

Data for Decision Makers: Data Concepts and Applications

Course Handbook

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Preface

In today's data-driven world, the responsibility of public service demands more than experience and intuition; it requires evidence-based decision-making grounded in a deep understanding of data. For government officials at all levels, from local administrators to national policymakers, data is not just a tool - it is an indispensable asset in crafting policies that are effective, equitable, and accountable. *Data for Decision Makers* is developed with you in mind: to support those entrusted with public leadership in leveraging data to serve communities more effectively.

Across the domains of public health, education, transportation, environmental policy, and beyond, the availability of data has never been greater. But with this abundance comes complexity. Making sense of it - identifying relevant patterns, understanding root causes, evaluating outcomes, and anticipating future trends - requires more than access. It demands a strong foundation in the principles and practices of modern data use.

This course highlights how data literacy empowers government officials to navigate uncertainty, combat misinformation, and design policies that truly respond to the needs of the public. From statistical reasoning and geographic information systems to predictive modelling and real-time dashboards, the tools of data are transforming governance. Understanding these tools is essential to strengthening transparency, accountability, and public trust.

This course bridges the gap between technical expertise and policy leadership. It offers clear, accessible explanations of core data concepts alongside practical examples from the public sector. Whether your role involves strategic planning, budget allocation, programme evaluation, or legislative development, this course will help you make more informed, timely, and impactful decisions.

Public service is a profound responsibility. By embracing the potential of data, government leaders can enhance their ability to meet that responsibility with clarity, foresight, and integrity.

Part I

Data Concepts

1 Introduction

In an era defined by information, the ability to make sound decisions increasingly hinges on the intelligent use of data. Across sectors and industries, from healthcare and education to finance and public policy, decision-makers are confronted with unprecedented volumes of information. Yet, it is not the sheer quantity of data that holds value, but our capacity to interpret, understand, and apply it effectively.

Data is more than numbers on a spreadsheet; it is the language of modern insight. When approached with the right tools and understanding, it becomes a powerful asset for identifying patterns, predicting outcomes, evaluating strategies, and ultimately, improving results. For decision-makers, this means developing fluency not just in reading reports, but in questioning assumptions, validating sources, and interpreting results within context.

Understanding modern data concepts - from statistical reasoning and data visualisation to machine learning and real-time analytics - is no longer optional. It is foundational. These concepts empower leaders to move beyond intuition and anecdote, and toward evidence-based action. As data continues to shape the world around us, the ability to engage with it critically and creatively is becoming an essential skill.

This course aims to equip its participants with both the conceptual grounding and practical knowledge to navigate this landscape. Whether you are a seasoned executive, a policy analyst, or an emerging leader, this course is designed to bridge the gap between data science and decision-making. It demystifies the tools and techniques of modern data analysis and offers real-world applications that demonstrate how data can drive progress and innovation.

Good decisions are not just supported by data; they are shaped by those who know how to use it wisely.

1.1 Data-driven decision-making

Data-driven decision-making or DDDM refers to the process of making decisions based on data and information rather than intuition or experience alone. It involves collecting, analysing, interpreting, and presenting data to support decision-making processes¹⁻³.

In this approach, decisions are made by relying on facts, figures, trends patterns, and insights derived from data. The goal is to make objective, evidence-based decisions that are more accurate, consistent, and transparent.

i Note 1: Features of data-driven decision-making

Data-driven decision-making is widely used in various fields such as business, health-care, finance, education, and government. It allows organisations and individuals to:

1. **Informed Decisions** - make decisions based on data rather than assumptions or guesswork;
2. **Improved Accuracy** - reduce errors and biases by relying on objective information;
3. **Efficiency** - Optimise resources and processes by identifying trends, patterns, and inefficiencies;
4. **Transparency** - ensure that decisions are made in an open and transparent manner; and,
5. **Scalability** - Apply to large-scale operations or complex problems where traditional methods may be insufficient.

Data-driven decision-making often involves the use of tools, techniques, and technologies such as data analytics, machine learning, artificial intelligence, and visualisation software. By leveraging these tools, organisations can transform raw data into actionable insights that drive better outcomes.

In today's organisations, this approach has become increasingly important as it allows for more objective and accurate decision-making. The process typically includes identifying relevant data sources, applying analytical techniques, and leveraging technologies like machine learning, artificial intelligence, and visualisation tools to transform raw data to actionable insights that drive better outcomes.

An organisation that is data-driven also benefits in being able to spot opportunities and threats early. By analysing data regularly, organisations can anticipate changes and act before problems arise.

Saving costs is another advantage. In a survey of executives of Fortune 1000 companies regarding their data investments since 2012 commissioned by the Harvard Business Review, nearly half (48.4%) of respondents report that they are documenting measurable results from their investments in big data and 80.7% of the executives describing their investments in big data as being successful^{1,4}.

1.2 The case for data-driven decision-making

The context described above alongside the potential benefits proffered are strong reasons for considering a shift towards using data more effectively in decision-making processes. The following case studies provide a more nuanced narrative of opportunities and challenges of

adopting a data-driven approach to decision-making specifically in the context of governance within governments (rather than just in businesses).

References

2 All about data

We'll explore everything from the basics—such as what data is and why it matters—to more advanced topics like data collection, storage, analysis, and visualization. Through practical examples and real-world applications, you'll learn how to harness the power of data to drive insights, solve problems, and make informed decisions in fields ranging from business and technology to healthcare and beyond. By the end of this course, you'll not only understand the importance of data but also be prepared to apply these concepts in your own work or further studies⁵.

2.1 References

3 Case study: Data use and analytics in water quality management

This is a case study about the Division of Water (DOW), a local government agency in the State of New York, which has attempted to improve its analytic capabilities by developing efficient data management practices, suggest governance models, and identify analytic techniques potentially beneficial to addressing harmful algal blooms (HABs; see Figure 3.1) and high chloride concentrations³.



Figure 3.1: Harmful algal blooms (HABs) may look like green dots, clumps or globs on the water surface.

The DOW faces challenges in using its legacy systems and traditional analytical methods effectively in addressing the problems of HABs and high chloride levels. DOW aims to enhance its decision-making processes through DDDM by improving its ability to gather and analyse data more effectively, beyond their current capabilities, to better inform policy decisions.

From this process, nine key factors across four overarching determinants have been observed and articulated as being crucial to consider by an organisation in implementing a comprehensive strategy for DDDM (see Note 2). These factors interrelate and influence each other, requiring a holistic approach to ensure successful adoption.

i Note 2: Nine key factors for an effective DDDM strategy

Data determinants

DOW bases its decisions on internal water data from sampling and assessments, supported by a quality assurance process ensuring reliability and compliance with federal standards like those of the Environmental Protection Agency (EPA). Despite these strengths, challenges include manual sampling processes, incomplete data coverage, missing values, compatibility issues, and interoperability problems that hinder seamless data exchange and system integration.

1. *Data quality and coverage* Ensuring robust data infrastructure is foundational, as it supports the collection, storage, and accessibility of high quality data necessary for effective analysis.

2. *Compatibility and operability*

DOW manages water-related data through interconnected teams responsible for producing and analysing information from various sources like lakes and streams. While collaboration is facilitated by multiple analysts and teams, this setup poses challenges in maintaining consistent and compatible datasets due to differing file versions and a lack of field locking in their proprietary Filemaker system, risking data integrity. Additionally, varying levels of observation across systems complicate integration efforts.

Data compatibility and interoperability ensure that information flows freely, efficiently, and accurately across different systems, which is vital for organisations to function well, innovate, comply with regulations, and adapt as needed.

3. *External data*

DOW utilises external datasets to address complex environmental and social issues beyond its internal data. While this approach enhances knowledge creation by incorporating charts and maps that combine water chemistry with geographical data, it faces challenges. These include potential quality issues due to lack of control over external sources and incompatibility with specific analytical needs, as seen with United States Geological Survey (USGS) land-cover data not providing sufficient detail on farm types affecting water bodies.

Utilisation of external data potentiates and enriches an organisation's existing information which can lead to better and richer insights that can be derived from them.

Technological determinants

4. *Information systems and software*

5. *Analytical techniques* Investment in both skilled personnel and advanced tools is essential to transform raw data into actionable insights.

Organisational determinants

6. *Cooperation*

7. *Culture*

Institutional determinants Engaging with external institutions and navigating legal frameworks can provide resources and support, or pose restrictions, respectively.

8. *Privacy and confidentiality* Addressing legal requirements regarding data protection is crucial to ensure comprehensive analyses.
9. *Public procurement* Navigating bureaucratic processes efficiently can accelerate tool adoption without unnecessary delays.

These key determinants are interrelated and interdependent. For example, if an organisation has strong data infrastructure (determinant 1) but lacks the right analytical tools or skilled personnel (determinant 2), their DDDM efforts will be hampered. Similarly, even with good internal structures (determinant 3), if external regulations make it hard to access necessary tools or collaborate externally (determinants 7 and 9), progress is still limited. Without proper stakeholder engagement (determinant 6) and user involvement (determinant 5), the organisation might develop solutions in isolation, leading to less effective decisions. Moreover, privacy constraints (determinant 8) can affect data availability, which in turn impacts analytical capabilities since data is a key input.

While DDDM is often seen as a technical issue involving tools and data, it's also deeply influenced by organisational and institutional factors. This makes sense because any significant change requires not just new technology but also cultural shifts within the organisation to embrace these changes.

These determinants also influence the ability of an organisation to adapt over time. For example, if the organisation faces challenges in public procurement, which is a structural issue, this could create delays that affect the organisation's overall strategy. Conversely, strong stakeholder engagement might mitigate some of these delays by providing alternative solutions or resources.

3.1 Leadership role

Leadership plays a critical part in driving organisational change. Without supportive leadership, many of these determinants could be obstacles rather than opportunities. For instance, if leaders aren't committed to DDDM, they might not push for necessary cultural shifts or investment in new tools.

3.2 Balancing existing practices

The balance between existing practices and new methods is important. While the state agency was implementing DDDM, traditional approaches were still relied upon. This blend can be beneficial initially but may need careful management to avoid conflicts or inefficiencies as newer methods prove their worth.

3.3 Measuring success

How would this state agency assess its progress in implementing DDDM? They might look at metrics like the quality and timeliness of decisions, reduction in issues (like HABs), efficiency improvements, and user satisfaction. These outcomes can help gauge whether their efforts are paying off despite facing various challenges.

3.4 Conclusion

A tailored strategy that evaluates specific organisational strengths and weaknesses across these determinants is essential for effective DDDM implementation. This approach ensures that each organisation maximises opportunities while minimising challenges, leading to more informed and efficient decision-making processes.

References

4 Case Study: Enhancing Local Governance Through Data-Driven Decision-Making in Indonesia

In an era where technology and data are transforming governance, adopting a data-driven approach is crucial for improving decision-making and fostering transparency. This case study explores Indonesia's journey toward integrating data into local governance, highlighting both challenges and opportunities, and offers recommendations for mid-level government officials to enhance their governance strategies⁵.

4.1 Context

Indonesia, the largest archipelagic nation in the world, operates under a federalist system with provinces and regencies. With a diverse population of over 270 million people, it faces significant challenges such as inequality, environmental degradation, and sustainable development. These issues necessitate effective local governance to ensure equitable growth and environmental preservation.

4.2 Current Situation

Currently, Indonesia's policy-making is often influenced by top-down directives rather than data-driven insights. Decisions are frequently based on the instructions of superior officials due to a history of autocratic administration. Additionally, there is a lack of standardised data quality frameworks, leading to fragmented and siloed data systems. Limited analytics capacity and reliance on outdated technologies further hinder effective decision-making.

4.3 Challenges

1. **Autocratic Administration** A cultural tendency towards hierarchical decision-making limits the use of data in governance.
2. **Fragmented Data Systems** Siloed systems across different levels of government result in data inconsistencies and inefficiencies.

3. **Lack of Skilled Personnel** Insufficient training and expertise in data analysis impede effective data utilisation.
4. **Public Distrust** Concerns about data accuracy and misuse erode public confidence in data-driven decisions.

4.4 Opportunities

1. **Recent Regulations** The 2022 Data Governance Regulation provides a framework to standardize data collection and use.
2. **International Collaboration** Partnerships with international organizations offer resources for capacity-building and technological support.
3. **Available Data Sources** Rich datasets on demographics, environment, and economy can enhance policy-making, such as managing forest fires or coral reef preservation.
4. **Capacity-Building** Training programs can equip officials with data analysis skills, fostering a culture of evidence-based decision-making.

4.5 Recommendations

1. **Develop Data Quality Frameworks** Establish standardized protocols to ensure data accuracy and consistency across all levels of government.
2. **Enhance Analytical Skills** Implement training programs to build expertise in data analysis and visualisation tools.
3. **Foster Public Trust** Promote initiatives that demonstrate the benefits of data-driven decisions, such as improving public services or environmental outcomes.
4. **Encourage Collaboration** Facilitate intergovernmental cooperation to share best practices and resources for effective data use.
5. **Adopt Technology** Invest in integrated digital platforms to streamline data collection and sharing processes.
6. **Establish Feedback Mechanisms** Create channels for public input to ensure that data-driven policies reflect community needs and concerns.

4.6 Conclusion

Indonesia's shift towards data-driven governance presents a transformative opportunity to address pressing challenges and enhance decision-making effectiveness. By overcoming existing barriers and leveraging available resources, Indonesia can set a precedent for other developing nations. Mid-level officials worldwide are encouraged to consider these insights in their own governance strategies, fostering a global culture of transparency, collaboration, and innovation in public service.

References

5 Case Study: The Use of Data in Local Governance - A Michigan Perspective

This case study explores the current state of data-driven decision-making in Michigan's local governments, highlighting challenges and opportunities for integrating data into policy and governance².

5.1 Current Situation of Policy and Decision-Making in Michigan Local Governments

Michigan's local governments have seen significant growth in data-driven decision-making over the past five years. This approach is now widespread across all sizes and regions, with many jurisdictions using data to inform budgeting and resource allocation. Despite this progress, most data use remains informal or ad hoc, particularly among smaller communities.

The [Michigan Public Performance Survey \(MPPS\)](#) reveals that while larger jurisdictions are more likely to engage in formal performance measurement, over half of the state's smallest jurisdictions also incorporate some form of data into their decision-making processes. This indicates a trend towards broader adoption, albeit at varying levels of formality.

5.2 Challenges and Concerns

1. **Cost Concerns:** Many local governments, especially smaller ones with limited resources, perceive data use as costly. The MPPS found that 62% of non-data users cited cost concerns, though only 28% of current users reported significant issues, suggesting costs may be manageable.
2. **Informal Practices:** The reliance on informal methods can lead to inconsistent outcomes and less accountability. Only about 16% of jurisdictions have formal performance measurement practices, indicating a gap in structured data use.
3. **Resource Constraints:** Smaller jurisdictions often face limitations in staff and financial resources, hindering their ability to adopt more formal data practices.

5.3 Opportunities and Benefits

1. **Fiscal Efficiency:** Data-driven approaches help identify cost savings and program efficiencies, crucial for jurisdictions grappling with fiscal challenges.
2. **Improved Service Delivery:** By aligning services with community needs, data can enhance service quality and responsiveness.
3. **Enhanced Transparency and Trust:** Effective use of data fosters transparency, improving public trust in government decisions.
4. **Policy Communication:** Data provides a clear evidence base for policy-making, aiding communication between governments and stakeholders.

5.4 Conclusion

The integration of data into Michigan's local governance has proven valuable despite challenges like cost concerns and resource limitations. The broader adoption of data-driven practices, even informally, highlights its potential to improve decision-making and service delivery.

5.5 Recommendations

1. **Capacity Building:** Invest in training to enhance technical and analytical skills among local officials.
2. **Encourage Collaboration:** Foster partnerships with academic institutions or tech firms to support data initiatives.
3. **Leverage Resources:** Utilise available tools and frameworks, such as those provided by Michigan's MPPS, to guide data practices.
4. **Promote Leadership and Cultural Change:** Champion leadership roles that prioritize data use and cultivate a culture of evidence-based decision-making.

By adopting these strategies, countries can effectively integrate data into local governance, enhancing policy outcomes and public trust.

References

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Part II

Data Management

8 Data privacy, security, and protection

9 Data tools

10 Data entry system

Part III

Data Analysis and Visualisation

11 Introduction to data analysis

Exploratory data analysis

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