OPENAIR

Operational Network of Air quality Impact Resources

Data infrastructure maturity assessment model

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Introduction

Air quality data infrastructure enables the collection, management, quality assurance, analysis, reporting, sharing, governance, privacy, and security of air quality data.

There are many different technologies and commercial options for data infrastructure available to local governments that wish to establish air quality monitoring networks.

Every local government will be at a different stage in their broader 'smart city' journey, in terms of their use of smart technology, and the development of necessary skills and processes to fully engage with the data these technologies produce. All of these factors define your 'data capability[1]' as an organisation. Data capability matters because it affects what you can do with data, how you manage it, who can access it, and where it is shared.

This OPENAIR supplementary resource presents a framework for local governments to assess the relative maturity of their data infrastructure and data capabilities, particularly in the context of air quality monitoring. This assessment model can help you to understand your current capabilities, and what your future options may look like.

Who is this resource for?

This resource is for local government staff engaged with the design and delivery of an air quality monitoring project, including:

- people leading new air quality monitoring projects
- smart city professionals
- information, communication and technology (ICT) professionals
- data custodians.

[1] A data capability is a function or behaviour that is required to handle data in an organisation.

How to use this resource

The data infrastructure maturity assessment model described in this resource is composed of five maturity levels: from basic (level 1) to advanced (level 5). A maturity level is a plateau or stage for achieving a certain level of maturity, appropriate to the needs of an organisation. You can use this model to identify important data capabilities; to assess current (and desired) data capability maturity levels from the perspective of people, process, and technology; and to develop a road map[2] to improve air quality data monitoring, and data management.

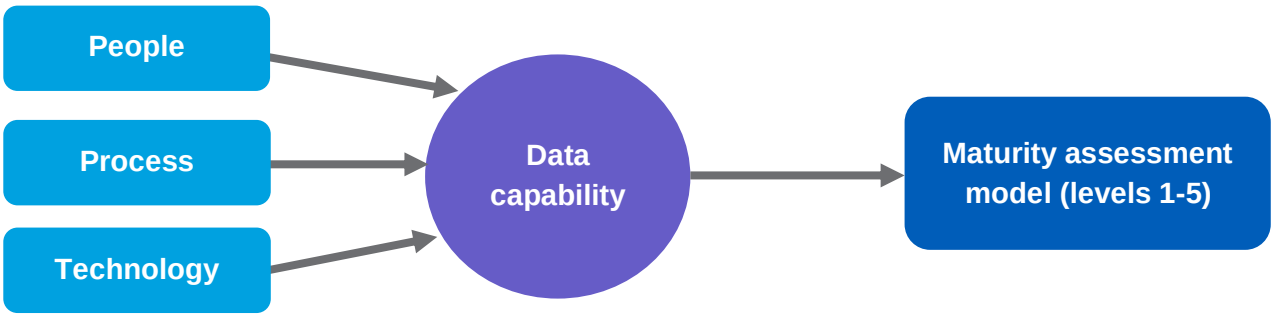

Figure 1. Data capability maturity assessment

This resource will also help you to:

- establish a common language within your organisation to identify current and target data capability maturity levels
- develop initiatives to address specific gaps in your organisation's data capability maturity.

The data infrastructure maturity assessment model

The data infrastructure maturity assessment (DIMA) model used in this resource is a systematic approach to assessing the maturity of an organisation's air quality data capabilities. The DIMA model can be tailored to particular contexts and/or data handling needs, and used to identify current, transition, and target maturity levels.

This model is mainly adapted from the smart city maturity model developed for The Scottish Government by UrbanTide. Other data-specific maturity models (such as those from the CMMI Institute[3], DAMA[4], and EDM Council[5]) have also been reviewed to identify relevant data capabilities, underpinning elements, and assessment questions.

[2] A road map is a sequence of initiatives for establishing or improving air quality data capabilities.
[3] (CMMI Institute, 2019)
[4] (DAMA, n.d.)
[5] (EDM Council, n.d.)

A capability-driven approach provides a holistic view of the three dimensions (people, process, and technology) that are crucial to the effective and efficient handling of air quality data.

Maturity dimensions

An organisation's data infrastructure capability (and maturity assessment) depends on three dimensions: **people**, **process**, and **technology** (see Table 1). The DIMA model allows for a staged approach to assessing the maturity level of each dimension, as well as any related sub-capabilities or processes (such as air quality data collection, management, quality assurance, analysis, reporting, sharing, governance, privacy, and security).

Table 1. Maturity dimensions

Dimension	Name	Description
1	People	This dimension refers to the data-related roles, responsibilities, skills, and training required to handle air quality data. Focus is on the availability of appropriate internal and external skilled resources for handling air quality data.
2	Process	This dimension refers to air quality processes, and related policies. Focus is on good air quality data handling practices. This may include processes for air quality data collection, management, quality assurance, analysis, reporting, sharing, governance, privacy, and security.
3	Technology	This dimension refers to the tools and platforms used for handling air quality data. Examples include technologies for data collection, communication, storage, management, user access, security, analytics, visualisation, and sharing.

Maturity levels

The DIMA model is organised into 5 maturity levels (see Table 2). These levels correspond to the levels used in smart city maturity models[6], such as the one created by UrbanTide[7], as well as other models[8][9][10]. A 'maturity level' is a stage for achieving a certain data capability, appropriate to the needs of an organisation and project. The gaps in the current and desired maturity levels can inform the development of a road map to improve your organisation's air quality data monitoring and handling.

[6] A maturity model provides a systematic and staged approach to assessing the maturity of data capabilities.
[7] (UrbanTide, n.d.)
[8] (CMMI Institute, 2019)
[9] (Data Crossroads, n.d.)
[10] (Klisenko & Serral Asensio, 2022)

Table 2. Maturity levels from low (1) to high (5)

Level	Name	Description	Outcome
1	Ad hoc	Lack of defined air quality data handling capabilities. Operation-focused and project-driven approach to air quality data handling. Air quality data reuse, integration, and sharing are limited.	Reactive air quality data handling
2	Opportunistic	Some elements of air quality data handling capabilities are identified. Some data roles, processes, and technology elements are explored and used for handling air quality data beyond a specific project or operation.	Transition to systematic air quality data handling
3	Purposeful and repeatable	Key air quality data capabilities are defined, used, and reused. Critical roles, processes, and technologies are established that support specific, strategic air quality priorities.	Strategic, organisation-wide air quality data handling
4	Operationalised	Key air quality data capabilities are being scaled and operationalised across the organisation. Changes to supporting roles, processes, and technologies are appropriately managed.	Managed air quality data handling; operationalised, organisation-wide air quality data handling and activation
5	Optimised	Data capabilities are continuously improved for handling air quality data. Data capability performance is monitored, and feedback is collected and analysed to improve maturity elements (people, process, and technology). Best practices are shared with the community.	Optimised, organisation-wide operationalisation of air quality data

Setting a target level

In an ideal world, every organisation would aim to develop their data capability to be at level 5, but in practice, most do not need to be at this level (and very few are). The right target is the level that best supports your organisational objectives. It may be that you define a short-term target of *level 3 (purposeful and repeatable)*, and a longer-term target of *level 4 (operationalised)*. This allows you to achieve some objectives up front, and then work to support more ambitious use of data in the future.

Assessment questions

The DIMA model's maturity levels and maturity dimensions provide a frame of reference for the data infrastructure capability self-assessment questions. The following section will guide you in answering these questions, in order to assess the maturity of your organisation's data infrastructure capability.

People assessment

This section provides a framework for assessing the *people dimension* of your data infrastructure capability. This includes roles and responsibilities, and skills and training.

Using the descriptions in Table 3, assess current and target maturity levels for each row of the table. Additional items and questions can be included, as appropriate to the needs of your organisation.

Table 3. People assessment

	1	2	3	4	5	Current	Target
Question: Do staff have the required skills and training, with defined roles and responsibilities, to effectively handle air quality data?							
Roles and responsibilities	No formal data owner, custodian, architect, engineer, or user roles and responsibilities are defined.	Some roles are defined.	Formal roles and responsibilities are defined.	Formal roles and responsibilities are defined.	Feedback is used to improve the organisational structure.		
Skills and training (internal + external)	Data-related special skills and training are not available.	Some data specialist skills and related training are available.	Data specialists are available, and required training is provided.	Data staff performance is managed, and training for upskilling is provided.	There is continuous professional performance improvement and career development.		
					Total scores		

Process assessment

This section provides a framework for assessing the *process dimension* of your data infrastructure capability. This includes air quality data collection, management, quality assurance, analysis, reporting, and sharing, as well as governance processes or assessment items.

Using the descriptions in Table 4, assess current and target maturity levels for each row of the table. Additional items and questions can be included, as appropriate to the needs of your organisation.

Table 4. Process assessment

	1	2	3	4	5	Current	Target
Question: Are there processes for data collection, management, quality assurance, analysis, reporting, sharing, governance, privacy, and security?							
Air quality data collection (internal + external sources)	No formal processes are defined for the collection of air quality data and metadata.	Some air quality data and metadata collection processes are defined.	Formal air quality data and metadata collection processes are defined, and are in alignment with the defined data policy for handling air quality data.	Air quality data and metadata collection processes (and related changes) are appropriately executed and managed.	Feedback is used to improve air quality data and metadata collection.		
Data management	No formal processes are defined for the management of air quality data and metadata.	Some air quality data and metadata management processes are defined.	Formal air quality data and metadata management processes are defined, and are in alignment with the	Air quality data and metadata management processes (and related changes) are appropriately executed and managed.	Feedback is used to improve air quality data and metadata collection.		

	1	2	3	4	5	Current	Target
			defined data policy for handling air quality data.				
Data quality	No formal processes are defined for profiling, quality assessment, and cleansing of air quality data and metadata.	Some processes are defined for profiling, quality assessment, and cleansing of air quality data and metadata.	Formal processes are defined for profiling, quality assessment, and cleansing of air quality data and metadata.	Air quality data and metadata quality assurance processes (and related changes) are appropriately executed and managed.	Feedback is used to improve air quality data and metadata quality assurance processes.		
Data analysis + reporting	No formal processes are defined for air quality data analysis and reporting. Air quality data is used in an ad hoc manner in decision-making.	No formal processes are defined for air quality data analysis and reporting.	Formal processes are defined for air quality data analysis and reporting.	Air quality data analysis and reporting processes are used to provide insights for decision-making. Analysis (and related changes) are appropriately managed.	Feedback is used to improve air quality data analysis and reporting.		
Data sharing + governance	No formal structure, policies, and processes are defined for air quality	Some structure, policies, and processes are defined for air	Formal structure, policies, and processes are defined for air quality data	Air quality data sharing and governance structure, policies, and processes are	Feedback is used to improve air quality data sharing and		

	1	2	3	4	5	Current	Target
	data sharing and governance. Air quality data is not shared.	quality data sharing and governance. Air quality data is internally shared.	sharing and governance. Air quality data is internally/externally shared, in alignment with the data sharing policy.	executed/enforced, and related changes are appropriately managed.	governance structure, policies, and processes.		
Data privacy + security	No formal structure, policies, and processes are defined for ensuring air quality data privacy and security.	Some structure, policies, and processes are defined for ensuring air quality data privacy and security.	Formal structure, policies, and processes are defined for ensuring air quality data privacy and security.	Air quality data privacy and security structure, policies, and processes are executed/enforced, and related changes are appropriately managed.	Feedback is used to improve air quality data privacy and security structure, policies, and processes.		
Total scores							

Technology assessment

This section provides a framework for assessing the *technology dimension* of your data infrastructure capability. The technology dimension refers to the data technology architecture and tools that are required and used by the people handling air quality data.

Using the descriptions in Table 5, assess current and target maturity levels for each row of the table. Additional items and questions can be included, as appropriate to the needs of your organisation.

Table 5. Technology assessment

	1	2	3	4	5	Current	Target
Question: Are data technology architecture and tools appropriate to handle air quality data?							
Data technology architecture	No formal air quality data technology architecture is defined. No defined technology standard.	Some form of air quality data architecture and standards exist.	Formal and integrated air quality data technology architecture and standards exist.	Cross-organisational air quality data integration and sharing architecture are in place. These are being scaled and adapted. Changes are appropriately managed.	Feedback is used to improve air quality data technology architecture, and to adopt new or improved standards.		
Data tools	Ad hoc or limited tools are available to handle air quality data.	Some essential tools are available to handle air quality data.	Specialist tools are available to support air quality data handling needs.	Tools and related changes are appropriately managed.	Continuous feedback is used to evaluate and improve existing tools, or to procure new tools.		
					Total scores		

Assessment summary

Assessment scores for the three maturity dimensions (*people*, *process*, and *technology*) can be collated and summarised for reporting purposes in Table 6. These scores can also be used to develop a road map for initiatives to improve your organisation's data infrastructure capability. Use the table to define the priority status (e.g. high, medium, low) of each dimension, and current/target maturity levels. For any new initiatives, include the due date and staff member(s) responsible for delivery.

Table 6. Assessment summary

Dimension	Name	Priority	Current maturity	Target maturity	Initiative	Due by	Responsible staff member(s)
1	People						
2	Process						
3	Technology						

Data infrastructure maturity assessment example

This section demonstrates an example scenario of a local government assessing their current and target data infrastructure capabilities.

EXAMPLE SCENARIO

ABC Council has been collecting different types of data (via multiple systems) for several years. People working within the council have well-defined roles and responsibilities. However, there are only a few trained data specialists/analysts, and training opportunities for employees in this field are limited. The council is managing a fair amount of data for its residents, utilities, and employees. It has some database systems, and some data and metadata management processes in place.

The council has initiated a pilot project for collecting air quality data in two precincts, and installed sensing devices at different locations. The collected data is being stored in a cloud-based platform. The data sharing and governance policies are not formally defined.

The council wants to expand its data services, and provide air quality data to residents and other agencies through a website. The council wants to assess their data capability maturity, and to identify which data capabilities they may need to further develop.

They have reviewed the maturity levels (in Table 2), and decided that they need to be at level 4 to achieve their objectives.

Tables 7 to 10 (below) provide example assessments (highlighted in yellow) of the data capability maturity of ABC Council, based on the information in this scenario.

Table 7. Example people assessment

	1	2	3	4	5	Current	Target
Roles + responsibilities	No formal data owner, custodian, architect, engineer, or user roles and responsibilities are defined.	Some roles are defined.	Formal roles and responsibilities are defined.	Roles and responsibilities (and related changes) are appropriately managed.	Feedback is used to improve the organisational structure.	**2**	**4**
Skills and training (internal + external)	Data-related special skills and training are not available.	Some data specialist skills and related training are available.	Data specialists are available, and required training is provided.	Data staff performance is managed, and training for upskilling is provided.	There is continuous professional performance improvement and career development.	**2**	**3**
					Total score	**4**	**7**
					Average score	**2**	**3.5**

Table 8. Example process assessment

	1	2	3	4	5	Current	Target
Question: Are there processes for data collection, management, quality assurance, analysis, reporting, sharing, governance, privacy, and security?							
Air quality data collection (internal + external sources)	No formal processes are defined for the collection of air quality data and metadata.	Some air quality data and metadata collection processes are defined.	Formal air quality data and metadata collection processes are defined, and are in alignment with the defined data policy for handling air quality data.	Air quality data and metadata collection processes (and related changes) are appropriately executed and managed.	Feedback is used to improve air quality data and metadata collection.	1	4
Data management	No formal processes are defined for the management of air quality data and metadata.	Some air quality data and metadata management processes are defined.	Formal air quality data and metadata management processes are defined, and are in alignment with the defined data policy for handling air quality data.	Air quality data and metadata management processes (and related changes) are appropriately executed and managed.	Feedback is used to improve air quality data and metadata collection.	2	4

Data quality	No formal processes are defined for profiling, quality assessment, and cleansing of air quality data and metadata.	Some processes are defined for profiling, quality assessment, and cleansing of air quality data and metadata.	Formal processes are defined for profiling, quality assessment, and cleansing of air quality data and metadata.	Air quality data and metadata quality assurance processes (and related changes) are appropriately executed and managed.	Feedback is used to improve air quality data and metadata quality assurance processes.	3	4
Data analysis and reporting	No formal processes are defined for air quality data analysis and reporting. Air quality data is used in an ad hoc manner in decision-making.	No formal processes are defined for air quality data analysis and reporting.	Formal processes are defined for air quality data analysis and reporting.	Air quality data analysis and reporting processes are used to provide insights for decision-making. Analysis (and related changes) are appropriately managed.	Feedback is used to improve air quality data analysis and reporting.	2	4
Data sharing and governance	No formal structure, policies, and processes are defined for air quality data sharing and governance. Air quality data is not shared.	Some structure, policies, and processes are defined for air quality data sharing and governance. Air quality data is	Formal structure, policies, and processes are defined for air quality data sharing and governance. Air quality data is internally/externally shared, in	Air quality data sharing and governance structure, policies, and processes are executed/enforced, and related changes are appropriately managed.	Feedback is used to improve air quality data sharing and governance structure, policies, and processes.		

		internally shared.	alignment with the data sharing policy.			1	4
Data privacy and security	No formal structure, policies, and processes are defined for ensuring air quality data privacy and security.	Some structure, policies, and processes are defined for ensuring air quality data privacy and security.	Formal structure, policies, and processes are defined for ensuring air quality data privacy and security.	Air quality data privacy and security structure, policies, and processes are executed/enforced, and related changes are appropriately managed.	Feedback is used to improve air quality data privacy and security structure, policies, and processes.	2	4
					Total score	11	24
					Average score	1.83	4

Table 9. Example technology assessment

	1	2	3	4	5	Current	Target
Question: Are data technology architecture and tools appropriate to handle air quality data?							
Data technology architecture	No formal air quality data technology architecture is defined. No defined technology standard.	Some form of air quality data architecture and standards exist.	Formal and integrated air quality data technology architecture and standards exist.	Cross-organisational air quality data integration and sharing architecture are in place. These are being scaled and adapted. Changes are appropriately managed.	Feedback is used to improve air quality data technology architecture, and to adopt new or improved standards.	2	4
Data tools	Ad hoc or limited tools are available to handle air quality data.	Some essential tools are available to handle air quality data.	Specialist tools are available to support air quality data handling needs.	Tools (and related changes) are appropriately managed.	Continuous feedback is used to evaluate and improve existing tools, or to procure new tools.	2	4
					Total score	**4**	**8**
					Average score	**2**	**4**

In Table 10, ABC Council have summarised their assessments from Tables 7, 8, and 9. They have also detailed their plans to develop specific capabilities that are currently lacking.

Table 10. Example assessment summary

Dimension	Name	Current maturity (average score)	Target maturity (average score)	Initiative	Due by	Responsible department
1	People	2	3.5	Train/upskill staff	Q2 202X	Human resources
2	Process	1.83	4	Define governance process	Q4 202X	Data management
3	Technology	2	4	Procure Microsoft Power BI reporting tool	Q1 202X	IT

References

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Further information

For more information about this project, please contact:

Peter Runcie

Project Lead, NSW Smart Sensing Network (NSSN)
Email: peter@natirar.com.au

This supplementary resource is part of a suite of resources designed to support local government action on air quality through the use of smart low-cost sensing technologies. It is the first Australian project of its kind. Visit www.openair.org.au for more information.

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