Two years after OPENAIR

Exploring challenges and long-term value in council-led air quality sensing

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Overview of this talk

- **OPENAIR as a unique research context**
- **+2Yrs case studies** (tales of success and challenges)
- **What explains variation in outcomes?**
- **Implications for councils, funders and environmental agencies**

Image: A Clarity Node-S installed by Sutherland Shire Council as part of the OPENAIR project

OPENAIR

Total project value: AUD 2.05 million

Period: Nov 2021 to July 2023

1. Best practice resources
2. Council pilot projects
3. Community of practice
4. NSW data portal

POWERED BY THE DIGITAL RESTART FUND

NSW GOVERNMENT Planning & Environment

NSSN NSW Smart Sensing Network

Australian National University

WESTERN SYDNEY UNIVERSITY

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Sitelines MEDIA

Revisiting OPENAIR +2Yrs

Study design

- Comparative case study analysis (5 municipal sensing pilots)
- Longitudinal outcomes perspective (In-depth interviews with staff at +2 years)
- Technology-Organization-Environment (TOE) framework to examine contextual differences
- Thematic analysis of interviews and PAR data from embedded practitioner research.

Outcomes across five projects varied considerably

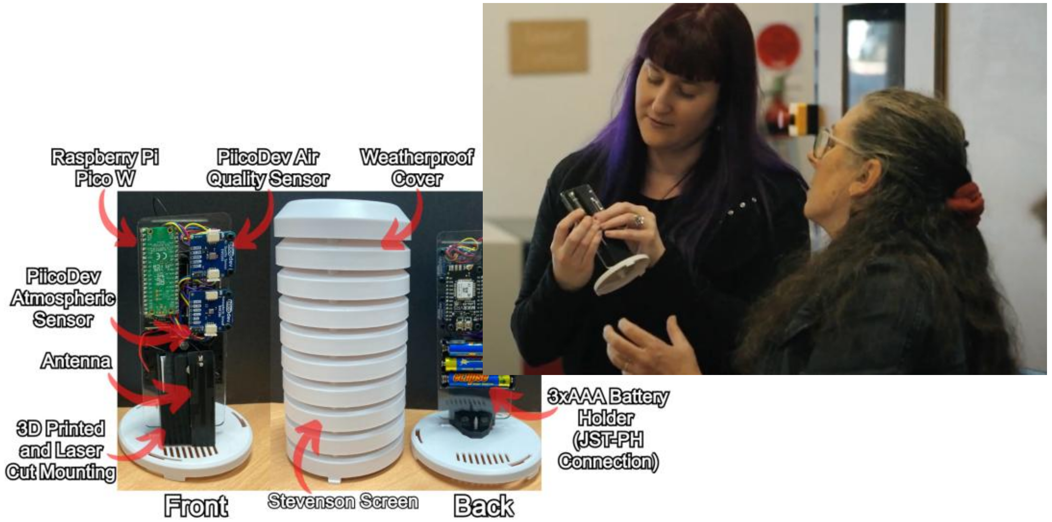
RQ: Given a common support environment, why do we see such variation?

High-value outcomes

Sutherland Shire

- Robust environmental intelligence
- Actionable smoke insights
- Ongoing funding
- Expanded sensing program

Lake Macquarie



- Community engagement
- Data literacy
- Open-source DIY sensing device developed
- Program expansion through FabLab

Key takeaway: Success was contextual and took different forms

Persistent challenges

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Muswellbrook

- Resource demands far exceeded expectations
- Limited specialist capability for deployment and interpretation
- Strong commitment, but constrained support and funding
- High ongoing costs limited long-term viability

Tweed Shire

- Successful sensor deployment and data collection
- Limited expertise for calibration, analysis and interpretation
- No sustained access to external specialist support
- Aviation emissions sat largely outside Council's remit

Key takeaway: Technically functioning systems ≠ meaningful outcomes

Key findings

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1: Technical challenges were common but did not explain variation in outcomes

2: Certain Organisational and Environmental factors were decisive

"Keystone Factors"

Resourcing; Skills and expertise; Cross-unit collaboration

"Modulating Factors"

Policy alignment; External partnerships

Certain **Organisational** factors shaped Council ability to:

- Make effective design and procurement decisions
- Respond effectively to technical challenges
- Interpret data
- Retain organisational knowledge
- Sustain activities beyond the pilot period

Certain **Environmental** factors shaped Council ability to:

- Overcome technical challenges as they arose
- Sustain project activities over time
- Secure ongoing support
- Convert technical activity into lasting value

Keystone and Modulating Factors

T	O	E
Technology factors	**Organisational factors**	**Environmental factors**
T1 Hardware robustness & suitability	O1 Leadership & senior support	E1 Policy alignment, remit & politics
T2 Calibration & data validity	O2 Resourcing & time	E2 External partnerships & support
T3 Power & communications	O3 Skills & expertise	E3 Community engagement & trust
T4 Data pipeline & storage	O4 Data policy & governance	E4 Site & meteorology
T5 Interoperability & integration	O5 Project management & procurement	E5 Open data ecosystem & platforms
T6 Data quality, completeness & utility	O6 Cross-unit collaboration	
T7 Site constraints, privacy & WHS	O7 Continuity & knowledge capture	
T8 Cost & vendor model	O8 Funding & budgets	

Keystone Factor	Modulating factor

Key findings (continued)

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3: Success was iterative and context dependent: Challenging conventional understandings of pilot success and value creation

Most value was non-technical and emerged slowly, iteratively, and beyond the original pilot timeframe

- Capability development
- Organisational learning
- Stronger partnerships
- Social impact (engagement, knowledge, trust)
- Follow-on funding and program expansion

Aligns with smart city framing of innovation:

Iterative experimentation, learning and adaptation over time; rather than confined linear project delivery.

The definition of what success looks like varied across Councils

Sutherland and Muswellbrook ran projects that succeeded in fundamentally different ways. Value emerged through different pathways depending on differing organisational priorities, local needs and institutional contexts.

Sutherland	Lake Macquarie
Technical success Environmental intelligence supported policy outcomes and operational insights. *[Strong DCCEEW alignment]*	**Social impact** Community engagement, digital literacy, and trust building. *[Alternative value framing]*

Implications

Successful smart low-cost municipal air quality sensing cannot be understood through technology alone

For Councils

- Recognise true resourcing requirements
- Invest in organisational capability alongside technology
- Build strong partnerships
- Ensure strong alignment between project aims and internal policy

For Funders

- Critically assess organisational capacity of applicants, not just project design.
- Invest in enabling systems, not just pilot projects.
- Recognise and support longer-term emergent value, beyond initial pilot framing

For Environment agencies

- Getting technology right is only part of the story – and not even the main part.
- Effective local government partners must have a strong foundation of organisational capacity and institutional alignment.
- Agency definitions of value associated with low-cost sensing may not always align with council definitions of value.

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Questions?

Get in touch

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Current research interests:

- Urban heat and bushfire smoke
- Community climate shelters
- Data centres (air quality, energy and beyond)

APPENDIX A: Technology factors assessed for the study

Code	Definition	Includes	Example
T1 Hardware robustness & suitability	Fit between sensing hardware and local environmental and site conditions affecting reliability	Sensor failure, degradation, or stable performance due to exposure or design	“Coastal exposure led to repeated corrosion failures until housings were redesigned.”
T2 Calibration & data validity	Processes that establish or undermine confidence in sensor accuracy under local conditions	Bias, drift, co-location, transparency of corrections	“Local humidity corrections were needed before results aligned with reference monitors.”
T3 Power & communications	Availability and reliability of power supply and connectivity supporting continuous operation	Solar shading, battery limits, network outages	“Intermittent coverage caused repeated gaps in daily records.”
T4 Data pipeline & storage	Ability to ingest, store, and access sensor data from device to analysis	APIs, dashboards, fragmented records, vendor lock-in	“Manual downloads slowed analysis due to lack of API access.”
T5 Interoperability & integration	Extent to which sensor data integrate with internal or external platforms using consistent formats	Schema harmonisation, enterprise integration, public feeds	“Inconsistent metadata prevented ingestion into council platforms.”
T6 Data quality, completeness & utility	Continuity and contextual sufficiency of records for intended analyses	Downtime, missing context data, high-completeness series	“Absence of wind data complicated interpretation of particulate peaks.”
T7 Site constraints, privacy & WHS	Practical constraints on siting, mounting, and compliance	Access limits, privacy risk, vandalism	“Preferred sites failed clearance and surveillance criteria.”
T8 Cost & vendor model	Ongoing cost structures and vendor arrangements shaping sustainability	Subscriptions, proprietary platforms, lifetime licences	“Annual subscription costs exceeded available operational budgets, limiting continuation beyond the pilot.”

APPENDIX B: Organisational factors assessed for the study

Code	Definition	Includes	Example
O1 Leadership & senior support	Presence or absence of executive mandate enabling prioritisation	Sponsorship, visibility, decision authority	"Senior endorsement accelerated approvals across units."
O2 Resourcing & time	Adequacy of staff time and budget relative to scope	Competing duties, dedicated funding	"Operational pressures delayed planned deployments."
O3 Skills & expertise	Availability of technical and analytical capability in-house	Training needs, external reliance, partnerships	"Advanced calibration depended on university partners."
O4 Data policy & governance	Organisational rules governing data quality, sharing, and risk	QA/QC rules, privacy processes, public release stance	"Unclear policy delayed decisions on public data sharing."
O5 Project management & procurement	Scoping and procurement processes affecting delivery	Fit-for-purpose purchasing, delays, backups	"Device choice reflected availability rather than measurement needs."
O6 Cross-unit collaboration	Effectiveness of coordination across internal teams	Support from IT, Property, comms units	"Installations depended on ad-hoc cooperation from enabling teams."
O7 Continuity & knowledge capture	Retention of learning and capability across phases	Documentation, staff turnover, handovers	"Turnover led to loss of tacit operational knowledge."
O8 Funding & budgets	Availability of ongoing capital and operational funding	Renewals, matched funding, budget constraints	"While capital funding supported the pilot, no recurrent budget was allocated for ongoing maintenance."

APPENDIX C: Environmental factors assessed for the study

Code	Definition	Includes	Example
E1 Policy alignment, remit & politics	Fit between project objectives and policy priorities or political context	Remit limits, controversy risk, advocacy use	"Expectations exceeded council's operational remit."
E2 External partnerships & support	Role of external actors in enabling or delaying delivery	University support, state agencies, permissions	"Partnerships provided calibration expertise unavailable in-house."
E3 Community engagement & trust	Public understanding, literacy, and confidence in data	Workshops, cautious release, messaging	"Live data release was deferred to avoid misinterpretation."
E4 Site & meteorology	Local environmental conditions affecting measurement and interpretation	Humidity, inversions, airflow, site effects	"Seasonal inversions amplified near-surface concentrations."
E5 Open data ecosystem & platforms	External publishing pathways and interoperability arrangements	Standards, APIs, open repositories	"Publishing was delayed due to unresolved metadata standards and platform integration requirements."