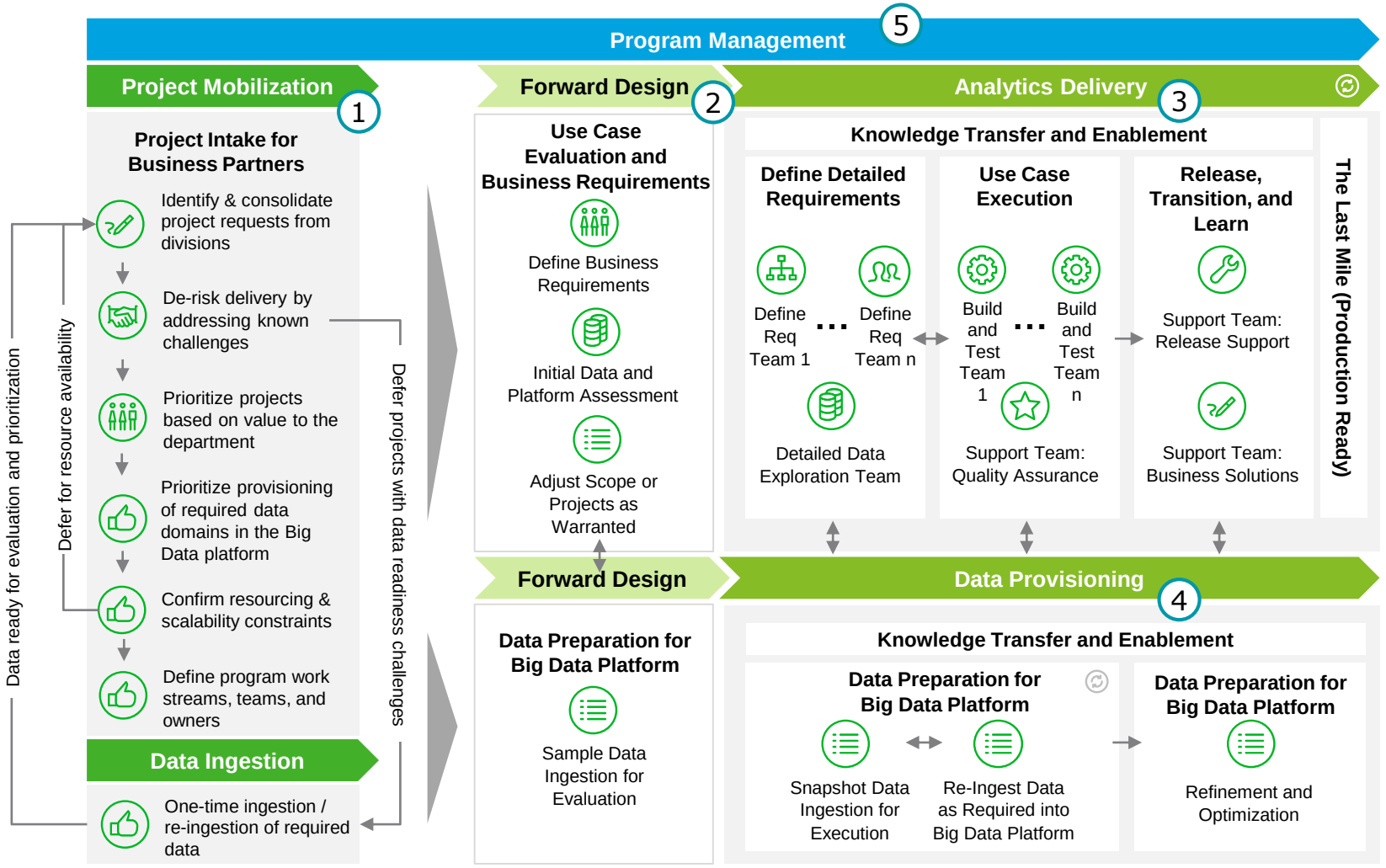
BUSINESS OUTCOMES

- **Fosters support** through quick wins and demonstration of consistent progress in place of stretched apart milestone deliveries
- **Reduces risk and cost** as the agile delivery approach improves visibility of potential problems and minimizes sunk costs
- **Improves overall delivery time** since agile analytics practices offers the ability to let products/methods be used before final completion (i.e., after an interim sprint)

Strategy | People | Process | Data | Technology

Recommendation 10 | Agile Analytics Delivery Model

The approach to delivering analytics at scale requires a combination of forward thinking through mobilization, flexible execution through agile principles, and clear understanding of the 'Last Mile'.



1. The **Program Mobilization** team ensures BIA use cases are sourced and prioritized based on the department's strategic vision. Any known challenges are identified to reduce delivery risks (e.g., data unavailability, resource constraints) and program teams, streams, and owners are established.

2. The **Forward Design** team will collaborate with divisions to define high level requirements, assess data and platform requirements, and ingest sample data for the identified use case. Next, the team will identify the data and infrastructure constraints to validate/modify/defer the use case.

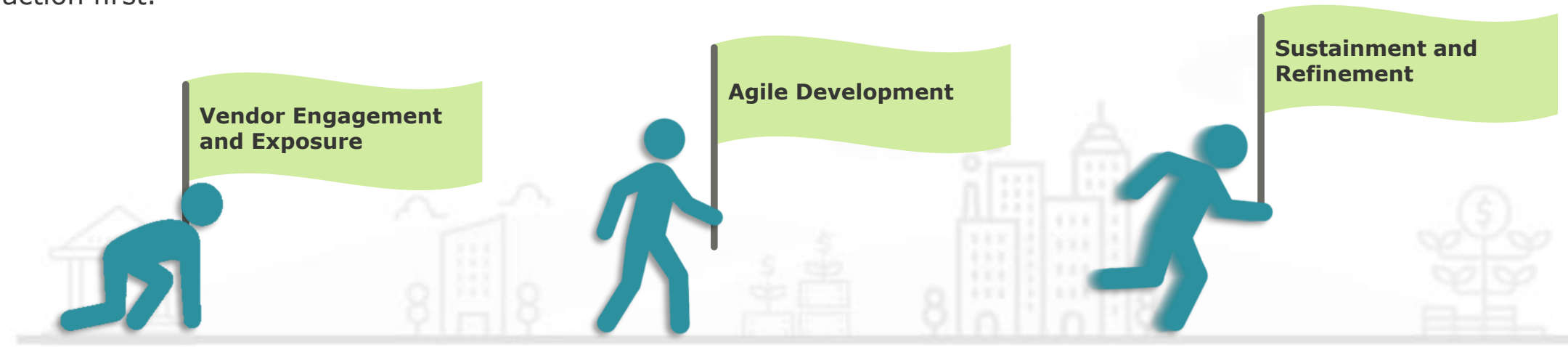
3. The **Analytics Delivery** teams will define detailed requirements, build, and test analytics use cases in a series of sprints for each release cycle. Quality assurance teams work closely to enhance the quality of the analytics solution. Once the analytics solution is built and fully tested, training and knowledge transfer is carried out for end users and the production solution is handed over to operations team.

4. The **Data Provisioning** team will initially ingest data in the Big Data platform for developing, testing, and QA purposes, inline with scope of the selected use case. Eventually they will automate this process to make the BIA solution production ready.

5. The **Program Management** team will provide oversight and program governance for all analytics deliverables. They will be critical for resource planning and resolving issues and risks at the program level.

Recommendation 10 | Starting with a Light Touch

The bulk of agile practice development and internalization will be delayed until wave 4, helping to minimize drastic upfront change, and help staff ease into the methodology through observation and interaction first.



K E Y A C T I V I T I E S

- Vendors deliver use cases in agile fashion, and product owners (i.e., those who raise the use case and benefit from its delivery) coordinate and observe development through sprints.
- BIA Hub similarly plans projects and observes delivery through sprints.
- Knowledge transfer is facilitated at the end of each use case to help agile capabilities and readiness within the department.

- Agile processes developed dictating end-to-end delivery model for analytics.
- Agile operating model defined to integrate with BIA overarching operating model, specifying an interaction model, governance, teams/roles, engagement process, etc.
- Agile coaching facilitated for initial use cases delivered internally, with a scrum master to manage activity.

- Use cases continue to be delivered internally in agile fashion.
- Teams and roles are expanded as necessary to accommodate growth of the BIA program and use cases being delivered.
- Agile processes are refined as necessary based on delivery success and review.

B E N E F I T S

- Early agile capability development, helping ease the organization into the methodology without up front investment and delayed application

- Transition from light engagement to full practice of agile methodologies are facilitated through explicit definitions and coaching
- Department becomes fully agile capable with respect to BIA program delivery

- Agile approach is reinforced throughout department with more and more use cases delivered internally
- Agile delivery capabilities become refined

Waves 1 to 3 — *Wave 4* — *Beyond Wave 4*

Recommendation 11 | Bringing Everyone Onboard with the BIA Vision

Successful implementation of the BIA vision will necessitate change management, ensuring that stakeholders are involved and engaged from the beginning, challenges are exposed and planned against, and the message of an organization committed to its BIA vision is reinforced.

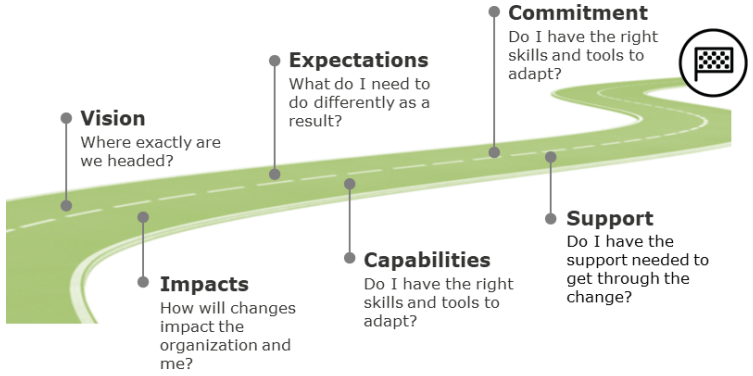
BUSINESS CHALLENGE

WWD will undergo significant change implementing proposed BIA strategies and practices, which can produce challenges with respect to adoption and integration if not managed appropriately. Given the maturity of the department on the IDO maturity scale and its existing dispersed operating model, it will be a leap to align stakeholders with the stated BIA vision.

RECOMMENDATION

Facilitate change management

A fundamental change in BIA practices and the implementation of both novel technical and organizational systems and procedures requires the use of change management practices.



APPROACH

In Wave 1, conduct a high level initial assessment to identify the stakeholders involved, determine where buy-in should be generated, identify and prioritize opportunities for change management interventions (e.g., communications, engagement, training), and assess the departmental/divisional capacity for change.

As part of the implementation of each of the recommendations, develop essential OCM capabilities required for them in an agile fashion. In addition, develop an OCM scorecard and use it to continuously measure and reinforce change.

BUSINESS OUTCOMES

- **Fosters stakeholder buy-in** across divisions through-out the process
- **Helps anticipate and mitigate potential roadblocks and overall needs** along the path of implementation
- **Reinforces the message of commitment** by the organization and management towards the advancement of its BIA strategy and overall capabilities

Strategy | People | Process | Data | Technology

Recommendation 11 | An Agile Change Management Approach

The conventional change management activities can be applied through a lean, flexible, and iterative approach to achieve sustainable change.

Change Preparation	Organizational Alignment	Communications	Training and Learning	Measurement and Sustainment
Assess and manage change readiness, facilitating leadership alignment and engaging stakeholders.	Plan, design, and execute role mapping.	Plan, design, develop, and deliver stakeholder communications throughout the project life cycle.	Design and deliver training/ learning solutions to enable uptake of new processes, tools, systems, and skills.	Measure effectiveness of change effort on an ongoing basis and transfer knowledge/skills.

Preparing for Change → *Managing Change* → *Reinforcing Change*

Integrate "change" with "agile" by aligning the project and change teams' processes and incorporating OCM impacts into the project outcomes.

In preparation for the initial wave of implementation, detailed assessments will identify the stakeholders involved, determine where buy-in should be generated, identify and prioritize opportunities for change management interventions (e.g., communications, engagement, training), and assess the organizational/ divisional capacity for change.

In parallel with other recommendations, essential OCM capabilities will be developed, from raising champions to drive buy-in and positive influence on other stakeholders, to definition of the communication approach, guiding principles, and deliverables, to establishing and rolling out training, all in agile fashion.

Progress and effectiveness of OCM efforts will be measured in subsequent waves via a Change Management Scorecard while champion and team member knowledge transfer will be facilitated to preserve and sustain adoption.

Appendix – A
Breakdown of Data Quality Framework

Recommendation 4 | Data Quality Breakdown

Roles & Responsibilities

Establishing the roles and responsibilities of the different potential users who will interface with the data will help preserve and simplify management of data quality.

Data Stewards
Responsible for overall governance of data domains / source systems. Reviews data quality results and provides key inputs regarding data standards, expected data quality, etc., to data quality specialist.

Data Quality Specialist
Responsible for quality of data assets, plans and manages data profiling and quality checks activities. Manages the data remediation process and prioritizes the data quality issues.

Processes

Standardization of data quality-related operations in the form of processes will support the introduction, tracking, and enforcement of data quality requirements.

Data Quality Requirements Definition
Foundational to implementing all other data quality processes, it is necessary that the standards and limitations of data quality be established based on alignment to business needs. Effort in defining requirements should be prioritized based on where data quality will provide the most added value.

Data Quality Monitoring
The necessity for monitoring serves a dual purpose. Firstly, it is important consumers are informed and aware of the level of quality of data used as part of business operation. Secondly, monitoring ensures data quality is adhered to and any changes therein are observed and acted upon if necessary.

Issue Management and Remediation
Procedures should be established for diagnosing issues, formulating options for remediation, and ultimately resolving issues. Tracking can be supported by standardizing activities, creating an assignment process, defining escalation procedures, and by defining resolution workflows.

Dimensions, Metrics, and Rules Management
Dimensions, metrics and rules should be continuously reviewed and updated to reflect business' current requirements and existing data quality.

Recommendation 4 | Data Quality Breakdown (continued)

Tools, Technology, and Techniques

A variety of technology solutions can be used to both monitor and enforce data quality, in conjunction with techniques for enforcing, preserving, and managing quality.

Data Profiling Tools
Essential for data discovery, these tools assess the overarching data patterns, summarizing visually (e.g., via histograms) or numerically as with an aggregate statistical metric.

Data Querying Tools
Following profiling, these tools enable further investigation of data quality, identifying lower level aspects such as uniqueness or integrity.

Data Quality Rule Templates
Templates provide a consistent format for documenting business rules (i.e., the human readable limits on data).

Data Quality Tools
Supporting automation, these tools can execute on defined data quality rules like limits and choose a course of action (e.g., assigning quality, removing bad data points, etc.).

Preventative Actions
Limit poor quality data from ingestion through data entry controls, guidance for upstream data producers, and by implementing data governance and stewardship.

Corrective Actions
Poor quality data that has passed preventative measures can be managed via automated, manually-directed, or otherwise plain manual corrections.

Statistical Process Control
A method that observes process quality by assessing variation across inputs, outputs, or steps for systematic and regular detection.

Root Cause Analysis
A method whereby problems are traced back to their respective origin, eliminating quality issues at their source.

Data Dimensions and Metrics

Metrics and dimensions established should relate to the following key performance indicators (KPIs) to fully address data quality.

	Example
Accuracy Captures the degree to which the data reflects the quantitative property it represents.	*Number of daily record sets exceeding a 24 hour sum across records*
Completeness Accounts for whether all data necessary at a particular level-of-detail is present.	*Number of hourly measurements missing from a daily record set*
Conformity Reflects the degree to which data complies with expected data standards.	*Percent of date fields not in YYYY-MM-DD format (as an example rule)*
Currency Reflects how timely or up-to-date the data is relative to needs.	*Time taken to make the data available for reporting*
Integrity Refers either to referential integrity (i.e., table key matches) or internal consistency (i.e., no missing data).	*Number of orphaned records in a table*
Consistency Broadly defined, from uniqueness within a dataset to meeting a set expectation or business rule.	*Percent of duplicate records in table*

Appendix – B

Breakdown of Data Governance Framework

Recommendation 5 | Data Governance Breakdown

Organization

Organization defines the network of resources to deliver governance capabilities.

Operating Model
Standing up a data governance program requires an organization to define an operating model that meets its requirements. Three basic models are decentralized, hybrid and centralized. The decentralized model involves data governance activities being managed in silos, whereas the centralized model requires data governance activities to be managed by a Center of Excellence. The hybrid model leverages the strengths of each to achieve an effective middle-ground. Once a model is selected, it needs to be further curated to meet an organization's needs.

Roles and Responsibilities
In order to implement data governance, an organization needs to define responsibilities of groups identified in the operating model and staff key roles (e.g., executive sponsor – responsible for funding of data governance program, data owner – owner of a data domain, data steward – manages and ensures quality of data stored in data domain). Well-defined roles and responsibilities lead to appropriate decision rights and accountability and is foundational for success of a data governance program.

Data Governance Meeting Cadence
A well established meeting cadence within the data governance group allows teams to share progress, raise and solve issues and ensure alignment on objectives. Additionally, a meeting cadence for each of the identified groups in the operating model can enhance team momentum and change course as required.

Technology

Technology provides solutions to enable data governance capabilities.

Business Glossary
A business glossary houses definitions of business terms (e.g., water flow, water consumption, etc.) across divisional units. It helps the business to agree upon common definitions that define the data.

Document Management Tools
Document management tools enable storage, management, and tracking of documents. They provide users easier access to data documents, improved file sharing and options to backup valuable data. It can be leveraged to house some of data governance documents.

Data modelling Tools
Data modelling tools assist architects with creating visual data models highlighting data sources, table relationships, and definitions across the data landscape.

Workflow Tools
Workflow tools enable automation, management, and optimization of business activities. They empower users to create, submit, and track requests and capture process related metrics.

Data Governance Scorecards
Data governance scorecards are used to track and report on data governance activities and compliance with policies.

Graphic Design Applications
Graphical design applications enable users to create architectural design diagrams and data flows.

Recommendation 5 | Data Governance Breakdown (continued)

Process & Policy Categories	Process	Policy
	Processes establish guidelines on management of routine data governance tasks.	*Policy* refers to guidelines and principles to enforce data governance processes.
	E X A M P L E S	E X A M P L E S
Data Quality Comprises of processes and policies related to standing up and maintaining data quality standards across source and target systems.	**Data Quality Remediation** Process of cleansing data related issues identified during the regular review of data quality reports or after an ad-hoc investigation.	Quality of critical data elements will be monitored regularly by business owners and data stewards and cleansed periodically to discover and remediate errors, issues, and risks.
Metadata Comprises of processes and policies related to managing information related to data (e.g., database table/column names, access permissions, file creation date, etc.).	**Assess Existing Metadata Sources and Information Architecture** Process of conducting interviews with key IT staff and reviewing documentation of system architectures, data models, etc.	Technical metadata for all terms defined in business glossary should be available.
Reference and Master Data Comprises of processes and policies related to managing high quality master and reference data.	**Reference and Master Data** Comprises of processes and policies related to managing high quality master and reference data.	All prioritized master data must have a unique key across all systems.
Data Integration and Interoperability Comprises of processes and policies related to movement and consolidation of data within and between data sources, applications, and organizations.	**Extract, Transfer, and Load (ETL)** Process of moving data around and between applications. Data is extracted from source system, transformed based on desired parameters, and loaded onto a target system.	All date fields will be transformed to MM/DD/YYYY format.
Data Security Comprises of processes and policies related to proper authentication, authorization, access, and auditing of data and information standards.	**Authentication** Process of validating user's access to the system to verify user identity. Passwords are commonly used to achieve this task.	Data stored in an electronic format must be protected by appropriate electronic safeguards and/or physical access controls that restrict access only to authorized user(s).
Data Storage and Operations Comprises of processes and policies related to maximizing value from stored data, from acquisition to disposal.	**Archiving** Process of moving data that is actively used to a separate storage device for long term retention.	Retention period for archived data is set to 3 years.

Recommendation 5 | Data Governance Breakdown (continued)

Data Architecture

Data architecture includes the business information model and metadata dictionary.

Enterprise Information Model
An enterprise information model provides a conceptual view of data across the enterprise and sets a foundation for all data and data-related projects. An enterprise information model can include components such as a conceptual overview of the division subject areas, views of entities and relationships for those subject areas, and application/project specific models.

Data Lineage
Data lineage refers to the overall lifecycle of data as it moves through various systems. Data lineage can provide knowledge of data origins and changes that take place as data travels from its source to various destinations.

Data Dictionary
The data dictionary houses technical data definitions such as table names, field names, and data definitions, which help technical resources to organize and provision datasets.

Data Governance Metrics

Data governance metrics establish measures to monitor performance of enterprise data.

Design Data Governance Metrics
Data governance metrics (e.g., volume of requests, number of escalated data governance requests, number of approved data standards) allow a data governance team to measure the quality and health of their processes.

Report, Monitor, and Review Data Governance Metrics
After establishing data governance metrics teams should report, monitor, and review metrics using dashboards and establishing apt processes.

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