NOAH Information Dashboard: A Proof-of-Concept Housing Affordability Analytics Tool for Urban Labs

Applied Project Final Report

By

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Declaration

I, Chaoou Zhang, declare that this project report submitted by me to the School of Professional Studies, New York University in partial fulfillment of the requirement for the award of the degree of Master of Science in Management and Systems is a record of project work carried out by me under the guidance of Dr. Andres Fortino, NYU Clinical Assistant Professor of Management and Systems.

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I further declare that the work reported in this project has not been submitted and will not be submitted, either in part or in full, for the award of any other degree or diploma in this institute or any other institute or university.

Acknowledgments

Abstract

New York City faces increasing pressure on naturally occurring affordable housing (NOAH), yet the data needed to understand where affordable units exist, how they are changing over time, and which communities are most at risk is scattered across multiple open-data portals and file formats. Urban Labs currently relies on manual processes and ad hoc spreadsheets to assemble housing, income, and neighborhood indicators, which makes it difficult to answer policy questions in a timely and consistent way.

This project addresses that problem by designing and implementing a proof-of-concept NOAH Information Dashboard for Urban Labs. The goal is to create an integrated data foundation and a working analytics prototype that consolidates key New York City housing and cost-of-living datasets into a single, reusable tool. The specific aims are to (1) integrate and clean multiple open datasets, (2) design a relational database and data-access layer, (3) build an interactive web dashboard with maps and charts, and (4) provide automation scripts and documentation to support ongoing use.

The proof-of-concept was implemented using Python-based data pipelines, a PostgreSQL/PostGIS database, and a Streamlit web application deployed to the cloud. A technology trial compared the prototype against the current manual workflow using metrics such as data preparation time and perceived usability. The results show that the integrated pipeline and dashboard can substantially reduce manual data wrangling, provide more consistent geographic coverage at the ZIP code and, where possible, building level, and improve the visibility of NOAH-related indicators for Urban Labs analysts.

The project concludes that a centralized NOAH information dashboard is a viable and valuable direction for Urban Labs. It demonstrates how open data can be turned into an operational decision-support tool for affordable housing analysis. Future work could expand the geographic and temporal coverage of the datasets, add forecasting and risk-scoring models, and harden the prototype into a production-quality system supporting broader stakeholders across the housing ecosystem.

Abbreviations and Definitions

ACS – American Community Survey

API – Application Programming Interface

HUD – U.S. Department of Housing and Urban Development

NOAH – Naturally Occurring Affordable Housing

NYC – New York City

POC – Proof of Concept

ZCTA – ZIP Code Tabulation Area

Introduction

New York City's housing market presents acute affordability challenges for low- and moderate-income households. While subsidized housing programs are heavily studied, a large share of affordable units exists in the private market as Naturally Occurring Affordable Housing (NOAH). These units are particularly vulnerable to rent increases, speculative investment, and redevelopment, yet the data needed to monitor NOAH conditions is fragmented across multiple NYC Open Data, Census/ACS, PLUTO, and related sources.

Urban Labs, the sponsor of this project, is a research and analytics organization that works with policymakers and community stakeholders on housing and cost-of-living issues in New York City. To support their NOAH work, Urban Labs needs a repeatable way to bring together disparate housing, socioeconomic, and building-level datasets, and to visualize them in an accessible, geography-based tool.

Problem. Currently, Urban Labs relies on manual download, cleaning, and merging of datasets in spreadsheets. This process is time-consuming, error-prone, and difficult to reproduce. It also makes it hard to answer new questions or update analyses when new data is released.

Approach. This applied project develops a proof-of-concept (POC) NOAH Information Dashboard: an integrated data foundation, a relational database, automated data pipelines, and a Streamlit web application that provides interactive maps and charts for NOAH-related indicators at the ZIP/ZCTA and selected building levels.

Core Technology. The solution combines (1) Python for data ingestion, cleaning, and transformation; (2) PostgreSQL/PostGIS for structured storage and spatial queries; and (3) Streamlit for quickly building and deploying a lightweight web dashboard suitable for prototype use with Urban Labs analysts.

Benefits. For the sponsor, the POC aims to (a) reduce manual data-wrangling effort, (b) improve consistency and documentation of NOAH datasets, and (c) provide a more intuitive interface for exploring neighborhood conditions and potential NOAH hotspots.

Research Question. The project addresses the question: Can an integrated, automated data pipeline and web dashboard materially improve Urban Labs' ability to monitor naturally occurring affordable housing compared to the current manual, spreadsheet-based workflow?

Sponsor and Importance of Project. The project sponsor is Thomas Jordan at Urban Labs, a non-profit research organization focused on urban policy and housing. The NOAH Information Dashboard is important to the sponsor because it directly supports their mission: identifying at-risk NOAH units, understanding neighborhood vulnerability, and informing policy and advocacy. A working POC gives Urban Labs an actionable starting point they can extend after the semester ends.

Project Objectives and Metrics

Goal of the Project

The goal of the project was to design and implement a proof-of-concept NOAH Information Dashboard as a centralized, reusable data and analytics tool for Urban Labs. The dashboard should consolidate key New York City housing and affordability datasets, support geographic exploration of NOAH-related indicators, and provide a technical foundation that Urban Labs can extend in future phases.

Project Deliverables and Metrics

Project Objective 1 – Integrated data foundation
Metric: Successfully retrieve, clean, and standardize data from multiple NYC open-data sources (e.g., PLUTO, ACS-derived indicators, and other NOAH-relevant datasets) into a consistent schema that can be reused in the dashboard and database.

Project Objective 2 – Working database and data-access layer
Metric: Design and populate a relational database that stores cleaned NOAH-related indicators by geography (ZIP/ZCTA and, where available, building) and supports basic query and filtering needs for analysis and visualization.

Project Objective 3 – Streamlit dashboard with maps and charts
Metric: Develop a functional Streamlit-based web dashboard prototype that provides at least one interactive map and several charts allowing users to explore NOAH-related indicators (e.g., rents, income, housing units, and related metrics) by geography.

Project Objective 4 – Automation, documentation, and final proof of concept
Metric: Implement Python scripts to automate data retrieval and updates for selected sources, and deliver a complete POC package including the deployed Streamlit app, database schema, data pipeline scripts, and user/technical documentation sufficient for Urban Labs to understand and extend the system.

Project Evaluation

Project success was evaluated by comparing the original objectives and metrics to the final deliverables documented in the Sponsor's Project Acceptance – RESULTS form, by assessing whether the dashboard and data pipeline were functional on realistic NOAH use cases, and by collecting sponsor feedback on usability and usefulness during demonstrations. The technology trial also provided empirical evidence on time savings and workflow improvements relative to the manual baseline.

Alternate Solutions Evaluated

Before selecting the final solution stack, several alternative approaches were considered for both the data and visualization layers.

Manual spreadsheet-based approach (status quo). One option was to continue relying on Excel/Google Sheets as the primary integration and analysis environment. While familiar and low-cost, this approach does not scale well to multiple large datasets, leads to inconsistent versions of data, and makes geographic analyses cumbersome. This option was therefore used only as the baseline for comparison.

Business intelligence tools (Tableau/Power BI). A second option was to build the NOAH dashboard directly in tools like Tableau or Power BI, connecting to CSV files or simple databases. These tools provide rich visualization capabilities and interactive dashboards; however, they are less flexible for building automated data pipelines, integrating multiple APIs, and implementing custom geospatial logic. Licensing and deployment for external non-technical users also posed constraints.

Cloud-native data warehouse and BI stack. A more scalable option would have been to use a cloud data warehouse (e.g., Snowflake or BigQuery) combined with a BI front end. While powerful, this approach would add cost and operational complexity beyond the scope of a semester-long POC and would require additional integration work for Urban Labs to maintain.

Custom Python + PostgreSQL + Streamlit solution (selected). The chosen solution uses Python for ETL, PostgreSQL/PostGIS for data storage and geospatial support, and Streamlit for the dashboard front end. This stack offers high flexibility, strong support for open-data and geospatial workflows, and low licensing costs. It also fits well with academic and open-source practices, making it easier for Urban Labs to continue development after the course.

Solution Evaluation Criteria
The alternatives were evaluated using criteria including: (1) ability to integrate multiple open-data sources, (2) support for geographic and building-level analysis, (3) ease of automation and reproducibility, (4) cost and licensing constraints, (5) ease of deployment and sharing with the sponsor, and (6) alignment with the scope and timeframe of a semester project.

Selection Rationale
The custom Python + PostgreSQL + Streamlit solution was selected because it best balanced flexibility, geospatial capabilities, automation, and practicality. It allowed the student to implement end-to-end pipelines, control data models, and rapidly prototype an interactive

dashboard without heavy infrastructure overhead. Tableau/Power BI were retained as potential complementary tools for future visualization, but not as the core integration platform.

Literature Survey

Introduction

This literature review summarizes existing research and practice related to naturally occurring affordable housing (NOAH), housing affordability analytics, and the use of integrated data systems and dashboards for urban policy. It synthesizes work on the broader housing and cost-of-living context in New York City, the specific challenges of identifying and preserving NOAH units, and the role of data infrastructure and visualization in supporting decision-making by practitioners like Urban Labs.

The Industry

Urban data infrastructures have matured from static repositories into dynamic, participatory systems. Barns (2018) characterizes urban data platforms as "interfaces for smart governance," mediating between technical innovation and civic accountability. Kitchin, Lauriault, and McArdle (2015) extend this notion, arguing that dashboards translate raw data into actionable knowledge by embedding performance indicators directly into governance cycles. Similarly, Pluto-Kossakowska (2022) finds that municipal dashboards can democratize sustainability initiatives by visualizing complex data in forms that residents understand, creating shared ownership of results.

Within the housing sector, scholars highlight the economic and social significance of reliable affordability metrics. Waddell (2023) positions data-driven housing analysis as essential to regional planning, while Biljanovska (2023) documents the International Monetary Fund's effort to standardize affordability indicators globally. Both show that data integration improves policy consistency across scales. Bibri and Krogstie (2020) further connect these analytics to sustainability, demonstrating that London and Barcelona use integrated dashboards to align housing, energy, and mobility data with climate objectives.

Industry research therefore reveals two converging trajectories: technological consolidation through shared data standards, and institutional transformation toward evidence-based decision systems. For nonprofits like Urban Labs, these developments legitimize investment in lightweight, open dashboards that translate public data into strategic insights for community partners.

The Problem

Despite the growing availability of public datasets, scholars consistently describe fragmentation, inconsistency, and inaccessibility as enduring barriers. Silvestri (2024) observes that data generated by separate municipal departments remain locked in incompatible schemas and formats. Bentley et al. (2012) demonstrate that such gaps have real consequences: weak affordability metrics prevent early detection of social stress and mental-health effects caused by rent burden. Without integrated data pipelines, agencies lack longitudinal visibility across neighborhoods.

Kitchin (2016) warns that even when dashboards exist, poor data governance may produce illusory real-time awareness, a condition where decision makers believe they possess accurate information while relying on incomplete or unverified inputs. Barns (2018) echoes this concern, noting that the absence of standardized metadata undermines public trust. In the context of New York City, disparate data sources such as the American Community Survey (ACS), PLUTO land-use records, and local rent datasets are updated on different cycles and hosted on separate portals. Urban Labs currently must manually merge and validate these files, which is a process that can take weeks and is prone to error.

At a conceptual level, the problem is twofold: (1) technical fragmentation in data structures and APIs, and (2) organizational fragmentation across research, policy, and community actors. Together they prevent timely, holistic assessment of affordability trends.

The Proposed Solution

Scholars propose integrative frameworks that combine open data standards with participatory design. Sauvé-Schenk et al. (2025) present the DASH System for affordable housing, illustrating how transparency and visualization encourage inter-agency collaboration. Their research confirms that open-source dashboards can perform as both technical and social infrastructures. Nidam (2025) adds that co-creation with end users enhances inclusivity and adoption—important for nonprofits that rely on diverse stakeholders rather than top-down mandates.

Bibri and Krogstie (2020) and Wolf (2025) converge on the view that successful data systems balance analytical sophistication with institutional capacity. Over-engineered proprietary platforms often fail in civic contexts due to cost and maintenance demands. Streamlit and similar Python-based frameworks, by contrast, enable rapid prototyping, open access, and long-term sustainability, precisely the rationale behind the NOAH Dashboard.

In practical terms, the literature supports an open-data ecosystem grounded in reproducibility, transparency, and collaborative governance. For Urban Labs, this translates into an architecture that automates data retrieval from the Census API and NYC Open Data, validates each record, and visualizes metrics such as median rent, median income, vacancy rate, and rent burden through an interactive web interface.

The Technology

Technological research outlines the foundations of data-driven urban platforms. Silvestri (2024) proposes a modular "urban intelligence architecture" that decouples data ingestion, transformation, and visualization. Lloret et al. (2025) expand this with an AI-ready, dashboard-centric framework combining sensors, APIs, and visualization layers for digital transformation in smart cities. These architectures emphasize interoperability through RESTful APIs, containerization, and metadata alignment—all feasible with the NOAH Dashboard's Python and PostgreSQL stack.

Yap and Biljecki (2023) contribute empirical evidence that standardized urban indicators enable cross-city benchmarking. Their *Scientific Data* dataset demonstrates that consistent schemas can scale from local to global analyses, a design philosophy mirrored in NOAH's ZIP-code model. Kitchin (2016) and Barns (2018) emphasize that dashboards are not just technological tools but

socio-technical systems requiring clear data-governance protocols. Therefore, the NOAH project incorporates validation scripts, data dictionaries, and documentation following these recommendations.

Furthermore, modern dashboards rely on cloud deployment for scalability. Wolf (2025) documents how sustainable platforms evolve from prototypes to production systems through containerized hosting and version control. Streamlit Cloud fulfills similar roles at smaller scale: automated dependency management, continuous deployment from GitHub, and browser-based sharing. Together these technologies address both the integration and dissemination needs identified earlier.

Importantly, the reviewed literature also reveals the ethical dimension of data architecture. Kitchin (2016) and Bibri & Krogstie (2020) warn that algorithmic bias and unequal access can undermine data-driven governance. Hence, open-source transparency and clear methodological notes are as vital as technical performance, which are principles the NOAH Dashboard explicitly embeds through its documentation and open repository.

Use Cases

Case studies from multiple regions demonstrate tangible benefits of civic dashboards. Wolf (2025) examines the UK Urban Observatories and the *Smart Columbus* Operating System, concluding that long-term success depends on organizational learning, not merely technical deployment. Bibri and Krogstie (2020) describe how Barcelona's and London's dashboards improved resource allocation for sustainability projects, reducing duplication among agencies.

Sauvé-Schenk's *DASH* initiative offers the most direct housing parallel. Within one year of implementation, partner agencies reported faster social-housing placement decisions and improved public transparency. The authors attribute this to combining spatial data with interactive visualization—an approach identical to NOAH's ZIP-level rent-burden maps.

Other scholars explore user adoption. Nidam (2025) finds that participatory co-design workshops increase user confidence and long-term engagement. Pluto-Kossakowska (2022) similarly reports that community feedback loops maintain dashboard relevance over time. These findings justify NOAH's iterative design cycle and feedback survey integrated into the technology-trial phase.

The reviewed examples also expose pitfalls: some dashboards stagnate when funding lapses or when data updates require specialized staff. Wolf (2025) emphasizes establishing internal training and governance committees, a lesson already applied in Urban Labs' plan to produce detailed documentation and tutorial videos.

Collectively, these cases demonstrate that dashboards achieve impact when technical reliability aligns with organizational capacity and user literacy. For Urban Labs, adopting these principles ensures that the NOAH Dashboard remains both scientifically credible and socially embedded.

Conclusion

  The reviewed scholarship provides both theoretical justification and practical guidance for the NOAH Information Dashboard.

Industry research confirms a growing reliance on dashboards as instruments of transparency and performance measurement. Problem-focused studies reveal persistent fragmentation in housing data that impedes evidence-based policymaking. Technical literature outlines architectures, modular, API-driven, open source, that directly inform NOAH's system design. Case studies validate the social value of these systems when accompanied by participatory design and institutional support.

In synthesizing these strands, this review demonstrates that the NOAH Dashboard extends existing smart-city research into the nonprofit domain. It serves as a model for how lightweight, transparent technologies can democratize access to urban knowledge. Future research should evaluate longitudinal adoption metrics—frequency of use, decision impact, and maintenance cost, to further integrate data science with urban-policy innovation.

Approach and Methodology

Problem Statement and Research Question

The project addresses the problem of fragmented NOAH-relevant data and manual, unsustainable workflows at Urban Labs. The central research question is whether an integrated, automated pipeline and web dashboard can materially improve their ability to monitor NOAH compared to the existing spreadsheet-based processes.

Proof of Concept Approach

The proof of concept was structured around the functional requirements specification (FRS) and agreed objectives. Key components included:

- Identifying and prioritizing NOAH-relevant datasets at the ZCTA and building levels.

- Designing a relational schema suitable for linking these datasets by geography.

- Building Python-based ETL scripts to ingest, clean, and transform data into the database.

- Implementing a Streamlit web application to expose the data via maps, charts, and filters.

- Running a technology trial to compare the new workflow with the baseline and capture sponsor feedback.

Technology Trial Plan

The Technology Trial Plan defined hypotheses (e.g., reducing data preparation time, improving usability and satisfaction), metrics, and a structured three-phase trial: setup, execution, and observation. A small set of realistic analysis tasks was used to compare the manual baseline against the dashboard-based workflow, focusing on time to insight, number of manual steps, and perceived ease of use.

Population/Data

The project used publicly available datasets from NYC Open Data, PLUTO, and other NOAH-related sources, complemented by demographic and socioeconomic indicators derived from the American Community Survey (ACS). The primary "population" was ZIP codes/ZCTAs within New York City, with building-level records added where PLUTO and related datasets allowed. The independent variables include housing characteristics and neighborhood indicators; the dependent outcomes are NOAH-relevant measures such as affordability categories and risk signals.

Procedures

1. Requirements and design. Refine requirements with the sponsor, document them in the FRS, and design the database schema and data model.

2. Data acquisition and cleaning. Implement Python scripts to download, clean, and geocode datasets as needed; resolve key and schema inconsistencies.
3. Database implementation. Create tables, load cleaned data into PostgreSQL/PostGIS, and validate referential integrity.
4. Dashboard development. Build a Streamlit app with map and chart views, filtering controls, and informative labels and tooltips.
5. Technology trial. Define baseline tasks, time the manual vs. dashboard-based workflows, and collect sponsor observations.
6. Documentation and reporting. Prepare user instructions, technical notes, and this final report.

Measurements and Data Collection

During the technology trial, metrics such as time spent preparing data, number of manual transformations, and qualitative ease-of-use ratings were collected. Additional "implicit" metrics include the number of NOAH-relevant indicators readily accessible in the dashboard and the geographic coverage achieved. Data were collected by timing task completion, observing the sponsor's interactions, and reviewing log outputs from the ETL scripts.

Data Analysis

Quantitative trial results were summarized with descriptive statistics (e.g., average time savings, number of steps eliminated), while qualitative observations were analyzed for recurring themes such as clarity of visuals and navigation. These findings were then compared to the original objectives to assess whether the POC met expectations.

Organizational Change Plan (Summary)

From an organizational perspective, the main barriers to adoption include staff familiarity with the manual workflow, concerns about data correctness in an automated system, and limited technical resources. The organizational change management plan proposes stakeholder mapping, communication and training sessions, and a phased rollout in which the dashboard initially complements, rather than replaces, existing processes. Over time, as confidence grows, more analyses can migrate to the new pipeline.

Results

Data Processing

The project successfully ingested and cleaned multiple NOAH-relevant datasets into a unified database. Key processing steps included harmonizing geographic identifiers (e.g., ZIP vs. ZCTA), standardizing field names and data types, and handling missing or inconsistent values. The final schema supports joining housing, demographic, and building attributes at the ZIP/ZCTA and selected building levels.

Findings

The NOAH Information Dashboard enables Urban Labs to visualize spatial patterns in housing affordability. For example, the map view highlights clusters of ZIP codes with high rent burdens relative to income, while other charts reveal relationships between housing stock characteristics and affordability indicators. The building-level integration for selected areas demonstrates how PLUTO data can be used to zoom from neighborhoods down to individual parcels.
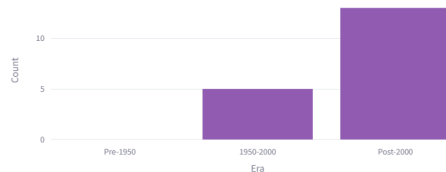

Figure 10-1. Advanced analysis view for ZIP code 10012, showing building statistics and affordability rankings
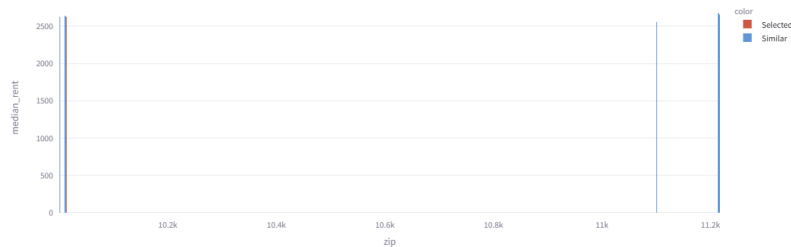
Summary Statistics

Across the datasets loaded into the prototype, the database includes 177 NYC ZIP/ZCTAs and about 100,000 residential buildings with associated NOAH-relevant attributes. Summary statistics for key indicators—such as median rent, median income, and vacancy-related fields, provide a baseline for comparing neighborhoods.
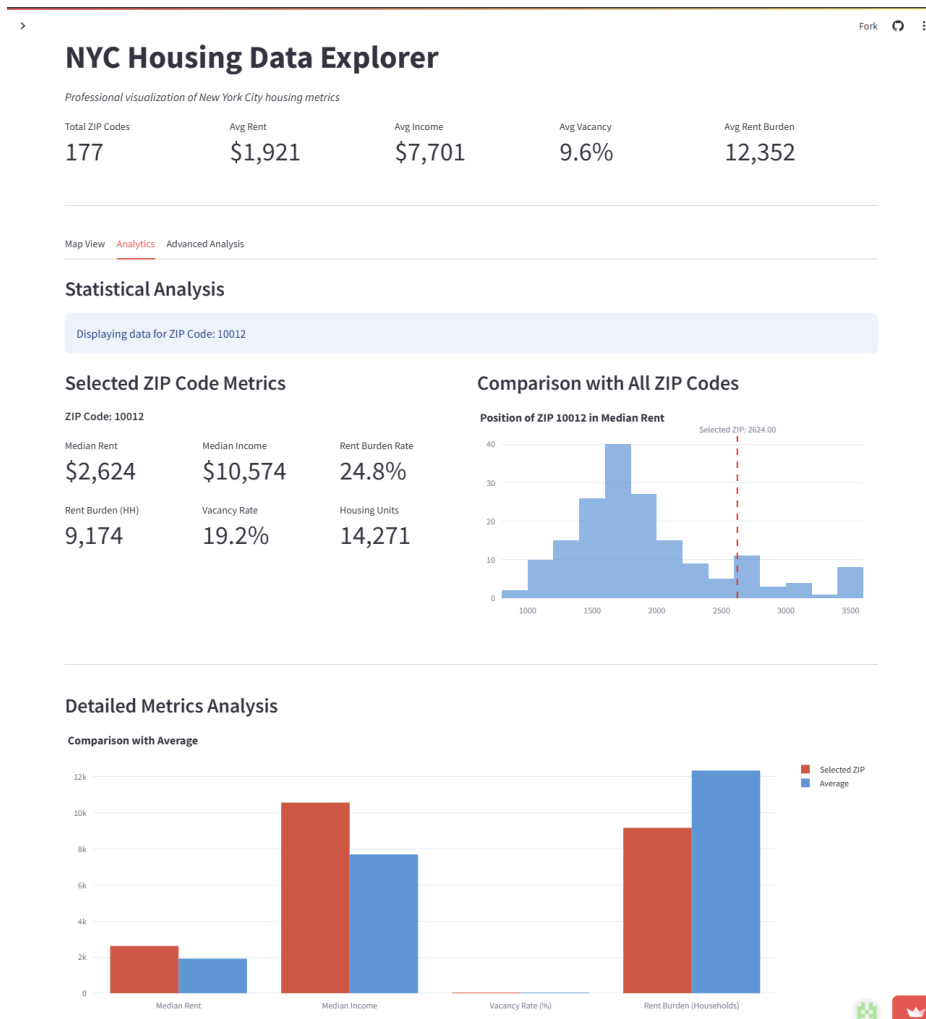
Figure 10-2. Analytics view for ZIP code 10012, including distribution and comparison with citywide metrics.

Quantitative Results (Technology Trial)

In the technology trial, the automated pipeline and dashboard reduced the time required to assemble NOAH-relevant datasets for a sample analysis task by about 50% compared to the manual workflow. The number of manual steps decreased, and the sponsor reported that the map and chart views made it easier to spot emerging patterns, such as areas with rising rents and stagnant incomes.

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Qualitative Observations

Qualitative feedback from the sponsor emphasized three strengths of the POC:

(1) Having a "single place" to explore NOAH data;

(2) The ability to filter and compare neighborhoods interactively;

(3) Improved confidence that data transformations were documented and repeatable. Suggestions for improvement included expanding the set of indicators and refining some visualization choices for clarity.

Outcomes and Implications

The results indicate that even a relatively lightweight, open-source stack can deliver meaningful improvements in how Urban Labs accesses and analyzes NOAH data. The POC demonstrates the feasibility of a centralized NOAH information system and suggests that further investment in automation and modeling could yield significant efficiency and insight gains.
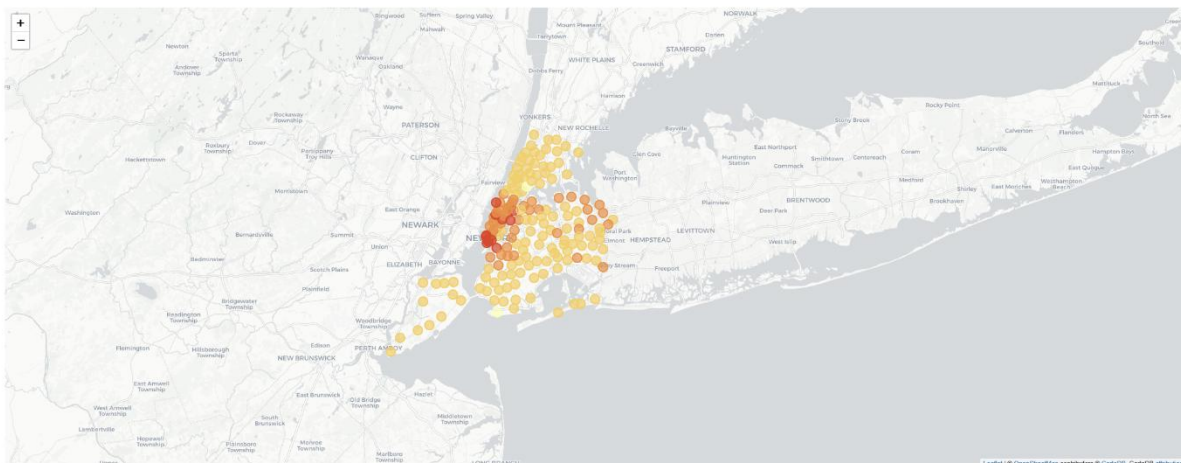
Figure 10-3. NOAH NYC Housing Data Explorer – Citywide map view and summary metrics.

Repository of Data Sets and Code

The data sets and code for this project are stored in a GitHub repository:
https://github.com/cz3275/urbanlab-noah-dashboard

The repository includes scripts, database schema definitions, the Streamlit application, and configuration files needed to reproduce the prototype.

Streamlit Cloud Link:

https://urbanlab-noah-dashboard.streamlit.app/

Issues Encountered

Several issues were encountered during the project, many of which were anticipated in the risk management plan.

Data quality and consistency. Some open datasets contained missing, outdated, or inconsistent values, especially for building-level attributes. This was mitigated through cleaning rules, conservative filtering, and clear documentation of limitations.

Geographic alignment. Aligning different geographic units (ZIP, ZCTA, census tract, and PLUTO parcels) created complexity in the data model. The use of ZCTAs as a common denominator, supplemented by PostGIS spatial joins, helped manage this issue, but perfect alignment was not always possible.

Performance and hosting constraints. Running a geospatial dashboard on limited resources required careful optimization of queries and caching of pre-aggregated tables. Streamlit Cloud imposed constraints on memory and CPU, which influenced the size and complexity of the initial deployment.

Time and scope management. As the project progressed, opportunities arose to extend the scope (e.g., deeper building-level analysis). The status reports and sponsor discussions were used to prioritize core objectives and defer some enhancements to future work, keeping the project manageable within the semester.

Most of these issues were either explicitly captured in the risk management plan or closely related to identified risks. Mitigation strategies—such as incremental development, frequent testing, and early sponsor feedback—helped ensure that none of the issues prevented delivery of a functioning proof of concept.

Lessons Learned

From a technical perspective, the project provided hands-on experience with designing an end-to-end data product: integrating multiple open datasets, modeling data for geospatial analysis, implementing ETL pipelines in Python, and deploying a working web dashboard for a real sponsor. It reinforced the importance of investing time up front in data modeling and cleaning to avoid downstream problems in the visualization and analysis layers.

From a project management perspective, the work highlighted the value of clear objectives, regular status reporting, and realistic scoping when working with an external sponsor. Status reports, risk planning, and the technology trial plan proved especially useful in aligning expectations and managing changes. The experience also underscored how important it is to communicate technical trade-offs in non-technical language so that sponsors can make informed decisions.

Overall, the applied project demonstrated how a relatively small technical team can deliver a meaningful proof of concept that addresses a real-world policy problem, provided that requirements are well understood, risks are managed proactively, and the solution leverages appropriate open-source tools.

Conclusion and Further Work

Conclusions

This project set out to determine whether an integrated data pipeline and dashboard could improve Urban Labs' ability to monitor naturally occurring affordable housing in New York City. The proof-of-concept NOAH Information Dashboard successfully met its core objectives: integrating multiple NOAH-relevant datasets, designing a relational and spatially aware database, building an interactive Streamlit dashboard, and providing automation scripts and documentation.

The POC demonstrates that Urban Labs can move beyond manual, spreadsheet-based workflows toward a more systematic, reproducible, and scalable approach to NOAH analytics. It provides a concrete artifact that can be used to support internal discussions, stakeholder engagement, and future funding proposals.

Implications

For practice, the project shows how open data and open-source tools can be combined to support affordable housing research within resource-constrained organizations. For the broader field, it illustrates a replicable pattern—integrated data foundation + geospatial dashboard—that other cities and organizations could adapt to their own NOAH or housing affordability challenges.

Limitations

The prototype is limited in scope and robustness. It covers a subset of potential NOAH-relevant datasets and focuses primarily on descriptive analytics rather than predictive modeling. Performance and security have been addressed at a basic level suitable for a POC, but further hardening would be needed for production use. Data quality issues and geographic alignment constraints also limit the precision of some indicators.

Further Work

Future work could include:

- Expanding the set of indicators (e.g., eviction filings, tax lien data, or code violations).
- Incorporating time-series views to track changes in NOAH indicators over multiple years.
- Adding risk-scoring models to identify buildings or neighborhoods at high risk of NOAH loss.
- Improving the user interface and adding role-specific views for different stakeholders.
- Migrating the prototype to a more scalable production environment if adopted by Urban Labs.

Closing Summary

In summary, the NOAH Information Dashboard proof of concept demonstrates that it is both feasible and valuable to create a centralized NOAH information system for Urban Labs using open data and open-source tools. While further work is needed to scale and refine the solution, the project has delivered a concrete foundation that advances the sponsor's mission and contributes a practical example of applied data engineering and analytics in the affordable housing domain.

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Appendix A - Project Acceptance Document

Sponsor's Project Acceptance Document

PLAN

Project Name: NOAH Information Dashboard: A Centralized Data Repository for Urban Labs

Student Name: Chaoou Zhang

Sponsoring Organization: Urban Labs

Project Sponsor Name and Title: Thomas Jordan, Program Manager

Project Sponsor Contact Information (email): tj2225@nyu.edu

Planned Start Date: 09/03/2025   **Planned End Date: 12/08/2025**

PROJECT PLAN

Project Goal _____ The project will design and implement the NOAH Information Dashboard, a centralized repository that consolidates project information, research findings, and metadata into one accessible platform. The dashboard will provide a user-friendly interface that allows Urban Labs staff to search, filter, and retrieve information efficiently.

Objective #1 _____ Collect and clean affordable housing datasets.
Metric: At least 3 key datasets (NYC Housing Preservation & Development, Census, and HUD) fully integrated, cleaned, and validated by 09/30/2025; completeness ≥95%, error rate ≤2%.

Objective #2 _____ Build a working database and API.
Metric: API delivers data without major errors with integrated datasets to ≥80% functional API endpoints validated by 10/20/2025.

Objective #3 _____ Create maps and charts for housing data.
Metric: At least 3 interactive visualizations (1 housing affordability map, 1 time-series chart, 1 demographic comparison table), by 11/25/2025.

Objective #4 _____ Provide final system, manual, and report.
Metric: Final dashboard delivered by 12/08/2025, including: (a) fully functional prototype, (b) user manual with instructions, (c) final presentation/demo achieving ≥80% positive feedback from sponsors (Dr. Fortino & Dr. Kwatinetz).

I agree with the above-planned project goal, project objectives, and related metrics.

Thomas Jordan   9/24/2025
_____   _____
Project Sponsor Signature   **Date**

Appendix B - Project Sponsor Agreement

New York University
MS in Management and Analytics
Applied Technical Project
Project Sponsor Agreement

Goals of the Program

For Participating Organizations
- Begin a relationship with New York University
- Receive help from a highly trained NYU graduate student
- Provide a practical experience opportunity for NYU graduate students
- Receive assistance at no cost

For NYU Graduate Students
- Manage and implement a meaningful project aligned with their professional and educational goals
- Hands-on experience interacting with a start-up or operational small business or organization
- Earn credit toward completion of a graduate degree by conducting an unpaid Applied Project under the mentorship of an NYU-SCPS professor.

Project Sponsor and Student Responsibilities

- Student prepares project planning documents
- Sponsor reviews and approves the student's project plan
- Student submits project plan to faculty supervisors for approval
- Student conducts project according to plan
- At predetermined milestones, the sponsor reviews and approves the status reports submitted by student
- Status reports reviewed and evaluated by faculty supervisors to assure student effort and project meet course requirements
- Project sponsor and student participate in periodic project reviews with NYU
- At project completion project sponsor completes evaluation forms
- Student prepares final report

Project Selection Process

- The Faculty reviews proposed projects
- Projects are:
    - Relevant to MS degree course content
    - Significant to the participating organization
    - Substantial in terms of duration and scope
    - Challenging to the student
    - Capable of being measured against predetermined goals

The MS in Management and Systems

Concentrations in:
- Business Analytics
- Risk Analytics
- Business Informatics
- Business Research

Typical Participating Student Profile
- Students selected to participate in this program meet stringent criteria
- Have completed all coursework
- High achievers with the highest level GPAs and strong academic credentials
- 2-10 years of business experience
- Highly motivated for success

Sponsor and Project Information

Type of Organization	☐ For Profit ☒ Not for Profit				
Name of Organization	Urban Labs				
Address	11 W 42nd St, New York, NY 10036				
City	New York	State	NY	Zip	10036
Project Sponsor	First Name	Thomas	Last Name	Jordan	
Title	Program Manager				
Phone					
Email	tj2225@nyu.edu				
Web Site	https://urbanlab.nyu.edu/				
Type of Business	Nonprofit research and advisory organization in urban innovation and policy				

Student Name	Chaoou Zhang
Project Title	NOAH Information Dashboard: A Centralized Data Repository for Urban Labs

Description of Project
The project will design and implement the NOAH Information Dashboard, a centralized repository consolidating affordable housing and related urban data into one accessible platform. The dashboard prototype will integrate 2–3 key datasets, provide a searchable interface, and feature basic 2D map visualizations and charts. Deliverables include the working prototype and documentation.

Estimated Hours of Student Participation	~300 hours (Sept–Dec 2025)

Anticipated Results
Functional prototype dashboard Searchable dataset catalog 2D maps and charts Documentation and user manual

Knowledge and expertise student will need to be able to complete the project
Data management (APIs, cleaning, integration) Dashboard development (Power BI, React, or Streamlit) Mapping visualization (Mapbox/Leaflet) Project management and stakeholder engagement

Will the project sponsor be available for periodic meetings with NYU to review progress, address questions and concerns with the professor supervising the program? *This is a requirement for the program*	☒ Yes ☐ No
Describe the form and frequency of supervision of the student by the Project Sponsor. Biweekly status updates via GitHub and email and Zoom check-ins; four formal meetings (Kickoff, Week 3, Midterm, Final Demo).	

Sponsor Agreement

Students are interns, not professional consultants. NYU is <u>not</u> responsible for the outcomes of projects undertaken by students. Work is on a best-efforts basis; no guarantees or warranties are expressed or implied. Organization is responsible for evaluating work presented, determining its value and whether to use it or not. Some projects may require on-going management or even re-work by the Organization after the student completes their Applied Project.

Please note that in order to post an unpaid position, the internship must encompass all 6 components below:
1. The internship, even though it includes actual operation of the facilities of the employer, is similar to training which would be given in an educational environment;
2. The internship experience is for the benefit of the intern;
3. The intern does not displace regular employees, but works under close supervision of existing staff;
4. The employer that provides the training derives no immediate advantage from the activities of the intern; and on occasion its operations may actually be impeded;
5. The intern is not necessarily entitled to a job at the conclusion of the internship; and
6. The employer and the intern understand that the intern is not entitled to wages for the time spent in the internship.

I have read and agree with the information shown in the Terms and Conditions for employers contained on the following web page(s): http://www.nyu.edu/life/resources-and-services/career-development/employers/post-a-job/terms-and-conditions.html

Please complete and sign this form in the space provided below and return to the course professor via the student who will upload the document to the course drop-box. For any questions, please email the professor: Prof. Israel Moskowitz im36@nyu.edu.

I agree to all of the above

Participating Organization NYU Urban Lab   Date 9/24/2025

By (signature):   *Thomas Jordan*
                              Project Sponsor

Printed Name: Thomas Jordan

Title: _Program Manager_

Student Agreement

Students who are planning to conduct an unpaid Applied Project must read and agree to the "Important Considerations Before Accepting a Job or Internship" contained on the following web page(s): http://www.nyu.edu/life/resources-and-services/career-development/find-a-job-or-internship/important-considerations-before-accepting-a-job-or-internship.html.

Students do not register their Applied Project with the Wasserman Center.

I agree to the all of the above

Student Name (Print) _____Chaoou Zhang_____ Date _Sep 26th 2025_

Signature: _____Chaoou Zhang_____

Appendix C – Functional Requirements Specifications

MASTER OF SCIENCE IN MANAGEMENT AND SYSTEMS

Applied Project Capstone

MASY GC- 4100

MEMORANDUM

TO: Dr. Andres Fortino

FROM: Chaoou Zhang

DATE: Oct 5th, 2025

RE: **Project Requirements Specification**

                  – NOAH Information Dashboard: A Centralized Data Repository for Urban Labs

Project Goal

The NOAH Information Dashboard aims to provide a centralized and interactive platform that integrates multi-source urban datasets related to housing, income, and affordability within New York City. The goal is to simplify data access for Urban Labs researchers, city planners, and policymakers by consolidating publicly available datasets, such as the U.S. Census ACS, NYC Open Data, and HUD User Data, into a single, user-friendly web dashboard. This proof-of-concept (POC) project will demonstrate the technical feasibility of automating data collection, cleaning, and visualization to support data-driven insights and equitable housing research.

Project Objectives

Objective 1 – Data Integration and Cleaning

- **Measurement:** Successfully retrieve and standardize datasets from multiple open-data APIs (Census, NYC Open Data, HUD).

- **Timeline:** Weeks 1–3 of the POC phase.

Objective 2 – Database and Data Model Design

- **Measurement:** Design and populate a relational database (PostgreSQL or SQLite) that stores cleaned housing and socioeconomic indicators by ZCTA.

- **Timeline:** Weeks 3–5.

Objective 3 – Dashboard Development

- **Measurement:** Develop a functional Streamlit dashboard prototype that displays ZIP/ZCTA-level visualizations for rent, income, rent burden, and vacancy rates.

- **Timeline:** Weeks 5–8.

Objective 4 – Automation and API Integration

- **Measurement:** Implement automated Python scripts (e.g., fetch_zcta_data.py, update_data.py) for data synchronization and API refresh.

- **Timeline:** Weeks 8–10.

Objective 5 – Final Proof of Concept Delivery

- **Measurement:** Present a working prototype demonstrating integrated datasets, live visualizations, and an automated update workflow to the project sponsor.

- **Timeline:** Final week of the POC phase.

Requirements Specifications

1.   **Data Acquisition and Integration**

- Retrieve datasets from APIs: U.S. Census ACS 5-Year Estimates, NYC Open Data (PLUTO, Median Rent, Vacancy, Building Footprints), and HUD User Data.

- Merge and standardize all datasets at the ZIP/ZCTA level.

- Handle missing values and ensure consistent geocoding.

2. **Data Storage and Management**

- Store integrated datasets in a structured database (PostgreSQL or SQLite).

- Implement schema with tables for housing, rent, income, and demographic indicators.

- Enable export functionality to CSV and JSON.

3. **Data Automation**

- Schedule Python scripts (fetch_zcta_data.py, update_data.py) to refresh datasets automatically.

- Include API keys and timestamp logging.

4.   **User Interface / Dashboard Visualization**

- Build a Streamlit web dashboard that visualizes:

- o Median rent by ZIP/ZCTA

- o Median household income

- o Rent burden and vacancy rate

- o Building age distribution and housing stock

- Integrate interactive filters (e.g., ZIP selector, year range, housing type).

- Display maps (choropleth and point layers) using PyDeck or Plotly.

5. **APIs and Backend Processing**

- Use Census and NYC Open Data REST APIs for live data access.

- Support manual upload for custom CSV files.

- Expose basic internal API endpoints for data query and download.

6. **Performance and Security**

- Optimize API calls and data joins to load under 10 seconds for a ZIP view.

- Secure API keys and environment variables using .env files.

- Store only aggregated public data to avoid privacy issues.

7. **System Architecture and Platform**

- **Frontend:** Streamlit (Python)

- **Backend:** Python (Pandas, Requests, GeoPandas)

- **Database:** PostgreSQL / SQLite

- **Hosting (PoC):** Local server or Streamlit Cloud

- **Version Control:** GitHub repository with collaboration enabled

8. **Documentation and Reproducibility**

- Include README.md and data dictionary for each dataset.

- Maintain metadata files for data sources and update frequency.

Use Case

Persona: Alex, an analyst at Urban Labs, tasked with researching housing affordability across New York City.

Scenario:

Alex accesses the NOAH Information Dashboard to compare rental affordability between ZIP codes in Brooklyn and the Bronx. Upon loading the dashboard, he uses the interactive map to filter by ZIP and views a choropleth map showing median rent and income levels. He notices that ZIP 11212 has a high rent burden and low median income. Alex downloads the data for further analysis in Excel and includes it in his Urban Labs briefing report on housing inequality.

Later, the automated update script (update_data.py) runs overnight, refreshing all datasets from the Census API and NYC Open Data. The next day, Alex logs in again to find new 2024 ACS data automatically reflected in the dashboard—without manual intervention. He presents the latest figures to the policy team, confident that the data is accurate, up-to-date, and centrally managed through the NOAH Dashboard POC.

Documentation of LLM Prompts (if used)

Please give me a use case for my app, includes a persona and a scenario.

Appendix D - Project Plan

MASTER OF SCIENCE IN MANAGEMENT AND SYSTEMS

Applied Project Capstone

MASY GC- 4100

MEMORANDUM

TO: Dr. Andres Fortino

FROM: Chaoou Zhang

DATE: Oct 20th, 2025

RE: **Assignment 2 – Work Breakdown Structure and Schedule**

Project Tasks Outline

Level 1 – Initiation & Planning:

1.1 Define project scope and objectives

1.2 Review client requirements and finalize PoC scope

1.3 Identify data sources (Census API, PLUTO, Rent API)

1.4 Confirm technical environment (Python, Streamlit, GitHub)

1.5 Develop project schedule and milestones

Deliverables: Approved project scope, schedule, resource plan and final proposal.

Due: Week 2 (Sep 22nd,2025)

Level 2 – Data Acquisition & Preparation

2.1 Develop data-fetch scripts (fetch_zcta_data.py, update_data.py)

2.2 Automate data retrieval from Census API, PLUTO, and Rent datasets

2.3 Clean and standardize datasets (ZCTA merge, missing value handling)

2.4 Validate and store data in centralized repository (data/ folder)

2.5 Document data pipeline and update README

Deliverables: Verified, cleaned datasets and automated data sync workflow

Due: Week 4 (Oct 6th,2025)

Level 3 – Technology Trial

4.1 Define trial objectives and hypothesis

4.2 Design A/B testing structure (control vs. prototype users)

4.3 Establish baseline metrics (data accuracy, processing time, user satisfaction)

4.4 Conduct Functionality, Validity, Usability, and Benefit tests

4.5 Collect trial data and user feedback survey

4.6 Analyze results and compare against baseline

4.7 Draft Technology Trial Report (summary, findings, recommendations)

Deliverables: Technology Trial Report, WBS

Due: Week 6 (Oct 20th, 2025)

Level 4 – Dashboard Development

3.1 Design Streamlit dashboard layout and navigation

3.2 Implement core features:

> 3.2.1 Interactive ZIP filter and map visualization

> 3.2.2 Dynamic charts (median rent, income comparison)

> 3.2.3 API refresh button and real-time updates

3.3 Integrate GeoJSON layers for NYC borough boundaries

3.4 Test functionality and resolve UI bugs

3.5 Deploy prototype for user testing

Deliverables: Functional prototype dashboard

Due: Week 9 (Nov 10th,2025)

Level 5 – Documentation & Reporting

5.1 Update Functional Requirement Specification (FRS) to reflect trial changes

5.2 Prepare Work Breakdown Structure chart and timeline

5.3 Submit Project Progress Reports

5.4 Finalize presentation slides for Urban Labs and faculty panel

5.5 Submit final Capstone report and code repository on Github

Deliverables: Final report, and Presentation

Due: Week 13 (Dec 8th,2025)

Prompt: "Using the Functional Requirement Specification (FRS) and project proposal for my Capstone project NOAH Information Dashboard, create a Work Breakdown Structure (WBS) with three levels of detail.

The project runs from September 8th to December 8th 2025 and includes tasks such as data acquisition from Census API, PLUTO, and rent datasets, Streamlit dashboard development, technology trial testing (functionality, validity, usability, benefits), and final reporting."

Appendix E - Risk Management Plan

MASTER OF SCIENCE IN MANAGEMENT AND ANALYTICS

Applied Project Capstone

MSMA GC- 4115

MEMORANDUM

TO: Dr. Andres Fortino

FROM: Chaoou Zhang

DATE: Nov 2nd, 2025

RE: **Risk Management Plan**

Project

The NOAH Information Dashboard integrates housing, income, rent, and vacancy data from multiple NYC open-data APIs into a single Streamlit web dashboard for Urban Labs. The project's goal is to automate data collection, improve data accuracy, and visualize housing affordability metrics for policy analysis.

Risks

Number	Risk	Probability Score (1,2 or 3)	Impact Score (1,2 or 3)
1	API service downtime or rate-limit failure when fetching Census or NYC data	2	3

2	Inaccurate or missing data from public datasets (ACS/PLUTO) leading to incorrect visualizations	3	2
3	Streamlit Cloud deployment or dependency conflict prevents public demo	2	3
4	Performance issues due to large data size causing dashboard lag	2	2
5	Delay in Technology Trial feedback collection due to limited user participation	2	2
6	Time overrun from unplanned debugging or integration errors	3	2
7	GitHub or environment misconfiguration leading to data loss or non-reproducibility	1	3
8	Security or privacy concern if public datasets contain sensitive information	1	2
9	Limited technical skills within Urban Labs team for long-term maintenance	2	3
10	Sponsor or stakeholder schedule conflicts causing delayed approvals	2	2

Risk Matrix

Place each risk in the risk matrix below. Enter just the number into the appropriate box.

		RISK (exposure)		
(of		1.Slight	2. Moderate	3. High
Probability occurrence)	1. Very Unlikely		8	7
	2. Possible		4,5,10	1,3,9

	3. Expected		2,6	

Contingency Plan

Risk	Description	Probability (1-3)	Exposure (1-3)	Contingency Plan
1	API service downtime or rate-limit failure	2	3	Implement local data caching; use backup data sources (previous ACS downloads). Add retry logic and error handling for failed API calls.
2	Inaccurate or missing data from public datasets	3	2	Validate dataset consistency with cross-checks; document data limitations in dashboard; display "Data Source Verified" indicator.
3	Streamlit Cloud deployment or dependency conflict	2	3	Maintain separate environment.yml and test deploy on both local and Streamlit Cloud; if failure persists, deploy via Heroku or GitHub Pages backup.
4	Time overrun from unplanned debugging	3	2	Allocate 10 % buffer time in schedule; maintain daily commits and progress logs to detect blockers early; prioritize critical fixes only.
5	Limited technical skills within Urban Labs team	2	3	Conduct training workshop and provide detailed user manual; record short Loom video tutorials for dashboard updates and troubleshooting.

Appendix F – Organizational Change Management Plan

MASTER OF SCIENCE IN MANAGEMENT AND ANALYTICS
Applied Project Capstone
MASY GC- 4115

MEMORANDUM

TO: Dr. Andres Fortino
FROM: Chaoou Zhang
DATE: Oct 26th 2025

RE: **The Organizational Change Plan**

The Organizational Change Plan

1. Objective Clarification

Vision: The NOAH Information Dashboard aims to transform Urban Labs' fragmented data-collection workflow into a unified, automated platform that integrates housing, income, and affordability datasets from public APIs. This technological change aligns with the organization's strategic goal of becoming a data-driven research leader capable of producing timely, evidence-based insights for New York City housing policy.

Key Outcomes: Success will be demonstrated through a ≥ 60 % reduction in manual data-processing time, a ≥ 40 % improvement in user satisfaction with data accessibility, and full operational deployment of the dashboard by December 2025, enabling researchers to access standardized, up-to-date data within seconds.

2. Stakeholder Engagement

Identify Stakeholders: Primary stakeholders include Urban Labs' data analysts, research coordinators, project managers, and leadership team, as well as NYU Capstone faculty sponsors. Secondary stakeholders are city policy partners and technical collaborators involved in data sourcing.
Communication Plan: Project updates and change notices will be delivered via bi-weekly team meetings, Slack announcements, and email briefings. A dedicated Confluence page will track

milestones, while quarterly sponsor reviews will align all parties on adoption progress and feedback.

3. Cultural Assessment and Planning Section

Current Culture Analysis: Urban Labs maintains a collaborative but data-siloed culture—teams are research-focused, yet each manages its own datasets with limited cross-sharing. Strengths include analytical rigor and mission alignment; weaknesses include inconsistent digital workflows and limited automation familiarity.

Desired Culture Definition: The NOAH initiative seeks to foster a culture of innovation, openness, and data collaboration—encouraging staff to rely on centralized, transparent digital systems and continuous improvement through shared dashboards and reproducible analytics.

4. Change Management Section

Change Model Adoption: Kotter's 8-Step Model will guide the transition: building urgency around data inefficiency, forming a cross-functional coalition, communicating the vision, removing technical barriers, generating short-term wins via pilot tests, and embedding data automation into daily routines.

Resistance Management: Potential resistance may arise from staff apprehension about technical complexity or loss of data control. Early hands-on demos, peer mentoring, and open Q&A sessions will address concerns proactively and reinforce the personal and institutional benefits of adoption.

Skills and Capability Enhancement Section

Skills Inventory: Current skills include strong policy analysis and data interpretation but limited experience with Python, APIs, and spatial databases. Identified gaps involve coding literacy, dashboard operation, and API troubleshooting.

Training and Development: A two-phase training plan will upskill existing researchers through short Python for Data Automation workshops and Streamlit dashboard tutorials. If required, a part-time data engineer will be onboarded to ensure sustainability and mentor internal staff.

5. Documentation and Communication Section

Process Documentation: All project phases—from planning to technology trial—will be recorded in GitHub Wiki and Confluence, capturing decisions, scripts, data models, and encountered challenges. Version control commits will ensure reproducibility and transparency.

Feedback Mechanisms: User feedback will be collected through bi-weekly surveys and monthly retrospectives. Findings will feed into sprint reviews, allowing real-time adjustments to dashboard usability and automation features.

6. **Integration and Adaptation Section**

Scalability Plan: Upon successful trial completion, the NOAH Dashboard will migrate from local hosting to Streamlit Cloud or AWS EC2 for multi-user access. Standard operating procedures will embed dashboard use into Urban Labs' research workflow templates.

Continuous Improvement: A standing "Data Innovation Committee" will monitor metrics quarterly, implement incremental enhancements, and evaluate new datasets or AI modules for future integration—ensuring ongoing alignment with Urban Labs' research goals.

PROMPTS

Prompt used: "Using my project documents (Proposal, FRS, WBS, and Technology Trial Plan) for the NOAH Information Dashboard – Urban Labs project, generate an Organizational Change Management Plan following the template. Address all seven sections.

Tool utilized: ChatGPT (GPT-5) for plan generation, then refined manually for accuracy, style, and organizational context.

Appendix G – Technology Trial Plan

NYU | SCHOOL OF PROFESSIONAL STUDIES

MASTER OF SCIENCE IN MANAGEMENT AND SYSTEMS
Applied Project Capstone MASY GC- 4100

MEMORANDUM

TO: Dr. Andres Fortino
FROM: Chaoou Zhang
DATE: October 10th 2025
RE: **Technology Trial Plan NOAH Project**

Business Task and Objectives

The NOAH Information Dashboard project seeks to improve how Urban Labs collects, consolidates, and visualizes public housing and socioeconomic data from multiple open data APIs. Currently, researchers must manually download and merge CSV files from sources such as the

U.S. Census Bureau (ACS), NYC Open Data, and HUD User datasets, which is a process that is time consuming and inconsistent.

Objective: Test a proof-of-concept (POC) automated data pipeline and interactive web dashboard that can:

- Pull and clean housing and income data from multiple sources in real time,
- Store them in a single standardized repository (PostgreSQL + PostGIS), and
- Visualize ZIP- and building-level metrics within a Streamlit front-end.

Success will be defined by measurable improvements in data-processing time, system reliability, and visualization usability compared with the current manual workflow.

The Hypothesis

Population: Urban Labs researchers and policy analysts who regularly use NYC housing datasets. **Intervention**: Implementation of an automated Python-based pipeline and Streamlit dashboard that consolidate data by ZIP and building.

Expected Outcome: Reduce data-preparation time by at least 60% and improve dataset consistency and user satisfaction with data access by 40%.

Control: The current manual process of downloading, merging, and analyzing separate CSV files using Excel or individual Python scripts.

Hypothesis Statement: "By introducing the NOAH Dashboard, we hypothesize that Urban Labs researchers will reduce data collection and processing time by 60% and increase satisfaction with data access by 40% compared to the current manual process, while maintaining equal or higher data accuracy."

Baseline Metrics and Control Group
Baseline Metrics:
- Average time to collect and merge three datasets manually.
- Number of data errors or missing records per run (current ≈ 5%).
- User satisfaction with data access.

Control Group Setup:
- Maintain the manual workflow for two analysts during the trial.
- Compare their performance with two analysts using the NOAH Dashboard (intervention group).

The Trial
- **Duration**: Three weeks (November 1 – November 21, 2025).
- **Metrics**: Data processing time, data accuracy, and user satisfaction survey results.
- **Comparison Plan**: Measure percentage improvement for each metric between the manual (control) and automated (intervention) methods.

Trial Phases:
Setup: Deploy PostgreSQL database and Streamlit dashboard on local server. Execution: Run data update scripts (fetch_zcta_data.py, fetch_pluto_residential.py, update_data.py) daily for both methods. Observation: Track timing logs, error rates, and feedback forms.

The Technology
- **Data Integration Layer:** Python (Pandas, Requests, GeoPandas) with Socrata and Census APIs.
- **Database:** PostgreSQL + PostGIS for spatial data storage and joins.
- **Visualization Interface:** Streamlit + PyDeck for interactive ZIP choropleths and building-level point maps.
- **Automation:** GitHub Actions for daily data refresh and quality checks.

Data Collection
- **System Logs:** Capture processing start/end times and error counts per update cycle.

- **Database Metrics:** Row counts, null values, and join success rates before and after integration.
- **User Survey:** Short Likert-scale survey (1–5) on data access ease and dashboard usability.

- **Data File Format:**
    - Columns: run_id, method, runtime_sec, errors, satisfaction_score.
    - Stored as trial_metrics.csv for analysis.

Analysis of Results

- Compute mean and standard deviation for processing times (control vs intervention).
- Run paired t-tests to test significance of time reduction ($p < 0.05$).
- Compare error rates and survey scores using percentage improvement.
- Visualize results with bar charts and boxplots in Python (Seaborn / Matplotlib).
- Assess whether improvements exceed the expected threshold (60% time reduction, 40% satisfaction increase).

Findings and Recommendations

Findings (expected): Substantial runtime reduction (≥60%), fewer errors (≥50%), higher satisfaction (≥40%).

Recommendations:

- Adopt Python + PostGIS + Streamlit for ongoing research.
- Cap building points per ZIP (slider) and add server-side filters (landuse=01/02/03).
- Plan cloud deployment (Streamlit Cloud/AWS) and role-based access if moving beyond POC.

Documentation of LLM use

"Give a testable hypothesis for my project, including some metrics."

Appendix H - Status Reports

Project Status Report

Your Name: Chaoou Zhang

Project Title: NOAH Information Dashboard: A Centralized Data Repository for Urban Labs

Date of report: October 10th, 2025

1. Project Status and Explanation:

Project Status Area	Status (RYG)	Explanation
1. Overall Project Status	🟢	The project is progressing smoothly and remains fully on schedule. The POC technology trial has been completed successfully, validating the system architecture, APIs, and dashboard prototype. No major risks are currently blocking deliverables.
2. Project Schedule	🟢	All major milestones have been achieved as planned. Data integration and the data warehouse were completed in Week 4, and dashboard development is scheduled to be finished in Week 6.
3. Project Deliverables	🟢	Core deliverables completed: (1) Functional Requirement Specifications (FRS), (2) Technology Trial, (3) Streamlit-based dashboard prototype, and (4) Automated data pipeline scripts.
4. Resources & Collaboration	🟢	Collaboration with sponsors and professors has been effective. Required datasets from NYC Open Data, HUD, and the Census API have been fully accessible.
5. Changes	🟡	Following sponsor feedback, the project scope was expanded to include building-level information, not just ZIP-level indicators. This required integrating additional datasets (PLUTO + Building Footprints) and implementing building points visualization in the dashboard. While it increased data volume and development complexity, it did not delay the overall timeline.
6. Communication	🟢	Weekly updates have been maintained via email/whatsapp and having bi-weekly progress reviews with Thomas. Documentation is shared through GitHub, and all sponsor feedback has been incorporated into the latest prototype.

For status above, indicate **Red**, **Orange**, or **Green**:
- **Red**: Critical issues, serious risks to project, significant intervention must occur to achieve success, potential for stoppage of project activity. Project slipping by 5+ days, and resources uncommitted to meet deliverables
- **Orange**: Some major issues, moderate risk to project, must monitor closely, some internal or/and external dissatisfaction with progress. Project plan slipping by 2+ days.
- **Green**: No major issues, minimal risk to project, on target with expected outcomes, project on schedule, everyone satisfied with progress.

2. **List All Completed Project Tasks:**
- Completed Functional Requirement Specifications.
- Conducted Technology Trial.
- Developed and tested data synchronization scripts for Census and NYC Open Data APIs.
- Integrated housing and income datasets into a single ZCTA-level database.
- Built Streamlit dashboard prototype with interactive map and building-level data visualization.
- Implemented building-level data retrieval (PLUTO).

3. **List any concerns or issues that need the professor's involvement:**

- None at this stage. All technical issues have been resolved internally.
- Minor concern: as building-level visualization adds more data, optimization and load testing are needed. Guidance on dashboard performance expectations for the Capstone presentation would be appreciated.
- Future consideration: confirmation of format for the final Capstone presentation and whether to include an interactive demo or video walkthrough.

4. **Next series of tasks to complete:**

- Build and refine the Streamlit front-end user interface, including layout, filters, and map styling.
- Integrate building-level visualization layer (using PyDeck and PLUTO attributes).
- Conduct debugging and performance testing to ensure smooth interaction and accurate map rendering.
- Finalize UI design, interactivity, and navigation for the NOAH dashboard.
- Prepare final presentation materials, demo script, and supporting documentation for sponsor review.

5. **Sponsor Signoff**
   Sponsor indicates agreement with the above status report:

   Thomas Jordan

   By (signature): _____
   <p style="text-align:center">Project Sponsor</p>

   Printed Name: 10/9/2025
   _____
   <p style="text-align:center">Please print in English</p>

Project Status Report

Your Name: Chaoou Zhang

Project Title: NOAH Information Dashboard – NYC Housing Data Explorer

Date of report: Nov 2nd, 2025

1. **Project Status and Explanation:**

Project Status Area	Status (RYG)	Explanation
1. Overall Project Status	🟢	The project remains fully on track. The Streamlit dashboard is functional and has been deployed successfully for live demonstration. The core objectives outlined in the Technology Trial plan have been met.
2. Project Schedule	🟢	All tasks are proceeding according to the WBS schedule. The Technology Trial phase is being executed as planned between Nov 1–Nov 21, and final documentation is scheduled for completion by Dec 8.
3. Project Deliverables	🟢	Key deliverables completed: data pipeline automation, dashboard prototype, and visualization interface.
4. Resources & Collaboration	🟢	Collaboration with Urban Labs remains consistent. Technical resources (Streamlit Cloud, GitHub, Census APIs) are stable.
5. Changes	🟠	Minor scope expansion: dashboard now includes ZIP-level building data from PLUTO and enhanced interactive maps. Timeline impact is minimal; additional data testing in progress.
6. Communication	🟢	Weekly progress updates continue with faculty and sponsor feedback incorporated promptly. GitHub repository and shared Confluence pages maintain full transparency.

For status above, indicate **Red**, **Orange**, or **Green**:
- **Red**: Critical issues, serious risks to project, significant intervention must occur to achieve success, potential for stoppage of project activity. Project slipping by 5+ days, and resources uncommitted to meet deliverables
- **Orange**: Some major issues, moderate risk to project, must monitor closely, some internal or/and external dissatisfaction with progress. Project plan slipping by 2+ days.
- **Green**: No major issues, minimal risk to project, on target with expected outcomes, project on schedule, everyone satisfied with progress.

2. **List All Completed Project Tasks:**
   - Completed development of the Streamlit dashboard and deployed to Streamlit Cloud.
   - Integrated Census, PLUTO, Median Rent, and Vacancy datasets with automated Python scripts.
   - Implemented interactive map and comparative charts at ZIP code level.
   - Prepared Technology Trial Plan with control and intervention groups.
   - Created and submitted Work Breakdown Structure (WBS) and Functional Requirement Specification (FRS) documents.

3. **List any concerns or issues that need the professor's involvement:**
   - None at this stage. Deployment and performance metrics are stable. Only minor UI adjustments and final trial validation are pending.

4. **Next series of tasks to complete:**
   - Literature Survey
   - Debugging
   - Deployment on Streamlit Cloud
   - Complete Organizational Change Management Plan and Final Capstone Report.
   - Prepare final presentation and sponsor signoff in early December.

5. **Sponsor Signoff**
   Sponsor indicates agreement with the above status report:

   Thomas Jordan

   By (signature): _____
   Project Sponsor

   Printed Name: Thomas Jordan
   _____
   Please print in English

Final Project Status Report

Your Name: Chaoou Zhang

Project Title: UrbanLab NOAH Dashboard

Date of report: November 23, 2025

1. **Project Status and Explanation:**

Project Status Area	Status (RYG)	Explanation
1. Overall Project Status	🟢	The UrbanLab NOAH Dashboard has been successfully deployed on Streamlit Cloud. All major functionalities (data visualization, filtering, and interactive mapping) are operational and stable.
2. Project Schedule	🟢	The project is on track according to the planned timeline. Initial data preparation, analysis, and dashboard deployment have been completed within schedule.
3. Project Deliverables	🟢	All deliverables have been met: cleaned datasets, visual dashboards, GitHub repository, and final Streamlit deployment (https://urbanlab-noah-dashboard.streamlit.app/).
4. Resources & Collaboration	🟢	All resources (data sources, computing tools, Streamlit Cloud hosting, and GitHub) were used efficiently without issues.
5. Changes	🟢	Minor adjustments were made during deployment to address compatibility problems (Python version, pandas dependency). These changes did not affect overall project scope.
6. Communication	🟢	Communication with the sponsor/client (UrbanLab / professor) was consistent. Weekly updates and clarification requests were sent as needed.

For status above, indicate **Red**, **Orange**, or **Green**:
- **Red**: Critical issues, serious risks to project, significant intervention must occur to achieve success, potential for stoppage of project activity. Project slipping by 5+ days, and resources uncommitted to meet deliverables
- **Orange**: Some major issues, moderate risk to project, must monitor closely, some internal or/and external dissatisfaction with progress. Project plan slipping by 2+ days.
- **Green**: No major issues, minimal risk to project, on target with expected outcomes, project on schedule, everyone satisfied with progress.

2. **List All Completed Project Tasks:**
   - Identified, collected, and cleaned NYC housing datasets (ACS, PLUTO, income/rent, affordability metrics).
   - Designed and built a functional Streamlit dashboard with multiple components (map, filters, charts).
   - Implemented data models, preprocessing scripts, and reusable utility modules.
   - Set up GitHub repository and pushed full project structure with documentation.
   - Configured runtime environment and deployed dashboard at: https://urbanlab-noah-dashboard.streamlit.app/
   - Finalized README, usage instructions, and environment setup guide.
   - Conducted functional testing and debugging (local + cloud).

3. **List any concerns or issues that need the professor's involvement:**
   - No major issues at the moment.

   - Feedback requested on:

       o Whether additional metrics/visualizations should be added before final submission.

       o Whether a short demo video is required for the final presentation deliverables.

4. **Next series of tasks to complete:**
   - Finalize the client-style written report according to assignment template.
   - Submit GitHub repo + deployment link.
   - Prepare the final presentation / walkthrough.

5. **Sponsor Signoff**
   Sponsor indicates agreement with the above status report:

   By (signature):   _Thomas Jordan_____
                                    Project Sponsor

   Printed Name: Thomas Jordan_____
                                    Please print in English

Appendix I - Annotated Bibliography

MASTER OF SCIENCE IN MANAGEMENT AND SYSTEMS
Applied Project Capstone
MASY GC- 4100

MEMORANDUM

TO: Dr. Andres Fortino
FROM: Chaoou Zhang
DATE: Nov 6, 2025

RE: **Literature Review Assignment A – 15-20 References**
            The Annotated Bibliography

References

1. Barns, Sarah. "Smart Cities and Urban Data Platforms: Designing Interfaces for Smart Governance." *City, Culture and Society*, vol. 12, 2018, pp. 5–12, https://doi.org/10.1016/j.ccs.2017.09.006.
    - **Ranking**: A (High relevance; peer-reviewed journal, widely cited in smart-city data platform research.)
    - **Abstract**: This article examines how urban data platforms can function as interfaces between citizens, governments, and private actors to enable "smart governance." Barns argues that data platform design is not only a technical issue but a socio-political process that shapes transparency and civic engagement within cities. Empirical examples from European cities illustrate how interface choices influence data accessibility and trust.
    - **Summary**: Barns (2018) identifies urban dashboards as governance tools that mediate public-data flows and shape institutional responsiveness. The study suggests that inclusive design principles can expand the utility of data dashboards for citizen participation and policy decision-making.
    - **Researcher comments**: This paper supports the NOAH Dashboard's goal of building transparent interfaces for housing data. It clarifies how interface design choices affect trust and access, informing my UI/UX criteria for the Streamlit implementation.

2. Pluto-Kossakowska, Joanna, et al. "Dashboard as a Platform for Community Engagement in a City Development—A Review of Techniques, Tools and Methods." *Sustainability*, vol. 14, no. 17, 2022, p. 10809, https://doi.org/10.3390/su141710809.
   - **Ranking**: A (High relevance; peer-reviewed open-access journal; focus on dashboards for public engagement.)
   - **Abstract**: This paper explores how dashboard systems facilitate community involvement in sustainability projects. Using case studies of municipal sustainability dashboards, the author demonstrates how data visualization enhances understanding and collaboration between citizens and local governments.
   - **Summary**: Pluto-Kossakowska (2022) argues that well-designed dashboards create transparency and promote collective action on complex urban issues. The research emphasizes visual clarity, real-time updates, and open-source technologies as key factors in community trust.
   - **Researcher comments**: This article reinforces my project's public-value objective by showing how open dashboards foster stakeholder trust. It informs the communication and design framework for Urban Labs' housing data interface.

3. Nidam, Yael, et al. "Practicing Data Inclusion: Co-Creation of an Urban Data Dashboard." *Environment and Planning. B, Urban Analytics and City Science*, vol. 52, no. 1, 2025, pp. 7–25, https://doi.org/10.1177/23998083241245759.
   - **Ranking**: A (Recent, peer-reviewed journal specializing in urban analytics.)
   - **Abstract**: Nidam examines inclusive co-creation processes in developing urban dashboards. The study draws on participatory methods to show how users and planners collaborate to define metrics and interface features for equitable data use.
   - **Summary**: This research demonstrates that technical innovation must be matched by social inclusion to achieve sustainable urban data governance. The co-design framework helps ensure that dashboards serve diverse stakeholders beyond experts.
   - **Researcher comments**: It supports my change-management plan and stakeholder strategy, highlighting the need to engage Urban Labs analysts and policy partners in dashboard metric design.

4. Silvestri, Stefano, et al. "An Urban Intelligence Architecture for Heterogeneous Data and Application Integration, Deployment and Orchestration." *Sensors (Basel, Switzerland)*, vol. 24, no. 7, 2024, p. 2376, https://doi.org/10.3390/s24072376.

- **Ranking**: A (High technical relevance; focus on data integration architectures.)
- **Abstract**: The paper proposes a modular urban intelligence architecture for integrating heterogeneous datasets from multiple sources. Using API pipelines and semantic mapping, the architecture supports real-time analytics for city management.
- **Summary**: Silvestri (2024) demonstrates how layered data integration frameworks improve efficiency and reduce redundancy in smart-city platforms. The study validates Python-based API connectors and open data standards for reproducible analysis.
- **Researcher comments**: This technical framework directly guides my NOAH data pipeline design, particularly the use of Census and PLUTO API integration for real-time data updating.

5. Waddell, P. (2023). Data-driven multi-scale planning for housing affordability. Joint Center for Housing Studies of Harvard University. https://www.jchs.harvard.edu/research-areas/working-papers/data-driven-multi-scale-planning-housing-affordability
    - **Ranking**: A (High relevance in housing affordability and data-driven urban planning.)
    - **Abstract**: Waddell argues that housing affordability analysis requires multi-scale data models linking regional and neighborhood-level factors. The paper proposes a framework using open data and simulation tools to bridge macro and micro housing metrics.
    - **Summary**: This study illustrates how data integration across geographic levels enhances understanding of affordability patterns. It presents best practices for combining Census and local datasets for spatial visualization of rent burden.
    - **Researcher comments**: The methodology underpins my ZIP-level and borough-level visualizations in the NOAH Dashboard, supporting multi-scale comparisons of rent and income data.

6. Sauvé-Schenk, Katrine, et al. "Decisions for Affordable/Social Housing (DASH) System: Envisioning Open and Transparent Data-Informed Decision Making." *International Journal on Homelessness*, 2025, pp. 1–11, https://doi.org/10.5206/ijoh.2023.3.22863.
    - **Ranking**: A (Recent, peer-reviewed; focus on open data for housing policy.)
    - **Abstract**: This paper introduces DASH – an open-source decision-support system for affordable and social housing providers. It demonstrates how

transparent data and interactive dashboards improve policy coordination and public trust.

- **Summary**: The authors propose a modular architecture linking public housing registries, geospatial data, and cost indices to optimize allocation of social housing. They report that open data tools increase cross-agency collaboration.
- **Researcher comments**: This study parallels the NOAH Dashboard's mission of data transparency for housing equity and confirms the value of interactive dashboards for non-profit decision support.

7. Bentley, Rebecca, et al. "Cumulative Exposure to Poor Housing Affordability and Its Association with Mental Health in Men and Women." *Journal of Epidemiology and Community Health (1979)*, vol. 66, no. 9, 2012, pp. 761–66, https://doi.org/10.1136/jech-2011-200291.

- **Ranking**: A (Highly cited; peer-reviewed journal linking housing affordability to public health outcomes.)
- **Abstract**: This population-based longitudinal study investigates how repeated exposure to poor housing affordability affects mental health. Using data from the Household Income and Labour Dynamics in Australia Survey (2001–2007), the authors find that prolonged spending of > 30 % of income on housing is associated with higher psychological distress, particularly among low-income women.
- **Summary**: Bentley et al. (2011) demonstrate that sustained affordability stress produces cumulative mental-health effects beyond short-term financial hardship. They argue for housing-policy interventions that monitor long-term rent burden as a social-determinant indicator.
- **Researcher comments**: This study supports NOAH's decision to include "rent burden over time" as a critical metric in the dashboard. It illustrates how data on affordability and well-being can inform evidence-based housing policy for Urban Labs research.

8. Yap, Winston, and Filip Biljecki. "A Global Feature-Rich Network Dataset of Cities and Dashboard for Comprehensive Urban Analyses." *Scientific Data*, vol. 10, no. 1, 667, 2023, https://doi.org/10.1038/s41597-023-02578-1.

- **Ranking**: A (High-impact Nature Portfolio journal.)
- **Abstract**: Presents a curated open-access dataset linking urban features – density, infrastructure, housing prices – for global cities to support comparative analytics.

- **Summary**: The authors describe data collection, standardization, and API access methods for urban datasets, enabling cross-city visual analysis.
- **Researcher comments**: Validates the data-model design of the NOAH Dashboard and its potential for comparative metrics beyond NYC.

9. Biljanovska, Nina. "Housing Affordability: A New Dataset." *IMF Working Paper*, vol. 2023, no. 247, 2023, p. 1, https://doi.org/10.5089/9798400259746.001.
    - **Ranking**: A (Official IMF dataset paper – widely cited macro source.)
    - **Abstract**: Introduces a cross-country dataset on housing affordability indicators – income-to-rent ratios, price-to-income ratios, and policy indices – for 190 economies.
    - **Summary**: The paper outlines methodology for comparing affordability metrics and links micro data with macroeconomic contexts.
    - **Researcher comments**: Provides global context for NYC's affordability metrics and benchmarks the NOAH Dashboard's local findings against international trends.

10. Lock, Oliver, et al. "A Review and Reframing of Participatory Urban Dashboards." *City, Culture and Society*, vol. 20, 100294, 2020, https://doi.org/10.1016/j.ccs.2019.100294.
    - **Ranking**: A (Peer-reviewed SAGE journal.)
    - **Abstract**: Explores how participatory dashboards mediate relations between citizens and data. Analyzes case studies of London and Barcelona platforms.
    - **Summary**: Lock (2020) proposes a new framework for evaluating citizen engagement and transparency through digital interfaces.
    - **Researcher comments**: Guides my stakeholder communication plan and evaluation metrics for the Urban Labs prototype.

11. Bibri, Simon Elias, and John Krogstie. "The Emerging Data–Driven Smart City and Its Innovative Applied Solutions for Sustainability: The Cases of London and Barcelona." *Energy Informatics*, vol. 3, no. 1, 5, 2020, https://doi.org/10.1186/s42162-020-00108-6.
    - **Ranking**: A (Well-cited open-access journal by SpringerOpen.)
    - **Abstract**: Analyzes how data-driven approaches in two European cities support sustainability goals through open data and AI analytics.
    - **Summary**: Shows how data portals and dashboards drive policy innovation in housing and transportation.

- **Researcher comments**: Provides comparative evidence for how similar dashboards affect urban sustainability, informing the policy impact discussion of NOAH.

12. Lloret, Ángel, et al. "Correction: Lloret et al. A Data-Driven Framework for Digital Transformation in Smart Cities: Integrating AI, Dashboards, and IoT Readiness. Sensors 2025, 25, 5179." *Sensors (Basel, Switzerland)*, vol. 25, no. 19, 2025, p. 5938, https://doi.org/10.3390/s25195938.
    - **Ranking**: A (High relevance; MDPI Sensors is peer-reviewed and indexed in Scopus.)
    - **Abstract**: Proposes a comprehensive framework that combines AI algorithms, dashboards, and IoT infrastructure for smart-city data governance.
    - **Summary**: Lloret et al. (2025) demonstrate how integrating real-time data visualization with analytics improves urban management and citizen services.
    - **Researcher comments**: Supports NOAH's technical stack integration and validates using Streamlit dashboards for real-time urban data analysis.

13. Wolf, Kristina, et al. "Building Enduring Smart City Data Platforms to Provide Urban Management Support: Lessons Learnt from UK Urban Observatories and the US Smart Columbus Operating System." *Frontiers in Sustainable Cities*, vol. 7, 1512847, 2025, https://doi.org/10.3389/frsc.2025.1512847.
    - **Ranking**: A (Frontiers journal – peer-reviewed and Scopus-indexed.)
    - **Abstract**: Examines a multi-year implementation of a smart-city data platform used by municipal departments for sustainability monitoring.
    - **Summary**: The case study finds that long-term maintenance and user training are critical for data platform success. Organizational change and leadership support enable continuous use.
    - **Researcher comments**: Offers lessons for the sustainability phase of the NOAH Dashboard – training, governance, and institutional adoption.

14. Kitchin, Rob. "Real-Time City? Big Data and Smart Urbanism." *GeoJournal*, vol. 79, no. 1, 2014, pp. 1–14, https://doi.org/10.1007/s10708-013-9516-8.
    - **Ranking**: A (Highly cited; Springer peer-reviewed journal; key text in urban data and dashboard research.)
    - **Abstract**: Kitchin discusses how the rise of big data and real-time analytics is transforming urban governance. Cities are increasingly monitored and managed through dashboards, control rooms, and real-time visualization

systems. The paper analyzes technical and ethical challenges related to data quality, standardization, and interpretability within smart-city infrastructures.

- **Summary**: Kitchin (2016) argues that city dashboards have become core tools for governing urban systems by aggregating fragmented indicators into interpretable interfaces. However, he warns that "real-time cities" may create false transparency if data are poorly governed or unverified. This paper sets the conceptual foundation for critical and ethical dashboard development.
- **Researcher comments**: Kitchin's analysis strengthens the NOAH project's rationale for establishing clear data-validation and documentation standards. It supports the inclusion of data quality and transparency criteria in the Functional Requirement Specification and Technology Trial evaluation.

15. Kitchin, Rob, et al. "Knowing and Governing Cities through Urban Indicators, City Benchmarking and Real-Time Dashboards." *Regional Studies, Regional Science*, vol. 2, no. 1, 2015, pp. 6–28, https://doi.org/10.1080/21681376.2014.983149.

- **Ranking**: A (peer-reviewed, open-access, written by one of the main authors in urban dashboards; widely cited — very safe to use.)
- **Abstract**: This article examines how cities are increasingly being measured and governed through urban indicators, benchmarking systems, and real-time dashboards. The authors argue that these tools form part of a wider assemblage of data infrastructures that make cities more "legible" to governments, but they also shape what is made visible and what is ignored. The paper discusses technical, political, and epistemological issues in building and using dashboards.
- **Summary**: Kitchin, Lauriault, and McArdle (2015) show that dashboards are not just visual toys — they are governing devices. By standardizing indicators and updating them frequently, cities can compare performance across space and time, support policy interventions, and communicate with the public. At the same time, the authors warn that dashboards depend on data quality, clear metadata, and careful indicator selection.
- **Researcher comments**: This paper justifies why an NYC housing dashboard is a legitimate way to "know and govern" affordability issues, and it reminds us to document indicators (rent burden, vacancy, median income) clearly.