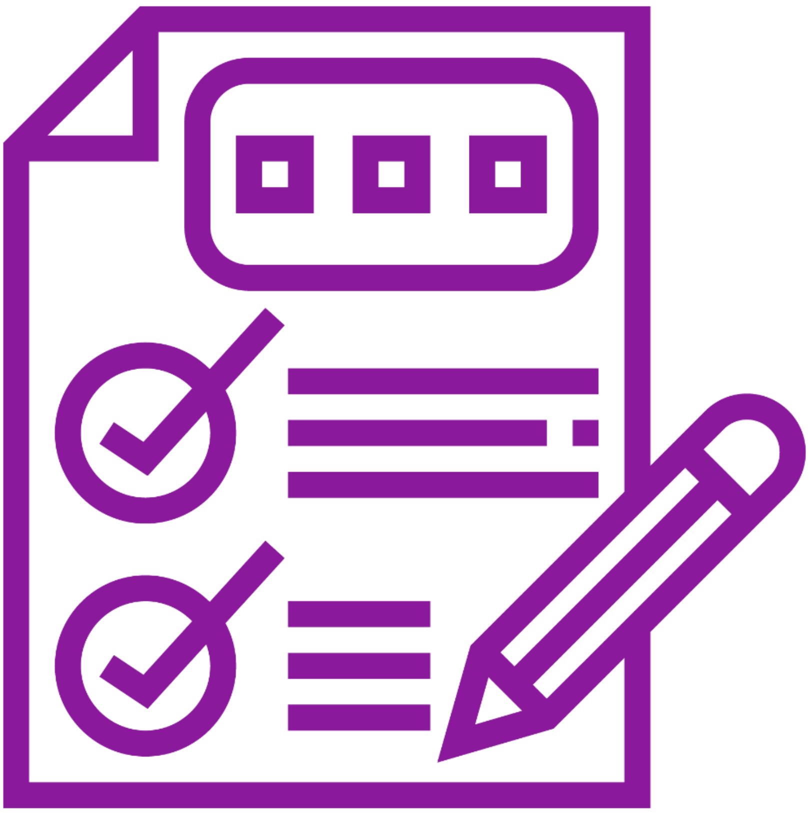
OPENAIR

Operational Network of
Air quality Impact Resources

Best Practice Guide

BP602 | Evaluate

Business case evaluation and future planning



Introduction

This Best Practice Guide chapter provides practical guidelines on how to prepare a Business Case Evaluation (BCE) for an air quality monitoring project. A good quality BCE should capture the reasons why your project was initiated, the rationale behind your chosen approach, and any factors that have influenced the project's outcomes and impacts.

The aim of a BCE is to analyse whether the planned course of action has resulted in the expected outcomes, and to identify areas for improvement in future business case development planning.

WHAT IS A BUSINESS CASE?
A well-defined business case acts as a roadmap for a project, guiding it through each phase in a logical and cost-effective manner. It ensures that project objectives are met iteratively, and that the project remains affordable, feasible, and sustainable.

WHAT IS A BUSINESS CASE EVALUATION?
A Business Case Evaluation (BCE) is a process that assesses a perceived need, and identifies the most effective way to address it, taking into account financial, environmental, and social impacts. While BCEs often involve quantitative analysis, their ultimate purpose is to support informed business decisions about proposed projects.

Who is this resource for?

This resource is designed for local government, community, or smart city project teams who are planning and/or operating a smart low-cost air quality sensing network, and need to establish and evaluate a business case for their air quality monitoring project.

How to use this resource

This Best Practice Guide chapter can be used as a guide to how to evaluate a business case and conduct a cost-benefit analysis. This will not only help to establish whether your air quality monitoring project has achieved the expected outcomes, but can inform other business cases for future projects.

Most BCEs include five key steps:

1. Define the drivers
2. State the problem
3. Formulate solutions
4. Analyse solutions
5. Recommend and report.

In this chapter, each of these steps is discussed in detail, with examples relevant to local government air quality monitoring projects.

Business Case Evaluation framework

There are five steps in a typical Business Case Evaluation (BCE) framework. In Figure 1, the recommended actions under each step have been adapted to be relevant to an air quality monitoring project.

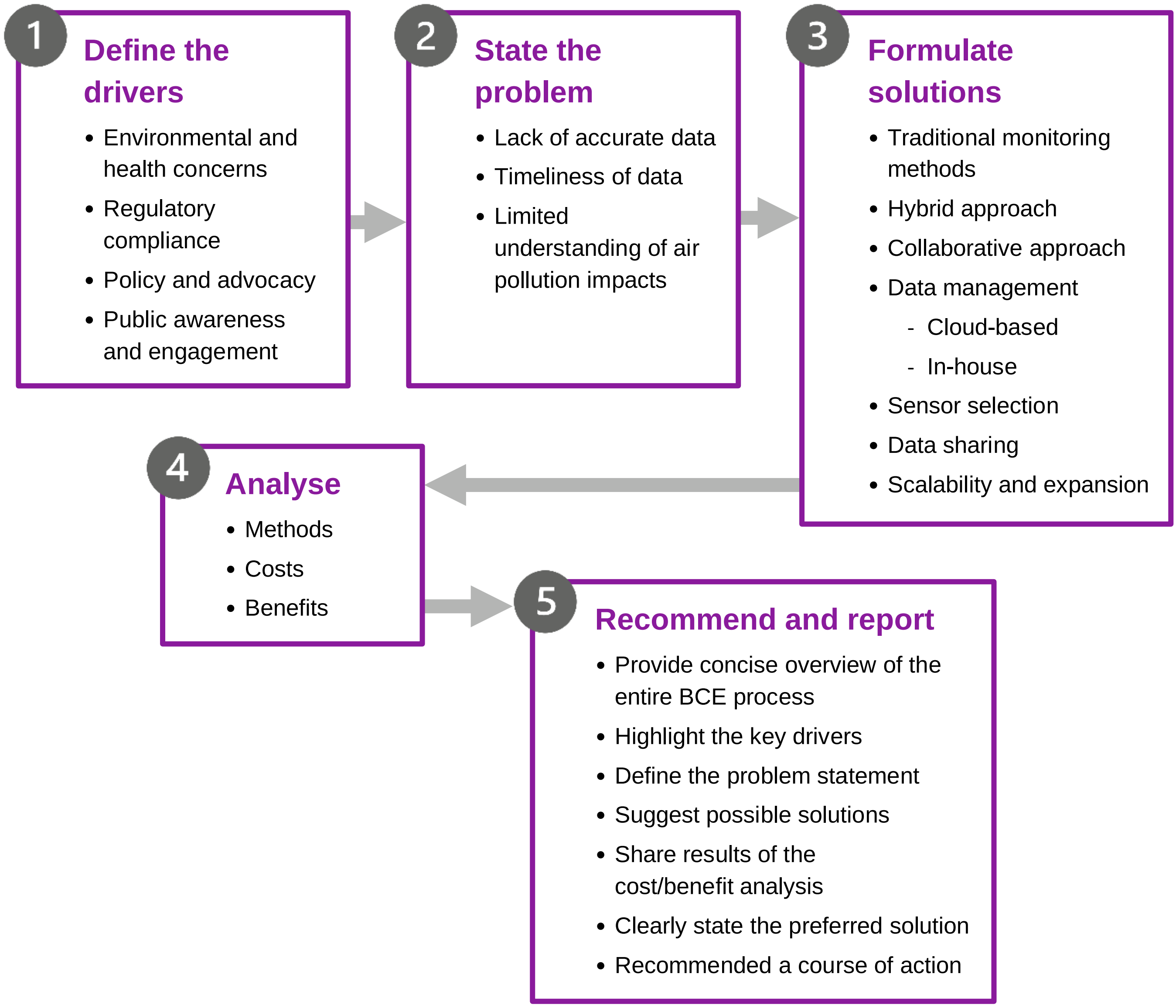


Figure 1. The five steps in a typical Business Case Evaluation framework

The five steps in a Business Case Evaluation

There is no one-size-fits-all formula for a Business Case Evaluation (BCE), as every project is unique. However, most BCEs typically follow five steps (see Figure 1). A BCE report is usually organised to reflect these five steps (with an Executive Summary included at the beginning of the document). The report you create should be clear, concise, and focused.

1. Define the drivers

It is essential to clearly define the drivers for your project to avoid losing focus, or drifting away from addressing the air quality issue of greatest concern to your team, organisation, or community. Drivers are the factors or motivations that initiate, shape, and support the implementation of a project, taking into account the specific context, goals, and stakeholders involved. Some common drivers for smart low-cost air quality sensing projects include:

- environmental and health concerns
- regulatory compliance
- policy and advocacy
- public awareness and engagement
- research and scientific investigation
- industrial and occupational health and safety
- smart city and technology innovation.

Environmental and health concerns

One of the primary drivers for air quality monitoring projects is the need to assess and mitigate the impact of air pollution on human health and the environment. Monitoring air quality using sensors can help to identify the sources, levels, and trends of air pollutants, and enable evidence-based decision-making to address environmental and health concerns.

Regulatory compliance

Compliance with environmental regulations and standards is often a key driver for air quality monitoring projects. Many countries and jurisdictions have regulations in place to protect air quality. Monitoring projects using sensors may be initiated to meet these regulatory requirements (such as reporting emissions data, demonstrating compliance with air quality standards, and fulfilling permit conditions).

Policy and advocacy

Air quality monitoring projects may be driven by policy initiatives or advocacy efforts aimed at addressing air pollution issues. Government agencies, non-governmental organisations (NGOs), and advocacy groups may initiate or support air quality sensing projects to gather data and evidence for policy development, implementation, and advocacy campaigns.

Public awareness and engagement

Increasing public awareness and engagement in air quality issues is another driver for these kinds of monitoring initiatives. Projects that involve community-based monitoring, or citizen science using sensors, can empower local communities, raise public awareness about air pollution, and engage citizens in understanding and addressing air quality challenges.

Research and scientific investigation

Air quality monitoring projects may be driven by scientific research objectives to better understand the sources, impacts, and dynamics of air pollution. Sensor-based monitoring can provide valuable data for research and scientific investigations related to air quality, atmospheric chemistry, epidemiology, and other fields.

Industrial and occupational health and safety

Air quality monitoring projects may be initiated by industries or workplaces to comply with occupational health and safety regulations, assess the effectiveness of emission control measures, and protect the health and safety of workers. Sensors can be used to monitor air quality in industrial settings, at construction sites, or in other workplaces where air pollution may be a concern.

Smart city and technology innovation

Air quality sensing projects may be driven by the desire to create ‘smart cities’ or leverage technological innovations for environmental monitoring. The use of sensing device, data analytics, and Internet of Things (IoT) solutions can enable real-time monitoring, data integration, and data-driven decision-making for air quality management.

2. State the problem

Accurately stating – or defining – the problem that gives rise to the need for your project is a crucial step in the BCE process, as getting this wrong may result in solutions that do not address the real problem at hand.

An example of a clear problem statement for a local government air quality sensing project is:

The current air quality monitoring system lacks accurate and timely data on local air pollution levels. This hinders effective measurement, understanding, and mitigation of air pollution impacts on public health and the environment.

This problem statement highlights the key **needs** that can be addressed by an air quality monitoring project, including:

- lack of accurate data
- insufficiently timely data
- limited understanding of air pollution impacts
- inadequate coverage of monitoring sites
- lack of stakeholder engagement.

Lack of accurate data

The existing air quality monitoring system may not provide accurate and reliable data on local air pollution levels due to outdated or malfunctioning sensors, insufficient coverage of monitoring sites, or other technical limitations. This can result in inaccurate or incomplete information, leading to challenges in assessing the severity of air pollution and implementing mitigation measures.

Lack of timely data

Delayed or infrequent data collection and reporting may hinder prompt responses to changing air quality conditions, and prevent timely action to protect public health and the environment. Real-time or near-real-time data is crucial to effective decision-making and timely interventions.

Limited understanding of air pollution impacts

Inadequate data on air pollution levels may limit understandings of the sources, patterns, and impacts of air pollution on human health, ecosystems, and climate change. This can hinder the development of evidence-based policies and strategies for mitigating air pollution impacts.

Inadequate coverage of monitoring sites

The existing air quality monitoring system may have limited coverage of monitoring sites, resulting in gaps in data collection and inadequate representation of different geographical areas or population groups. This can lead to an incomplete understanding of air pollution levels and impacts, and may not fully capture the variability of air quality across different locations and time periods.

Lack of stakeholder engagement

The existing air quality monitoring system may not effectively engage stakeholders (such as local communities, industries, policymakers, and other relevant parties). This can result in limited awareness, participation, and ownership, and may hinder the effectiveness of air quality management efforts.

3. Formulate solutions

It is important to brainstorm possible ways of addressing the problem your project aims to solve. Often, the best options may not be immediately apparent. This process takes time and creativity.

Some examples of problem-solving methods relevant to an air quality monitoring project include:

- traditional monitoring methods
- hybrid approaches
- collaborative approaches
- engaging external consultants

Traditional monitoring methods

Instead of using smart low-cost sensing devices, the project team could consider using traditional air quality monitoring methods, such as reference-grade monitors, which are known for their high accuracy and reliability. This approach would require higher upfront investment and maintenance costs, but may provide more precise and standardised data.

Hybrid approaches

The project team could consider a hybrid approach that combines both smart low-cost sensing devices and reference-grade monitors. This approach would involve deploying a network of smart low-cost sensing devices for widespread coverage, while also incorporating a few reference-grade monitors for validation and calibration purposes. This could provide a balance between affordability and data accuracy.

Collaborative approaches

The project team could explore collaboration opportunities with existing air quality monitoring initiatives or organisations. This could involve partnering with established monitoring programs or leveraging existing infrastructure, such as government-owned monitoring stations, to collect air quality data. This approach could potentially reduce the costs and challenges associated with setting up a new monitoring network.

Engaging external consultants

Another approach is for the project team to engage an environmental consultant or university researcher to conduct an air quality study. Typically, these are very targeted engagements over a limited time period. They can be expensive, and do not generally show trends over longer time periods.

4. Analyse solutions

The long-term implications and impacts of each possible solution need to be evaluated using a 'life cycle present value cost/benefit analysis.' This takes into account not only budgetary impacts, but also risks, environmental considerations, and societal costs, and encourages informed decision-making that considers all factors that influence a project's success and sustainability.

What is a life cycle present value cost/benefit analysis?

This is a method used to evaluate the economic viability of a project by comparing the **present value of its expected benefits** to the **present value of its expected costs** over the project's entire life cycle.

The life cycle present value cost/benefit analysis process

The seven key steps in this process are depicted in Figure 2.

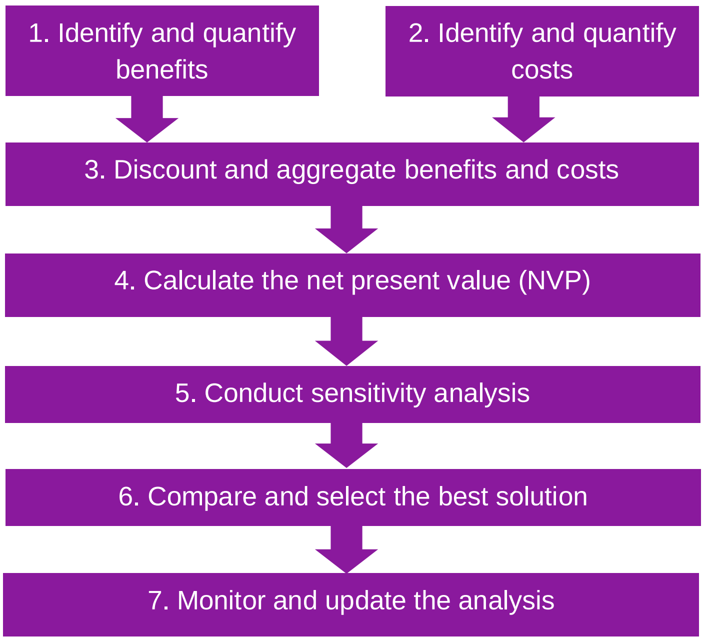


Figure 2. Steps in the present value cost/benefit analysis process

Step 1. Identify and quantify benefits

For each possible solution, identify and quantify the expected benefits of your air pollution monitoring project. These benefits may include improved public health outcomes, reduced environmental impacts, or enhanced decision-making. Benefits can be estimated using available data, expert opinions, or other relevant sources.

Step 2. Identify and quantify costs

For each possible solution, identify and quantify the expected costs of implementing and maintaining the air pollution monitoring project using smart low-cost sensing devices. These costs may include the initial costs of sensor deployment, data aggregation and analysis, validation and calibration efforts, community outreach and education, as well as ongoing costs of sensor maintenance, data management, and other operational expenses.

Step 3. Discount and aggregate benefits and costs

The benefits and costs of the project are typically spread over the project's life cycle, which may span multiple years. To compare them on an equal footing, they need to be discounted to their **present value** using an appropriate discount rate. The discount rate accounts for the time value of money, and reflects the opportunity cost of capital. Once discounted, the benefits and costs can be aggregated to obtain their respective present value.

Step 4. Calculate the net present value (NPV)

The NPV is calculated by **subtracting the present value of costs** from the **present value of benefits**. A positive NPV indicates that the project is expected to generate a net economic benefit, while a negative NPV indicates that the project may not be economically viable.

Step 5. Conduct sensitivity analysis

Sensitivity analysis involves testing the sensitivity of the NPV to changes in key assumptions, such as discount rate, benefit and cost estimates, and project timeline. This can help to identify the most critical factors influencing the economic viability of the project, and assess its robustness in different scenarios.

Step 6. Compare and select the best solution

Based on the NPV and sensitivity analysis, compare the NPV of each possible solution and select the one with the highest positive NPV, indicating **the most favourable economic outcome**. Other factors should also be considered at this stage, such as technical feasibility, environmental impact, social acceptance, and regulatory requirements.

Step 7. Monitor and update the analysis

Once the project is implemented, it is important to monitor the **actual benefits and costs**, and compare these to the **estimated or projected benefits and costs**. Periodic updates of the cost/benefit analysis may be necessary to ensure the project remains economically viable throughout its life cycle.

5. Recommend and report

The report you create at this stage of the process should provide a concise overview of the entire BCE process, highlighting the key drivers, problem statement, possible solutions, and the results of the cost/benefit analysis. Any recommended course of action in the report should be based on your research findings, and supported by sound reasoning and evidence.

The report should do the following:

- provide a concise overview of the entire BCE process
- highlight the key drivers
- outline the problem statement
- suggest possible solutions
- share results of the cost/benefit analysis
- clearly state the preferred approach
- recommend a course of action.

See Appendix A for an example of a report relevant to local government air quality sensing projects.

Cost/benefit analysis

Cost/benefit analysis is a systematic approach used to evaluate the potential benefits and costs of a project or proposal, typically conducted prior to making a final decision about whether it will be approved. Cost/benefit analysis involves identifying, quantifying, and comparing the **positive outcomes (benefits)** and **negative outcomes (costs)** associated with a particular course of action or project.

It is important to note that cost/benefit analysis may have some limitations, as it relies on assumptions, estimates, and subjective judgments, and may not capture all potential benefits or costs accurately. It is thus crucial to conduct a thorough and comprehensive analysis, considering all relevant factors and stakeholder perspectives to make informed decisions.

Benefits

Air quality monitoring projects offer many potential benefits, including:

- public health protection
- environmental protection
- policy and regulatory compliance
- improved decision-making and planning
- public awareness and education
- economic benefits.

Public health protection

Air pollution has detrimental effects on human health, causing respiratory illnesses, cardiovascular diseases, and other health problems. Air quality monitoring projects help in detecting and measuring air pollutants, enabling timely interventions to mitigate exposure risks and protect public health.

Environmental protection

Monitoring air quality is crucial to identifying pollution sources and trends, assessing the effectiveness of pollution control measures, and mitigating the impacts of air pollution on ecosystems (including vegetation, wildlife, and water bodies). By identifying areas with high pollution levels, air quality monitoring projects can support targeted actions to reduce pollution and protect the environment.

Policy and regulatory compliance

Air quality monitoring projects boost efforts to comply with local, national, and international air quality regulations and standards. They provide data that can be used to support policy development, evaluate the effectiveness of pollution control measures, and demonstrate compliance with regulatory requirements.

Improved decision-making and planning

Air quality monitoring data can inform urban planning, transportation, and infrastructure development decisions, helping to mitigate potential impacts on air quality. Monitoring can also support emergency response planning during episodes of high pollution levels, allowing timely actions to protect vulnerable populations and mitigate health risks.

Public awareness and education

Air quality monitoring projects raise public awareness about the impacts of air pollution on health and the environment. Through sharing data, educational materials, and information about pollution reduction strategies, these projects can promote behavioural changes, community engagement, and public participation in air quality management.

Economic benefits

Monitoring air quality can have economic benefits, including cost savings associated with improved public health outcomes, reduced healthcare costs, increased productivity due to better health, and improved environmental quality (which can attract investment and support economic growth in areas with clean air).

Costs

There are many project-related costs to be considered in a BCA, including direct, environmental, social, reinvestment, and risk costs. Figure 3 outlines **four types of costs** to consider when making decisions about a local government air pollution sensing project.

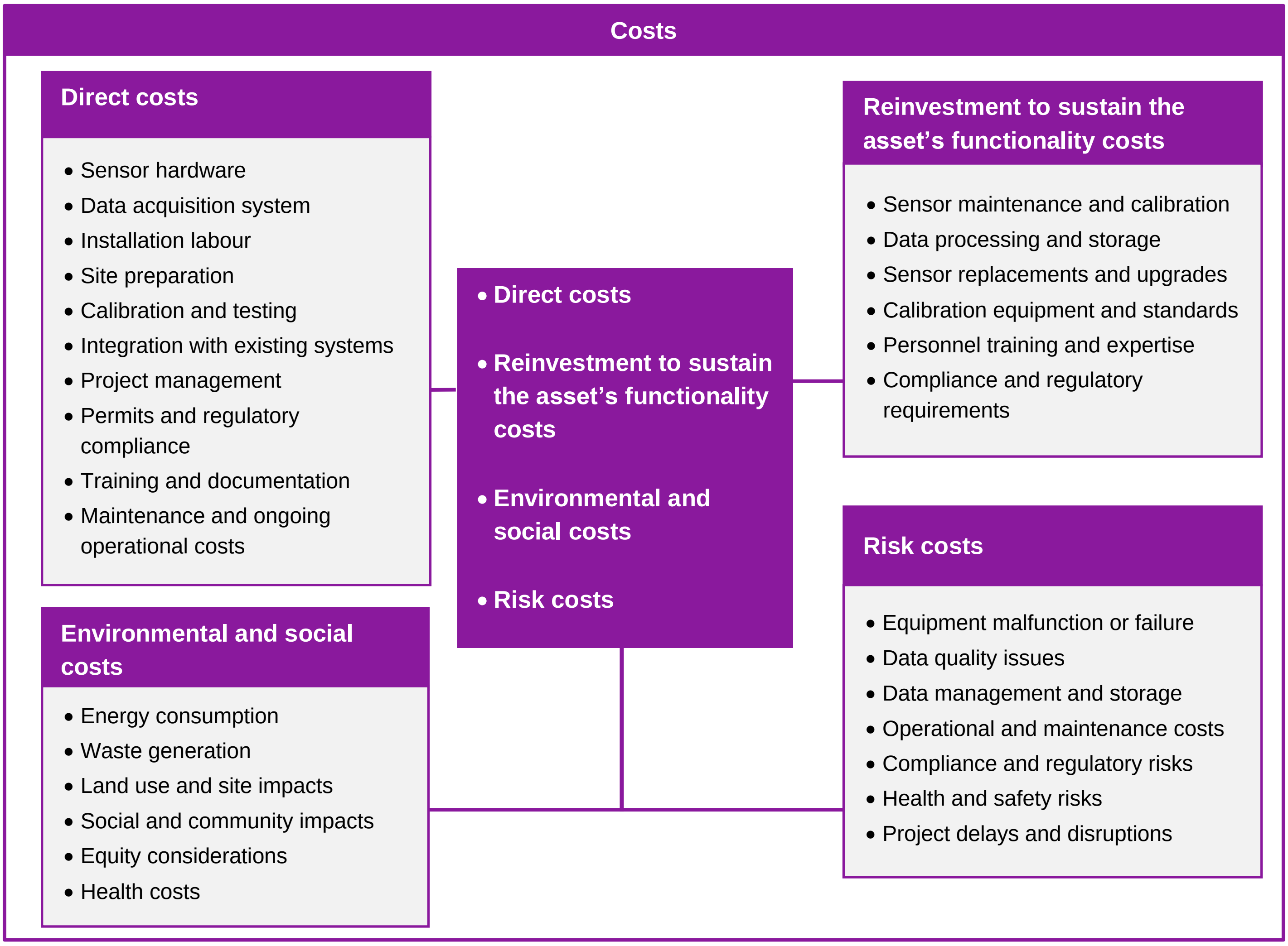


Figure 3. Four key types of costs to consider for air quality sensing projects

Direct costs

Direct costs are those that impact your project team's spending. Some of the common direct cost items for an air quality sensing project may include:

- sensor hardware
- sensor data platform
- installation labour
- site preparation
- calibration and testing
- integration with existing systems
- project management
- permits and regulatory compliance

- training and documentation
- maintenance and ongoing operational costs.

Sensor hardware

The cost of air quality sensor hardware can vary depending on type, accuracy, and brand. Hardware costs also depend on what sensors are measuring, whether it is particulate matter (PM), volatile organic compounds (VOCs), nitrogen oxides (NO_x), carbon monoxide (CO), or other pollutants.

Sensor data platform

There are a range of sensor data platforms provided either by sensor manufacturers or by third parties. Platforms may be on-site or cloud-based, and can involve both upfront and ongoing licensing costs.

Installation labour

There is a cost to the labour required to physically install the air quality monitoring sensors at designated locations. This may involve activities such as site preparation, mounting the sensors on infrastructure, connecting them to power sources and data loggers, and verifying their proper operation.

Site preparation

This is the cost of preparing the installation site for the air quality monitoring sensors, which may include activities such as site assessment, excavation, construction of mounting structures, and electrical work.

Calibration and testing

There is a cost to calibrating and testing the air quality monitoring sensors to ensure their accuracy and reliability. Calibration may involve comparing the sensor readings with reference standards, and adjusting the sensor outputs accordingly. Testing may include functional testing, performance testing, and validation to ensure sensors are operating as expected.

Integration with existing systems

Air quality monitoring sensors need to be integrated with existing systems, such as building automation systems, environmental management systems, or analysis and reporting systems. This may involve a range of costs linked to software development, data integration, and testing to ensure seamless data exchange between different systems.

Project management

There is a cost to project management activities (including planning, co-ordination, and oversight of the entire installation process). This may also involve tasks such as procurement, scheduling, risk management, and quality assurance.

Permits and regulatory compliance

This is the cost of obtaining necessary permits, and complying with local regulations related to air quality sensor installations. This may include fees for permits, environmental assessments, and compliance with relevant regulations and standards.

Training and documentation

Personnel may need training in how to operate and maintain air quality monitoring sensors, as well as in documenting the installation process, sensor specifications, and calibration records for future reference.

Maintenance and ongoing operational costs

There are costs associated with ongoing maintenance and operation of an air quality sensor network, including sensor maintenance, data communications, data storage, data analysis, and reporting.

Reinvestment costs to sustain the asset's functionality

This cost category is often ignored in traditional cost analysis methods, yet it is important to plan for and acknowledge. The reinvestment costs to sustain the functionality of an air quality sensing project will depend on various factors, such as the type and number of sensors used, the scale and complexity of the project, and the specific requirements for maintenance and calibration of the sensors. Potential reinvestment costs for an air quality sensing project may include:

- sensor maintenance and calibration
- data processing and storage
- sensor replacements and upgrades
- calibration equipment and standards
- personnel training and expertise
- compliance and regulatory requirements.

Sensor maintenance and calibration

Sensors used in air quality monitoring projects may require regular maintenance and calibration to ensure accurate and reliable data collection. This may involve cleaning the sensors, checking and adjusting their calibration, and replacing worn-out or damaged parts. The frequency and complexity of maintenance and calibration will depend on the type of sensors used, and the environmental conditions in which they operate.

Data processing and storage

Air quality monitoring projects using sensors typically generate large volumes of data that need to be processed, stored, and analysed. Reinvestment costs may include expenses for data processing software, hardware upgrades for data storage and analysis, and data management and integration solutions to ensure efficient data handling and storage.

Sensor replacements and upgrades

Sensors used in air quality monitoring projects may have a limited lifespan, and may need to be replaced or upgraded to maintain their functionality and accuracy. Reinvestment costs could include expenses for purchasing and installing new sensors, upgrading existing sensors to newer models with improved features or performance, and disposing of (or recycling) old sensors in compliance with relevant regulations.

Calibration equipment and standards

Calibrating air quality sensors typically requires specialised equipment and reference standards to ensure accuracy. Reinvestment costs may include expenses for purchasing and maintaining calibration equipment, obtaining or updating calibration standards, and conducting periodic calibrations to maintain sensor accuracy.

Personnel training and expertise

Proper operation, maintenance, and calibration of air quality sensors may require trained personnel with expertise in sensor technology, data analysis, and quality control. Reinvestment costs may include expenses for personnel training, certifications, and ongoing professional development to ensure competent operation and maintenance of the sensors.

Compliance and regulatory requirements

Air quality monitoring projects using sensors may be subject to regulatory requirements, such as reporting, permits, and compliance with environmental standards. Reinvestment costs may include expenses for ensuring compliance with relevant regulations, obtaining permits, conducting audits, and implementing necessary measures to meet regulatory requirements.

Environmental and social costs

While air quality monitoring projects usually aim to protect the environment and public health, they may sometimes have associated environmental and social costs, such as:

- energy consumption
- waste generation
- land use and site impacts
- social and community impacts
- equity considerations
- health costs.

Energy consumption

Air quality monitoring equipment (particularly continuous monitoring stations) may require a significant amount of energy to operate, including electricity for powering the instruments, data communication, and data storage. This energy consumption could contribute to greenhouse gas emissions and other negative environmental impacts associated with energy production, such as air pollution from power generation.

Waste generation

Air quality monitoring projects may generate waste, including electronic waste from equipment replacement or repair, consumables waste from maintenance activities, and paper waste from data recording and reporting. Proper waste management, including recycling and disposal, may entail additional costs and environmental impacts.

Land use and site impacts

Air quality monitoring projects may require dedicated sites or infrastructure for monitoring stations, which could result in land use changes, site preparation, and potential impacts on local ecosystems, wildlife habitats, and natural resources. These impacts may need to be assessed and mitigated, which could involve costs for environmental impact assessments, land acquisition, and habitat restoration.

Social and community impacts

Air quality monitoring projects may have social impacts, including potential disruptions to local communities, noise, and dust from construction or installation activities, as well as visual impacts from monitoring equipment. These impacts may need to be addressed through community engagement, communication, and mitigation measures, which could entail costs associated with stakeholder engagement, public relations, and community support initiatives.

Equity considerations

Air quality monitoring projects may have social equity considerations, as air pollution can disproportionately affect vulnerable populations (such as low-income communities, minority groups, and marginalised populations). Ensuring equitable access to air quality monitoring data, information, and benefits may require additional funding to cover outreach, translation, and accessibility measures.

Health costs

While the main goal of air quality monitoring projects is usually to protect public health, there may be health costs associated with addressing the impacts of air pollution. These can include healthcare costs for treating respiratory illnesses, cardiovascular diseases, and other health problems related to poor air quality. These health costs may be borne by individuals, communities, or healthcare systems, and may need to be considered in the overall cost/benefit analysis of the project.

Risk costs

Air quality monitoring projects may also incur various risk costs, which are the **potential costs associated with risks and uncertainties** that can affect the successful implementation and operation of the project.

Examples of risk costs associated with air quality monitoring projects include:

- equipment malfunction or failure
- data quality issues
- data management and storage
- operational and maintenance costs
- compliance and regulatory risks
- health and safety risks
- project delays and disruptions.

Equipment malfunction or failure

Air quality monitoring equipment can be subject to technical malfunctions or failures, resulting in inaccurate or unreliable data. This can lead to additional costs associated with equipment repairs, replacements, or recalibration, as well as potential delays in data collection and analysis.

Data quality issues

Data collected from air quality sensing networks may be subject to quality issues (such as errors, bias, missing values, or inconsistencies), which can impact the accuracy and reliability of the results. This may require additional efforts and costs to validate, verify, and correct.

Data management and storage

Air quality monitoring projects generate a significant amount of data that needs to be managed, stored, and analysed. This may involve costs associated with data storage, processing, analysis, and interpretation, as well as data security and privacy, and complying with data management regulations.

Operational and maintenance costs

Air quality monitoring projects require ongoing operational activities, such as regular calibration, cleaning, and maintenance of monitoring equipment, as well as data management, quality control, and reporting activities.

Compliance and regulatory risks

Air quality monitoring projects may be subject to regulatory requirements and compliance risks, including changes in air quality regulations, permits, or reporting obligations. Non-compliance with regulatory requirements can result in penalties, fines, or legal liabilities, which can add significant costs.

Health and safety risks

Air quality monitoring projects may involve fieldwork and exposure to air pollutants, which can pose health and safety risks to project personnel. Costs associated with implementing health and safety measures, training, and insurance to mitigate these risks need to be considered.

Project delays and disruptions

Air quality monitoring projects may face delays or disruptions due to various factors, such as adverse weather conditions, technical issues, or logistical challenges. These can result in additional costs associated with project schedule adjustments, and potential impacts on data quality and project outcomes.

Dealing with risk using the ‘Responsible Person Test’

The ‘Responsible Person Test’ is a method of evaluating risks by considering the perspective of a responsible person who is accountable for the outcome of a decision or action. This method involves following certain steps to evaluate risks:

1. *Identify the responsible person*

   Identify the individual or group who will ultimately be accountable for the decision or action being evaluated. This may be a project manager, team leader, department head, or any other responsible party.

2. *Consider the decision or action*

   Clearly define the decision or action being evaluated. This could be a specific task, project, process, or initiative.

3. *Evaluate potential risks*

   Consider the potential risks associated with the decision or action from the perspective of the responsible person. Ask questions such as:

   - What are the possible negative outcomes or consequences of this decision or action?
   - What is the likelihood (and impact) of these risks occurring?
   - How severe could the consequences be for the responsible person and the wider project?
   - What resources, time, or effort may be required to address these risks?
   - What legal, regulatory, ethical, or reputational implications may arise?

4. *Assess risk tolerance*

   Consider the risk tolerance of the responsible person or organisation. This may depend on factors such as the nature of the decision or action, the strategic importance of the outcome, the available resources, and the organisation's risk appetite.

5. *Make a risk-based decision*

   Based on the evaluation of potential risks, and the risk tolerance of the responsible person or organisation, make a decision on whether to proceed with the decision or action, modify it, or mitigate the risks in some way. This decision should take into account the potential benefits, costs, and risks associated with the decision or action.

6. *Document the decision*

   Document the decision made, the rationale behind it, and any mitigation measures or contingency plans that may be put in place to address the identified risks. This documentation can serve as a reference for future monitoring, reporting, and accountability.

WHAT IS THE ‘RESPONSIBLE PERSON TEST’?
The ‘Responsible Person Test’ is a subjective approach to risk evaluation that considers the perspective of the person who will ultimately be accountable for the outcome of a decision or action. It encourages responsible decision-making by taking into account the potential consequences and risks associated with a particular decision or action, and aligning these with the risk tolerance of the responsible person or organisation.

Future planning

Scalability and expansion are critical considerations for any air quality monitoring project using sensors. Some potential future planning steps include:

- modular sensor deployment
- geographical expansion
- sensor network optimisation
- integration with existing infrastructure
- partnerships and collaborations
- technological upgrades
- data management
- data quality and analysis
- long-term sustainability
- regulatory compliance.

Modular sensor deployment

Plan for a modular sensor deployment approach, where sensors can easily be added or removed from the monitoring network as needed. This can allow for flexible scalability and adaptation to monitoring requirements, budget constraints, or expansion plans.

Geographical expansion

Develop a roadmap for geographical expansion, considering factors such as air quality hotspots, population density, industrial areas, or sensitive ecosystems. This can help to prioritise areas for expansion, and allocate resources effectively.

Sensor network optimisation

Continuously optimise the sensor network based on data analysis and feedback. This can involve relocating sensors to areas with higher pollution levels, identifying data gaps, or adjusting sensor density to capture spatial variability. Regular monitoring and analysis of data can help to identify areas that need additional coverage or expansion.

Integration with existing infrastructure

Explore opportunities to integrate the air quality monitoring project with existing infrastructure, such as government-owned monitoring stations, or other established monitoring initiatives. This can leverage existing resources, data, and expertise, and facilitate expansion into new areas.

Partnerships and collaborations

Seek partnerships and collaborations with relevant stakeholders, such as local communities, academic institutions, or industry associations. Collaborative efforts can help to share costs, data, and expertise, and facilitate scalability and expansion.

Technological upgrades

Stay updated on advancements in sensor technology, and consider upgrading sensors, or adopting new sensor types as needed. Newer sensors may offer improved accuracy, reliability, and cost-effectiveness, which can enhance scalability and expansion potential.

Data management

Develop robust data management protocols to handle increasing data volume, and allow for scalability. This can involve automated data processing.

Data quality and analysis

Use data quality assurance, data calibration, and advanced data analytics techniques to extract meaningful insights from your collected data.

Long-term sustainability

Plan for long-term sustainability by considering factors such as maintenance, calibration, data storage, and funding. A sustainable business model and funding strategy can ensure the project's continuity and scalability over time.

Regulatory compliance

Stay updated on relevant regulations and standards related to air quality monitoring, and ensure your project remains compliant. This can involve obtaining necessary permits, following data privacy regulations, and adhering to quality assurance guidelines, which can impact the project's scalability and expansion plans.

Associated OPENAIR resources

Factsheet

Measuring impact

This factsheet provides an overview of impact measurement, evaluation, and reporting for local government air quality monitoring projects.

Best Practice Guide chapter

Measuring impact

This Best Practice Guide chapter provides guidance to assist with the measurement, evaluation, and reporting of impact created through a local government air quality monitoring project.

Appendix A

Example of a document to report on your project and make recommendations for a course of action

Title

Business Case Evaluation for a smart air quality monitoring project using low-cost sensors

Overview

The purpose of this Business Case Evaluation (BCE) is to assess the feasibility and potential benefits of implementing a smart air quality monitoring project using low-cost sensors. The project aims to deploy a network of sensors in urban areas to measure air quality parameters in real time, such as particulate matter (PM), nitrogen dioxide (NO_2), and ozone (O_3). The BCE was conducted by a team of analysts, representing …………, and the following recommendations and report are based on their findings.

Recommendation

After careful analysis and evaluation of the business case of the pilot, the team recommends proceeding with the implementation of the smart air quality monitoring project using low-cost sensors. The various factors described below support this recommendation.

Drivers

The set of drivers used for the project are:

- environmental and health concerns
- public awareness and engagement
- research and scientific investigation
- industrial and occupational health and safety
- policy and advocacy.

Problem

The primary objective of the project is to develop a community air quality management plan informed by measurements of local air quality data.

Benefits

The pilot has achieved good community health and well-being outcomes through the following actions:

- informing the community about health risks from exposure to bushfire smoke
- minimising health risks to the local government outdoor workforce from exposure to smoke
- contributing to a better understanding of the local levels of exposure to bushfire smoke

- enabling local measurement of air quality in the areas most exposed to poor air quality
- establishing management and mitigation strategies related to climate change impacts in the Local Government Area
- putting forward new policy recommendations for sustainable improvements to public health.

Real-time monitoring

Smart low-cost sensors used in the pilot created the opportunity for real-time monitoring of air quality parameters, enabling prompt detection of pollution spikes, identification of pollution sources, and timely intervention measures at local levels. Real-time data empowers decision-makers to take informed actions to mitigate the adverse impacts of air pollution on public health, the environment, and economic activities. This translates to cost savings and economic benefits, in addition to addressing climate change and improving planet health.

Community engagement

Implementing this air quality monitoring pilot project using smart low-cost sensors raised awareness about air pollution among communities, governments, and organisations. Citizens can now participate in air quality data collection and information gathering, and can take ownership of the project, leading to best practice activities to mitigate associated risks. The project can now also foster collaborations with local stakeholders, such as environmental groups, health agencies, and city authorities, to jointly address air quality issues.

Data-driven opportunities

The collection of air quality data through smart low-cost sensors in the pilot generated a wealth of data that can be analysed and used widely. Uses include leveraging the data for research, policymaking, urban planning, public health, environmental health, and business opportunities (such as developing innovative air quality solutions or services based on these data insights).

Costs

Cost-effectiveness

Traditional air quality monitoring methods can be expensive, requiring sophisticated equipment and infrastructure. By contrast, low-cost sensors offer a more affordable solution, with lower upfront costs and maintenance expenses. This makes the project financially feasible, and enables deployment in multiple locations, increasing the sensing network’s coverage.

Report

Market analysis

The team conducted a comprehensive analysis of the air quality monitoring market, including trends, regulations, and potential customers. The findings indicate a growing demand for air quality monitoring solutions driven by increasing public awareness, regulatory requirements, and health concerns. The market analysis also identifies potential customer segments, including government agencies, environmental organisations, public health agencies, and private entities.

Financial analysis

The team conducted a financial analysis, including cost estimates, revenue projections, and return on investment (ROI) assessment. The analysis considered the costs associated with the deployment, maintenance, and data management of the smart low-cost sensors, as well as potential revenue streams from partnerships, grants, and data-driven opportunities. The financial analysis demonstrates the cost-effectiveness of the project, and the potential for positive financial returns.

Technical feasibility

The team assessed the technical feasibility of implementing a smart air quality monitoring project using smart low-cost sensors. This included evaluating the accuracy, reliability, and compatibility of the sensors, as well as the availability of communication networks for data transmission. The team found that low-cost sensors have made significant advancements in recent years, with many sensors providing reliable and accurate measurements of air quality parameters, making the project technically feasible.

Risks and mitigation

The team has identified potential risks and challenges associated with implementing the air quality monitoring project, such as data accuracy, sensor reliability, regulatory compliance, and data privacy concerns. To address these challenges, the team has proposed several mitigation strategies, including sensor calibration, data validation, regulatory compliance measures, and data privacy safeguards. It is recommended to carry out calibration exercises to align the smart low-cost sensor measurements with high accuracy reference measurements, in order to expand the network for collaborative use. Additionally, data imputation techniques should be employed to fill in large gaps in sensor data, as this is a common characteristic of pollution data captured by sensors. This recommendation should be considered for future planning purposes.

Conclusion

Based on comprehensive analysis and evaluation, the team recommends proceeding with the implementation and operation of smart air quality monitoring in the Local Government Area.

Further information

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This Best Practice Guide section 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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