How NYC Moves

Tech-Accelerated Data Solutions for Transportation and Development Approvals in NYC

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NYC Office of the Mayor

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Acknowledgments

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Jacobs Urban Tech Hub @ Cornell Tech

The Jacobs Urban Tech Hub is an academic center at Cornell Tech developing programs dedicated to leveraging the power of technology to help optimize urban systems, improve government service delivery, and help cities adapt to future technologies. Cornell Tech focuses on creating pioneering leaders and technologies for the digital age, through research, business, and technology education. The campus encourages a practical, hands-on approach to learning, and its programs include real-world project collaborations with tech companies, community organizations and government agencies. This approach aims to bridge the gap between academia and industry, preparing students to be innovators in New York City's vibrant tech ecosystem.

Mayor's Office of Policy and Planning

The Mayor's Office of Policy and Planning, within the office of the First Deputy Mayor, manages policy development and innovation priorities in key areas of Mayor Eric Adams' wide-ranging policy portfolio. The office oversees the Mayor's Office of Economic Opportunity and implementation of major action plans including recommendations from the "New" New York Plan and Get Stuff Built. In addition, the office leads negotiations for the City's Project Labor Agreements on behalf of the City and develops new policy proposals under the direction of the Mayor and First Deputy Mayor such as the first expansion of the Earned Income Tax Credit in 20 years and the development of new procurement methods for the City.

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Executive Summary

The Urgency of Streamlining Processes

The need to expedite essential development and infrastructure projects in New York City has never been more pressing, given economic recovery challenges and the most severe housing crisis in half a century. The "Get Stuff Built" initiative by Mayor Eric Adams aims to tackle the City's bureaucratic processes that have slowed projects and inflate costs significantly. This initiative outlines the imperative of reforming the City Environmental Quality Review (CEQR), the Uniform Land Use Review Procedure (ULURP), and permitting processes to shape the City's future. Instituting these reforms is crucial to cutting project delivery timelines in half, ensuring more projects begin construction and public dollars are more effectively spent.

Downstream Impacts of Current Processes

New York City's methods to conduct the environmental review processes required by the State Environmental Quality Review Act (SEQRA) and for other operational planning not subject to SEQRA, in their current state, add substantial time and cost to successful development projects—estimated by the Citizens Budget Commision as approximately 9% or $67,000 per high-rise apartment, translating into a monthly rent increase of about $430[1]. These delays consume funds that could otherwise subsidize more affordable housing units and accelerate economic recovery.

Beyond those costs is the potential for delays and uncertainties to derail. Megaprojects expert Bent Flyvbjerg conclusively links projects' failure to longer timelines. Why? "The longer the [project] duration, the more opportunity for something [disruptive] to crash through and cause trouble,"[2] be it legal challenges, shifting political dynamics, or unanticipated black swan events. The common real estate adage puts it succinctly: "Time kills deals."

Transportation Analysis Bottlenecks

Transportation analysis, a cornerstone of project planning and review in NYC, often dictates project approval timelines. The current methodology, outlined in the CEQR Technical Manual, involves a multi-step tiered screening process that can be time-intensive and prone to delays, often necessitating extensive rollouts of temporary cameras and data collectors. This intensive process, while thorough, strains resources and inhibits timely delivery of urgent and community-driven initiatives, particularly during lengthy seasonal blackouts, constraining when data may be collected. No amount of upstaffing alone will be able to achieve Get Stuff Built's target of cutting approval times by 50%.

Photo: Ianna Chia (unsplash)

1 https://www.nyc.gov/assets/home/downloads/pdf/press-releases/2022/GetStuffBuilt.pdf

2 Flyvbjerg, B., & Gardner, D. (2023). *How Big Things Get Done* (p. 23).

Transportation Data Connect Symposium at the Microsoft Garage in New York City

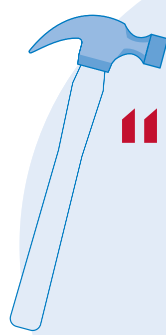
Technology's promise for review processes

- **Shorten Analyses**: Developing programs to accomplish basic tasks and standardizing data transformations can significantly reduce the time required for data entry, collection, and analysis
- **Adjust Requirements**: Use new sources of data or analysis to revisit and test previous assumptions leading to current requirements
- **Eliminate Steps**: Based on the use of improved methods and sources, remove steps or requirements that are no longer necessary
- **Automate Processing**: With concerted efforts to implement programs and technologies, entire segments of processes, including agency review, can be automated
- **Transform Methods**: Deployment of emerging technologies and practices not only enables automation, but allows for rethinking of underlying processes and imagining new approaches

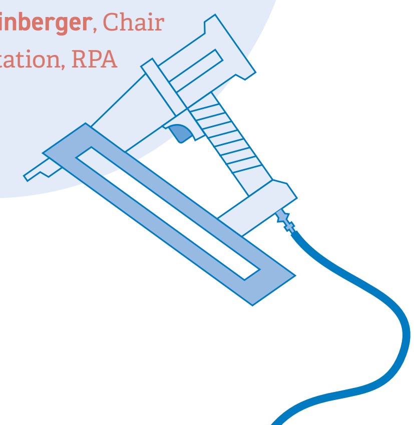
Applying Technology to the Transportation Analysis Process

Increasing the adoption of technology in review and analysis offers a way out of these dynamics—accelerating processes while maintaining or *increasing* confidence in results. As the Regional Plan Association's Rachel Weinberger presented: "Transportation analysis assumes a hammer, but now we have a nail gun." Transportation and mobility has been among the most innovative and dynamic sectors of the last decade, yet governments have struggled across the board to find public-benefiting opportunities that live up to the hype.

To navigate technology's potential for transportation analysis in New York City, the Mayor's Office partnered with Cornell Tech's Urban Tech Hub to host a two-day event, the Transportation Data Connect Symposium. Experts from government, transportation firms, tech companies, and academia gathered to explore available technologies and emerging transportation practices and discuss opportunities to leverage them to streamline multiple facets of transportation analysis and review. As uncovered during the proceedings and workshop, technology holds tremendous promise to shorten analyses, adjust requirements, eliminate steps, automate processing, and transform methods, in addition to enhancing a number of other Department of Transportation (DOT) projects and initiatives.



> "Transportation analysis assumes a hammer, but now we have a nail gun."
>
> — **Rachel Weinberger**, Chair for Transportation, RPA



Recommendations

Drawing from the insights gathered at the Symposium workshop, the outputs were refined into recommendations in the following five categories:

1 Produce Centralized Transportation Data Sources

Establish a Citywide model for transportation volumes from best available data and sources, replacing months-long requirement to collect and process new counts.

2 Leverage Computer Vision on City Assets to Count Vehicles

Utilize the thousands of existing cameras and sensors owned and operated by City agencies in the public realm to capture reliable traffic counts, while ensuring secure and privacy-friendly data practices.

3 Develop Software to Streamline Routine Agency Procedures

Automate transportation analysis steps to reduce redundancy and improve accuracy, such as developing seasonal adjustment factors and streamlining analytical procedures.

4 Review Latest Practices and Innovations for Opportunities to Improve Analysis Methods

Reassess thresholds for analysis based on historic projects and provide tools for increasing the use of mitigation measures beyond signal timing.

5 Build Cross-Sectoral Technology Capacity

Pursue actions to promote the effective use of technologies and solutions within the City, including modernizing procurement processes, targeted staff upskilling, developing industry-facing processes for vendor data solutions, and fostering internal and external collaboration.

Conclusion

By embracing the strategic implementation of advanced technologies and streamlining procedural inefficiencies, New York City has a unique opportunity to expedite the development of critical housing and infrastructure projects. These recommended reforms, derived from the collaborative insights of experts across various sectors, present a clear path forward. Implementing these measures will not only ensure that development processes are efficient and cost-effective but also align with the broader public goals of equity, sustainability, and economic recovery.

The urgency of the current housing crisis and economic challenges demands decisive action. By adopting these recommendations, New York City can transform its approach to urban development, paving the way for a more responsive, innovative, and inclusive future. The time to act is now—let's Get Stuff Built.

The time to act is now—let's

Get Stuff Built.

2

The Current Transportation/ Land Use Analysis Process and Its Impacts

The Need to 'Get Stuff Built'

New York City's unprecedented housing crisis and economic challenges are exacerbated by cumbersome, costly, and time-consuming mandated processes. These procedures often add 2-3 years and millions of dollars to development and infrastructure projects.[1] Recognizing these critical challenges, Mayor Eric Adams issued the "Get Stuff Built" report at the end of 2022.[2] This report outlines 111 concrete actions spanning environmental review (CEQR), land use (ULURP) approval, and building permitting, aiming to cut approval timelines in half while continuing to uphold its obligations under state law and the New York City Charter. Through Q1 2024, nearly a third of these actions have been implemented.

To fully appreciate the need to tackle these inefficiencies, we must highlight their financial impacts on the housing sector. Estimated by the respected Citizens Budget Commission, the costs associated with the extended review processes add at least 9% to overall project costs. For a high-rise residential building, this translates to an additional $67,000 per apartment or $430 to monthly rent. These processes also divert crucial affordable housing funds, with a three-month delay costing the equivalent of 11 apartments' subsidy for a 100-unit affordable housing development. Since the publication of the "Get Stuff Built" report, the inflationary environment's impact on limited public dollars has grown even clearer, with construction costs revealed to be 40% higher than pre-COVID levels.[3]

While the direct and indirect costs of the methods established in New York City to meet the obligations of SEQRA and operational planning are substantial, their downstream effects are even more troubling. Lengthy review processes delay the realization of public benefits, hinder the deployment of infrastructure, and slow the delivery of agency services. These prolonged reviews cause applicants to lock in project details early, inhibiting opportunities for community input or alternative proposals and solutions. Further consequences of lengthy processes include ambitious projects and their public benefits getting scaled down, fewer projects pursued due to uncertainty, and those that get to the finish line tending towards luxury, higher profit-maximizing developments to cover process and time costs.

Streamlining these procedural roadblocks is essential not just for speeding up construction but also for reshaping processes to reflect collective values. This includes prioritizing transit, pedestrians, and other non-auto users, and accelerating the delivery of projects that align with public benefits such as housing production, climate-friendly infrastructure, reducing environmental justice community burdens, and promoting Minority and Women-Owned Business Enterprise creation. A significant hurdle in achieving these goals–and the focus of this report–is the cumbersome transportation analysis process that lies at the heart of government review efforts which can be made more efficient.

The Transportation Analysis Bottleneck

Transportation analysis lies squarely on the critical path of government environmental and operational review efforts, integral from the very beginning of most planning projects, often being the last component completed or providing crucial inputs for other key aspects of planning (e.g. air quality assessment). Any effort to improve the efficiency and effectiveness of planning and review processes must address transportation analysis, as streamlining other areas of planning alone would do little to speed up overall project planning and delivery.

The established process for conducting a transportation analysis for most changes to the built environment in New York City is defined in Chapter 16 of the 2021 CEQR Technical Manual[4]. This process is applied to a wide range of projects subject to the City's discretion, including capital infrastructure construction, operational changes like converting general travel lanes to bus or bike use, and land use changes such as zoning regulations to accommodate additional residential growth or issuing special permits for specific uses like stadiums.

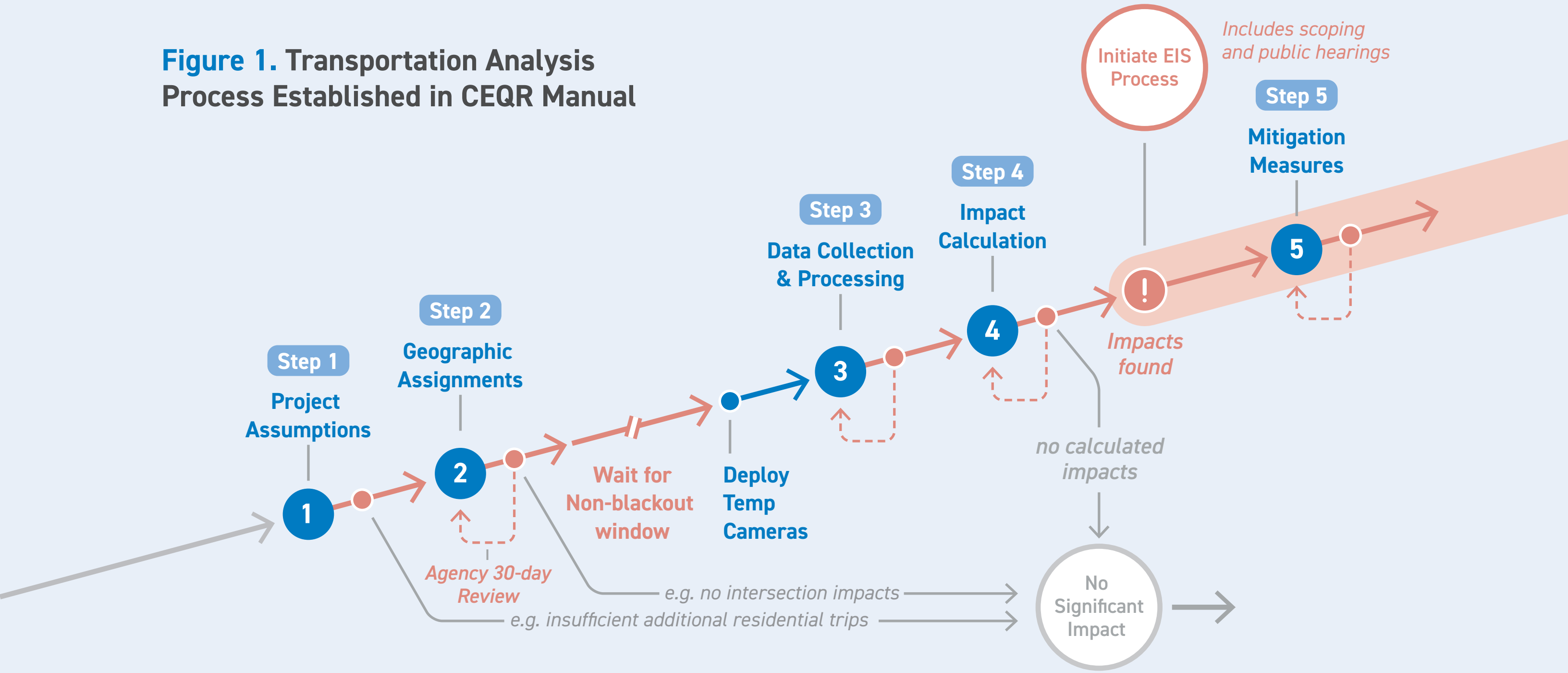
1 Improving New York City's Land Use Decision-Making Process - https://cbcny.org/sites/default/files/media/files/REPORT_Land-Use_09062022_0.pdf#page=26

2 Get Stuff Built: A Report of the Building and Land Use Approval Streamlining Taskforce - https://www.nyc.gov/assets/home/downloads/pdf/press-releases/2022/GetStuffBuilt.pdf

3 Y/Y Cost of Construction Moderates but after Rising to New Higher Perch - https://www.constructconnect.com/construction-economic-news/cost-of-construction

4 https://www.nyc.gov/assets/oec/technical-manual/16_Transportation_2021.pdf

Figure 1. Transportation Analysis Process Established in CEQR Manual



The CEQR transportation analysis follows a tiered screening process. This involves a linear series of steps, illustrated above, to determine if the effects of a proposed project exceed established thresholds. For each tiered threshold exceeded, and significant impacts identified, more detailed analysis is required. Otherwise, no further analysis is necessary. When all screening thresholds are exceeded, a disclosure of significant impacts and proposed mitigations is produced, typically in the form of an Environmental Assessment Statement or, if significant impacts are found, an Environmental Impact Statement. A thorough description of these five steps can be found in Appendix A.

Step 1: Project Assumptions

Once a project has been defined, initial screening excludes small projects and specific actions that won't generate sufficient trips to significantly impact traffic. For larger projects, a Travel Demand Factor (TDF) memorandum is produced using established assumptions and data sources like the US Census, adjusted for local conditions and behaviors to project future transportation activities. This TDF estimates the number of trips produced by a project by different modes (e.g. walking, driving, transit, etc.).

Step 2: Geographic Assignments

If a project exceeds the number of trips identified under the Tier 1 screening threshold, projected trips are assigned to the existing transportation network to determine if further detailed analysis is needed. This step involves evaluating potential traffic increases at specific intersections, pedestrian elements (e.g. sidewalks, crosswalks, corners), or transit nodes, with further analysis triggered by significant increases in traffic or pedestrian volumes.

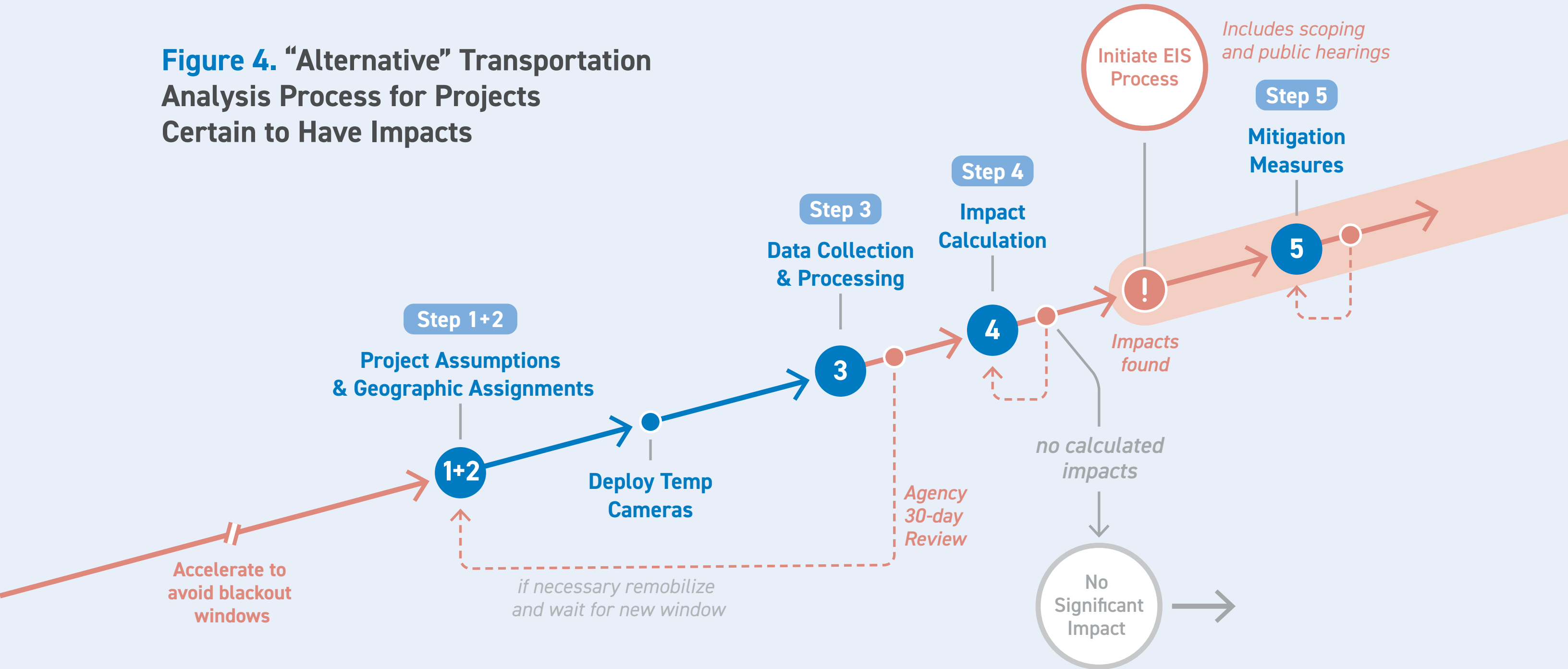
Step 3: Collecting Data

Existing traffic and pedestrian volumes are collected during peak hours using methods such as field observations, automated traffic counters, or video recordings. Data older than three years or from areas with significant changes are updated to accurately reflect current conditions.

Step 4: Determining Potential for Adverse Impacts

Once existing conditions are established, future conditions are projected, both with (With Action) and without (No Action) the project, using growth rates, other known development projects, and the incremental project related volumes determined from Steps 1 and 2. This data is analyzed to compare the With Action to the No Action conditions and assess the impact of the project on traffic, pedestrian flow, and transit facilities.

Figure 4. "Alternative" Transportation Analysis Process for Projects Certain to Have Impacts



Step 5: Developing Mitigation Measures

When significant impacts are identified, measures are developed to mitigate them as much as practicable. Mitigation can range from simple operational changes, like adjusting traffic signals, to more complex solutions like sidewalk widenings, dedicated turning lanes, or promoting alternative transportation modes. If impacts cannot be fully mitigated, they are disclosed as part of the Environmental Impact Statement.

Downstream Consequences of Transportation Analysis Methods

The transportation analysis methods from New York City's current transportation engineering paradigm have significant downstream consequences. Specifically, the need for updated field data at hyper-specific locations, the limitations of existing standard data sources, and flexibility that allows for conflicting "professional judgments" consume limited City resources and funds, with the ultimate cost paid by New York City residents in reduced capacity.

Agency Capacity Constraints

To avoid the lengthy summer and winter breaks and poor early-year weather conditions, most major planning projects begin their data collection and transportation analysis efforts in late spring or early fall. As a result of transportation analyses occurring in these discrete data collection windows, reviewing agencies face a bottleneck effect, requiring staff to review multiple projects simultaneously and overwhelming the available resources, which delays the overall process.

Challenges in Delivering Time-Sensitive Projects

The rigid requirements for transportation data analysis hinder the timely delivery and implementation of urgent and accelerated projects, especially if proposed during a seasonal blackout. This includes public projects proposed by community stakeholders or quick-build capital improvement projects.

Compounded Delays

A project sponsor may need to "re-mobilize" data collection for various reasons, including to address changes in assumptions, the existing transportation network, or in the project program due to new market conditions or community input (i.e. redoing portions, or the entirety, of the screening, data collection, analysis, and DOT approval process). As such, the project may be delayed due to the need to align with the limited data collection windows. This holdup can extend up to four months, lengthening approval timelines and project completion.

Elusive Regular Traffic Days

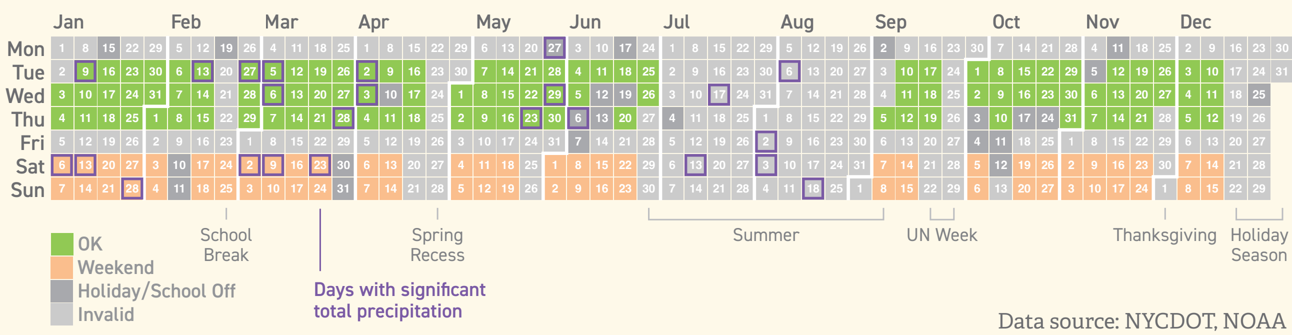
To account for days of the year where travel activity is known to be unusual or otherwise uncharacteristic of normal travel patterns, DOT designates data collection "blackout" days, including Federal and City holidays, school break periods, and special events. From the applicant perspective however, the numerous blackout days often render traffic counts inadequate or unacceptable. As illustrated in the DOT 2024 Traffic Collection Days calendar,[1] large portions of the year are marked periods where traffic counts will not be considered, limiting the available days for valid data collection. Weeks with blackout days outnumber those without, necessitating field observations to be extended by days or even weeks to obtain sufficient data.

Additionally, traffic counts can be invalidated after the fact due to anomalous factors, unusually heavy rain or snowfall, or City-wide or localized events that are unknown or not pre-scheduled blackout days. These can include street fairs, construction projects, significant collisions, races, concerts, or playoff games, which might prompt the DOT to invalidate data and require further collection days.

An analysis of recorded traffic counts for Tuesdays in Fall 2019, see below, shows that even with stringent blackout periods, the difference between acceptable and unacceptable daily traffic counts is under 2%. While this topline figure likely misses intra-day nuances, it nonetheless raises questions about the efficacy of an analytical approach that may require discarding over half the data collected. In contrast, continuous data collection and analysis techniques can better handle the inherent irregularity of traffic patterns, allowing outlier travel behaviors to be identified without sacrificing the broader, more consistent trends.

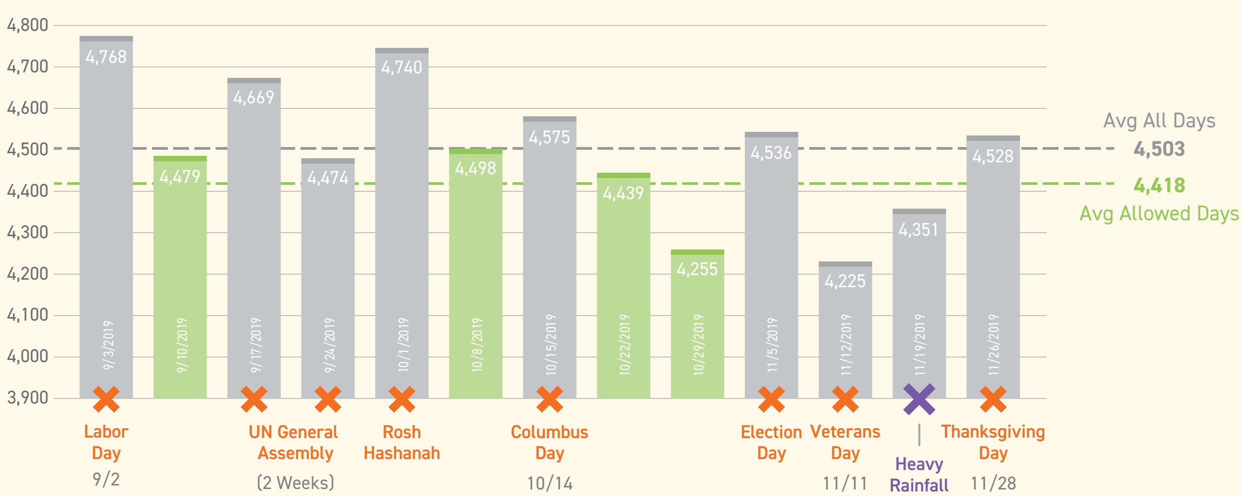
1 See Appendix B for the official version

Figure 2. Visualizing the NYC 2024 Traffic Count Collection Day Calendar



Data source: NYCDOT, NOAA

Figure 3. Traffic Counts and Blackout Reasons for Tuesdays in Fall 2019



Data source: VHB Automated Traffic Recorder data – data set was not a product of and has not been reviewed by NYC DOT.
Note: DOT has reduced the overall number of blackout days; in 2024 fewer of these would be blackout days

Unofficial "Alternative" Process

To bypass some of the lengthy agency approval times, many applicants, especially those anticipating a finding of impacts, avoid submitting anything to DOT until after data collection and processing are complete. This common workaround conservatively overestimates traffic impacts and over-samples data collection locations. However, this approach may still require coordination with DOT or even *re-mobilization*, if inaccurate assumptions are made.

Applying Technology to the Transportation Analysis Process

Acknowledging the critical path role of transportation analysis in local government planning and implementation, and recognizing the opportunity for new technologies and advanced solutions to accelerate these analyses, the Mayor's Office established a strategic partnership with Cornell Tech's Urban Tech Hub. This collaboration leveraged the Hub's expertise in applying advanced technologies to urban challenges to navigate the complex array of emerging solutions and service providers. Specific technologies applicable to the transportation analysis process are detailed in the Technology & Techniques Background section (page 46).

The use of advanced digital technology in transportation analysis may offer several concrete benefits that address existing inefficiencies and enhance overall project outcomes:

- **Larger and Broader Data Sets**: Provides access to a wider range of more extensive and timely transportation data.
- **Accelerated Data Processing**: Speeds up the reformatting, transformation, and processing of data.
- **Streamlined and Automated Processes**: Simplifies analysis steps and approval processes, making them more efficient.
- **Superior Methodologies**: Employs advanced methodologies for higher-quality analysis outputs.
- **Improved Visualization and Communication**: Enhances data visualization and communication, making findings more accessible to stakeholders.
- **Comprehensive System Models**: Aggregates models of transportation system behavior for thorough measurement and testing.
- **Enhanced Predictive Analytics**: Improves predictive assessment and analytics capabilities, providing deeper insights into potential impacts and outcomes.

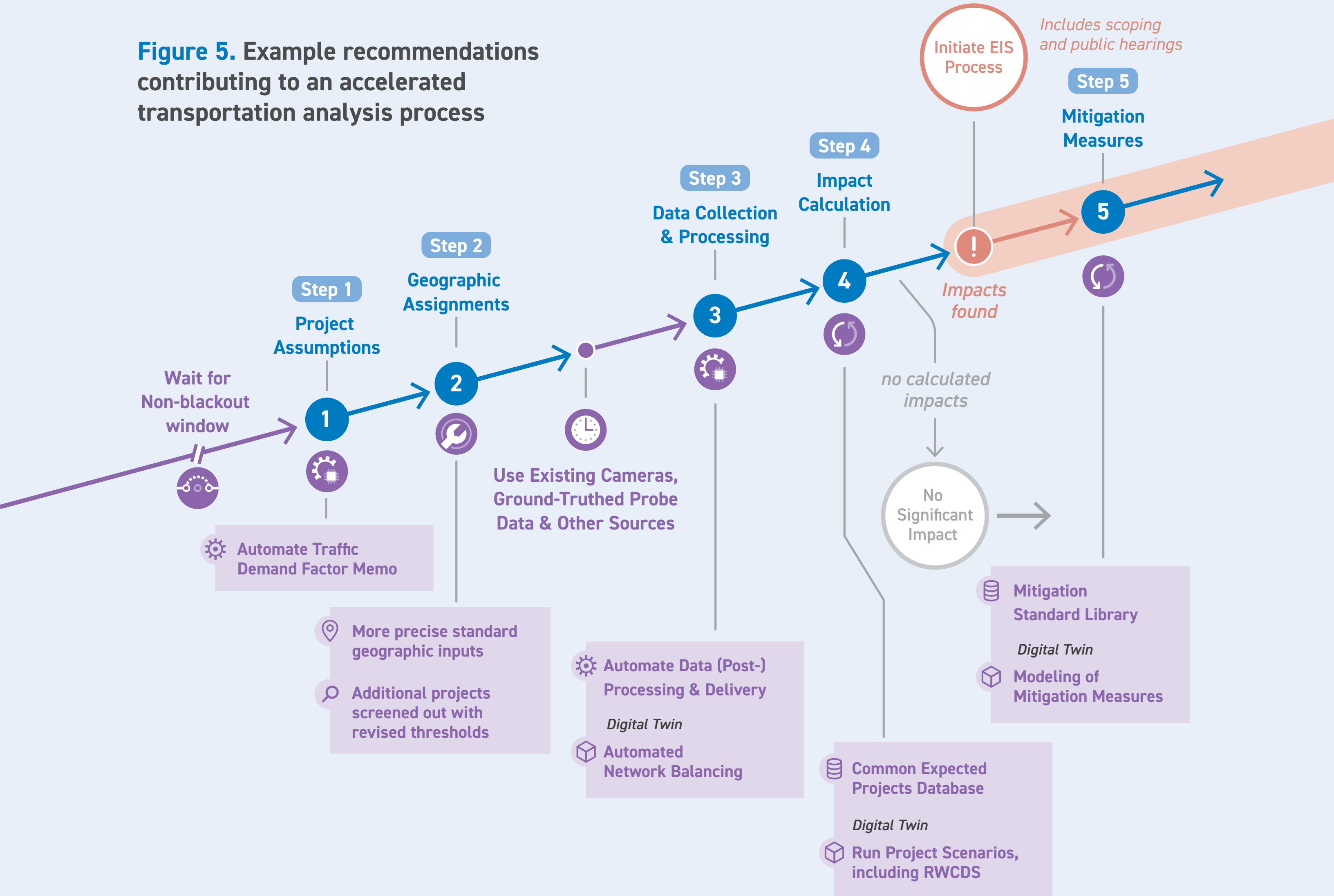
Beyond these benefits, a concerted technological approach can yield a simulation of the City's transportation systems, potentially in the form of application-specific traffic models or comprehensive "digital twin." The latter allows endless testing of scenarios and recalculation of impacts, which can feed into or improve upon multiple steps throughout the transportation analysis and review process. Ultimately, the greatest potential for adopting advanced digital technologies lies in integrating the analysis and review steps into project planning.

Evaluating the broad spectrum of emerging technologies, techniques, innovations, and solutions, and their ability to enhance, streamline, or even "solve" transportation analysis steps is an unwieldy challenge crossing disciplines, jurisdictions, and agency responsibilities. To better assess and identify opportunities to apply emerging technologies to the transportation analysis process, especially Data Collection (Step 3), the Mayor's Office and the Urban Tech Hub devised and hosted a symposium, gathering local expertise from City staff, transportation consultants, technology providers, and academia.

The proceedings and workshop validated technology's tremendous promise to improve the transportation analysis process. Generalizing the benefits described above yields five dimensions for technology to improve processes and procedures: shorten analyses, adjust requirements, eliminate steps, automate processing, and transform methods. These are described further in Figure 5.

The symposium proceedings, including the translation of problems into preliminary solutions, are detailed in the section NYC Transportation Data Connect Symposium (page 38). Recommendations drawn from the collaborative activities on Day 2 are in the following section of this report, Recommendations (page 16).

Figure 5. Example recommendations contributing to an accelerated transportation analysis process



Technology's promise for review processes

Shorten Analyses: Developing programs to accomplish basic tasks and standardizing data transformations can significantly reduce the time required for data entry, collection, and analysis

Adjust Requirements: Use new sources of data or analysis to revisit and test previous assumptions leading to current requirements

Eliminate Steps: Based on the use of improved methods and sources, remove steps or requirements that are no longer necessary

Automate Processing: With concerted efforts to implement programs and technologies, entire segments of processes, including agency review, can be automated

Transform Methods: Deployment of emerging technologies and practices not only enables automation, but allows for rethinking of underlying processes and imagining new approaches

3

Recommendations

Drawing from the insights and findings of the NYC Transportation Data Connect Symposium Day 2 Workshop, the following pages detail recommendations focused on leveraging technology and data to enhance New York City's transportation analysis process. Organized into five categories, these recommendations synthesize the key challenges of existing procedures and potential steps to address them identified during the workshop.

These recommendations are designed to elevate the application of established and emerging technologies to eliminate delays and impediments standing in the way of 'Getting Stuff Built,' enhancing the efficiency, resilience, and responsiveness of New York City agencies. The recommendations focus on creating centralized, high-confidence sources of transportation data, utilizing computer vision and machine learning on City assets, streamlining policies and procedures, realigning analysis practices with public goals, and building cross-sectoral capacity for technology use.

Primarily technical and technological, these recommendations prioritize streamlining existing processes according to established requirements and practices, rather than crafting new proposals to tackle City priorities such as equity and climate resiliency. There are worthwhile propositions to overhaul fundamental transportation analysis methodologies, integrate additional considerations into required analyses, and enhance opportunities for public input. The report's perspective is that procedural impediments must be addressed before considering additions to the process. Or, to put it pithily: the least accessible, equitable, or sustainable subway station is the one that doesn't get built.

Moving Forward

By implementing these recommendations, New York City can establish a foundation of transportation innovation, ensuring City processes align with and City agencies are prepared to meet the evolving needs of a dynamic population and economy. We encourage stakeholders—policymakers, planning agencies, community members, and private sector partners—to take decisive action in the following areas:

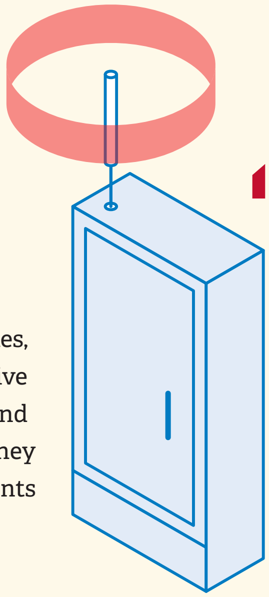
1. **Produce Centralized Transportation Data Sources**
2. **Leverage Computer Vision on City Assets to Count Vehicles**
3. **Develop Software to Streamline Routine Agency Procedures**
4. **Review Latest Practices and Innovations for Opportunities to Improve Review Analysis Methods**
5. **Build Cross-Sectoral Technology Capacity**

By dismantling procedural barriers and embracing technological advancements, New York City can accelerate the development of critical housing, service, and infrastructure, ultimately benefiting all residents. Let's ensure that our City's future needs are met with innovation, efficiency, and inclusivity. Now is the time for action.

Let's **Get Stuff Built.**

Relevant Urban Tech Principles

Given the fluid nature of technology and the need to stay current with software and hardware developments, the following principles aim to guide the navigation of transportation technology complexities, ensuring sustainable, interoperable, and cost-effective solutions. These principles have helped formulate and refine the recommendations that follow, ensuring they are grounded in the latest technological advancements and best practices.



> "Embracing open standards....fosters market competition, enhances technological innovation, reduces costs, and avoids vendor lock-in."

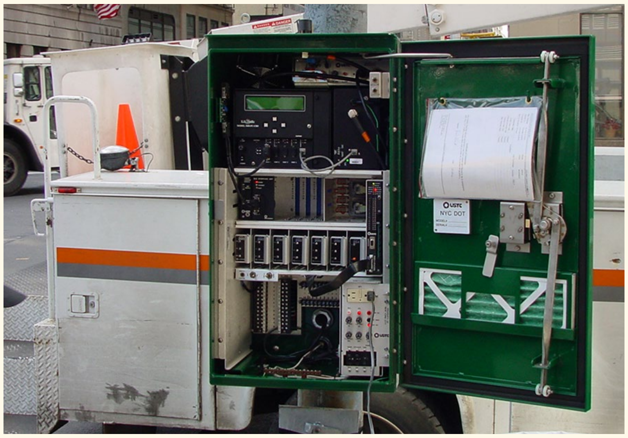
1. Technological Advancements Continue Over Time:

The technology landscape is dynamic, with products continually adding new capabilities and previously underperforming technologies becoming viable. Software improvements often outpace hardware upgrades, and anticipating them can provide greater capabilities for the investment. AI accelerates this trend, increasing accuracy and capability with added training data.

2. Open Standards Promote Interoperability and Scalability

Embracing open standards like the Advanced Transportation Controller Cabinet Standard V2[1] fosters market competition, enhances technological innovation, reduces costs, and avoids vendor lock-in. Standardized software libraries and hardware components enable seamless integration with existing infrastructure and data sources, ensuring scalability for future growth. This approach levels the playing field for vendors, encouraging a cohesive and efficient transportation data backbone.

Interior of NYC ASTC traffic controller used citywide. Its open architecture is based on ATC national standards.
Photo NYCDOT



3. Collected Data is Multi-Purpose

The capabilities of nearly any existing camera in the public realm can be augmented with computer vision, applying to numerous applications across divisions and agencies. Given the limited space on DOT street light poles, and the costs associated with installing and maintaining them, there is a need for strategic deployment of these technologies to utilize existing cameras and sensors to their fullest potential. Ensuring robust data privacy measures for the collection and use of data from cameras and sensors protects sensitive information and maintains public trust.

4. Repetitive Tasks and Processes Provide Automation Opportunities:

Defined processes and procedures often involve repetitive tasks that can be automated to increase efficiency and reduce human error. Gathering data from sensors and various sources, translating information between formats or systems, and validating outputs are all prime candidates for automation. Large Language Models (LLMs) further expand the potential for streamlining by handling text processing, extracting key information from documents, or even generating legible, formatted language based on a range of inputs.

1 https://www.ite.org/technical-resources/standards/its-cabinet/

1 Produce Centralized Transportation Data Sources

Developing and deploying centralized and accepted transportation information and resources offers a path out of lengthy, siloed, and manual processes. City agencies should use the full range of public resources and data, ground-verified big data sources, and emerging technology practices to publish and regularly refresh digital models of travel throughout the City. The following transportation information deployments are listed in increasing order of required effort.

1.1 Publish Definitive Source for Transportation Volume Model of Existing Conditions

Construct a transportation volume model to be the primary data source for *existing conditions* within the standard transportation analysis process. This model could provide necessary data at each intersection and other key locations throughout the entire New York City transportation network, as detailed below. The data fusion database described in 1.2 is well-suited to serve as the model's foundation. For locations without a fixed sensor, the model should interpolate counts based on probe data sources and network balancing techniques consistent with ground truthing framework established in section 5.3 (page 36). As discussed in this report, probe data collection technologies will require further validations and corroborations, such as ground truthing from fixed sensors, to be used as the primary source for transportation volumes.

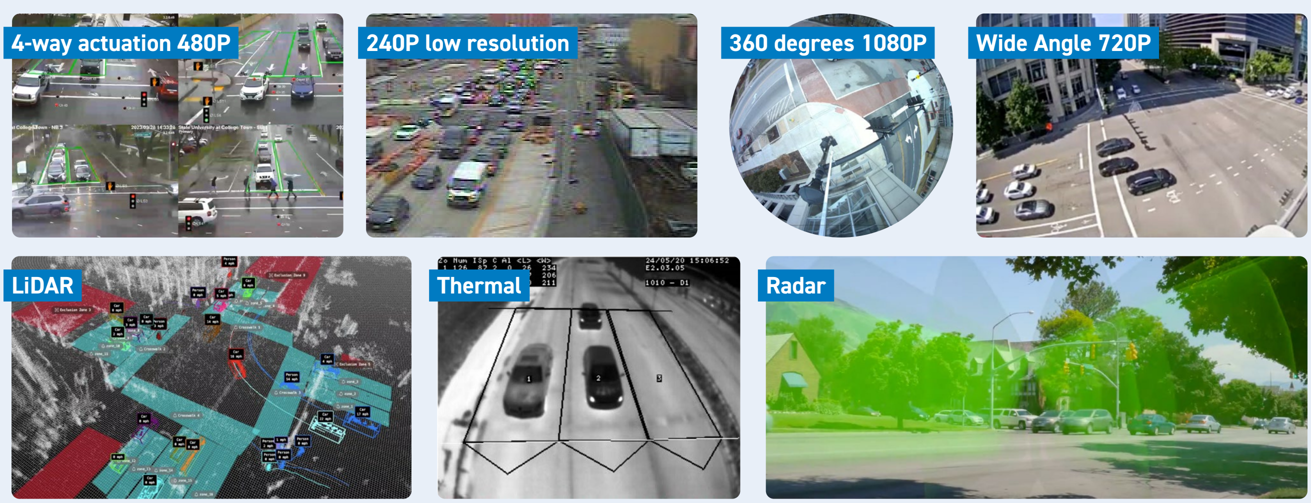
Transportation Model Requirements

To meet CEQR analysis requirements, this model should include the following data points at all intersections within the City:

1. Turning Movement Counts (in 15-minute intervals)
2. Vehicle Classifications (auto, taxi/FHV, truck, bus, bicycle, etc.)
3. Average Control Delay (as defined in the Highway Capacity Manual)

Beyond the above for vehicles, volumes for pedestrian, bicycle, ferries, and other modes of travel should also be included in the model. The model should be tabulated in 15-minute increments for weekday and weekend conditions and reflect a typical non-holiday day. These annualized values should be updated at regular inter-

Figure 7. Illustration of Potential Data Sources combined into a data fusion database



Source: Gridmatrix

vals, with output datasets available to applicants and all agencies to use for analysis.

The CEQR process should rely on the transportation volumes updated as of a designated point in time, potentially the public scoping. These transportation volumes, reflecting existing conditions, also serve as the base for projected No Action and With Action scenarios, supported by other streamlined or centralized processes such as described in 3.4.

1.2 Establish a Transportation Data Fusion Repository for Standardized Storage & Access

Plan and implement a data fusion database and process that unifies transportation data from the multitude of cameras, sensors, big data sources collecting relevant data within City limits into the singular resource for historic transportation data at intersections and key locations. The primary data source for the data fusion database should be continuous count data from fixed cameras and sensors, including those owned by DOT, as well as external agencies like New York's Metropolitan Transportation Authority (MTA) and Port Authority, obtained through data sharing agreements.

Beyond fixed, continuous data sources, data fusion should integrate the bevy of temporary or "short" count data collected in the DOT's Traffic Information Management Systems (TIMS), and probe data of high confidence from connected vehicles (CVs) and location-based services (LBS) through City applications like Department of Citywide Administrative Services' (DCAS) Fleet Office of Real Time Tracking (FORT) and private big data providers.

Data Flexibility, Confidence, and Calibration

The data fusion database must be designed to be flexible across multiple dimensions, anticipating the inclusion of future types of sensors such as LiDAR, accommodating different data fidelities, and automatically pulling data at intervals appropriate for each data source. When mapped, the data fusion data sources should help identify priority locations for new sensors.

Each data source, whether raw or interpolated, should have an associated level of confidence registered within the data fusion database. Over time, the data fusion process should enable the calibration of transportation data sources against one another, increasing confidence levels for all data sources.

1.3 Pilot a Digital Twin to Simulate the Transportation Network

Using the data fusion database as the source for volumes and modal splits, and the transportation volume model as a basis for describing movement through the network, apply data science and machine learning (ML) techniques to create a digital reproduction or *digital twin* of a neighborhood or other targeted area of City's transportation systems. The digital twin should be able to simulate conditions over long periods of time, record minute details of conditions at specific locations, and project impacts of complex variations of changes to the system. See the following pages for an explanation of how to further distinguish from models and a description of a digital twin training process.

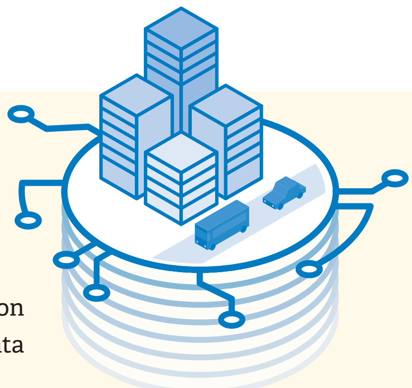
Unlike traditional traffic models, a digital twin continuously updates and refines its algorithms with real-world data, enhancing its predictive capabilities over time. This dynamic approach allows for ongoing improvements in accuracy and reliability. Based on successful results from the pilot, the digital twin should be expanded over time to encompass larger areas of the City. The best approaches for building, co-developing, hosting, maintaining, and ultimately owning this comprehensive digital twin should be explored as part of the design and pilot process.

Use Cases Beyond Standard Transportation Analysis

In contrast to transportation models, such as proposed in 1.1, which are static and tailored to specific transportation analyses and questions, a digital twin is a flexible base for running thousands of scenarios, adjusting assumptions, and assessing impacts at multiple scales. It's the distinction between an Atlantic weather model predicting 20 named tropical storms for the upcoming season and a continuously updated hurricane path tracker. Digital twin capabilities can be applied to a range of challenges, such as research for policy decisions, planning for special events, optimizing emergency responses, proactively managing congestion, and overall making data-driven infrastructure investments to build a more efficient, resilient, and responsive transportation system.

A digital twin's ability to simulate and analyze conditions from historical data to future projections provides a robust foundation for enhancing the CEQR process, transportation analysis more broadly, and even transportation operations. As a sophisticated tool capable of evaluating a wider range of impacts across numerous proposals in significantly shorter timeframes, a digital twin offers the opportunity to streamline and recalibrate the planning, review, and decision-making processes, ultimately improving the efficiency and effectiveness of transportation management.

> "A digital twin is a set of virtual information constructs that mimics the structure, context, and behavior of a natural, engineered, or social system (or system-of-systems), is [1] dynamically updated with data from its physical twin, [2] has a predictive capability, and [3] informs decisions that realize value. The bidirectional interaction between the virtual and the physical is central to the digital twin."
>
> **— National Academies of Sciences, Engineering, and Medicine. 2024**



Transportation Model vs. Digital Twin

Model

Simplified representation of transportation systems using static data and fixed assumptions to analyze current and future conditions.

Provide periodically updated snapshots of transportation volumes for vehicles, pedestrians, bicycles, and other travel modes from various intersections and key locations.

Digital Twin

Dynamic, real-time simulation of transportation systems integrating live data and predictive analytics to continuously mirror, and potentially optimize, real-world operations.

Run thousands of scenarios and adjust assumptions in real-time, supporting uses like event planning, emergency response, infrastructure investment, and policy research.

Dynamic travel conditions such as in the following scenario would only be possible to simulate with a digital twin: *a playoff baseball game coinciding with a school holiday, emergency construction on a nearby arterial, and a police investigation preventing subways from moving.*

Generalized Steps of Training a Transportation Digital Twin

Step 1: Aggregate and Standardize Transportation Data

Collect comprehensive traffic data from both direct and indirect sources, including cameras, sensors, probe data, and historic flow counts. **Standardize this data** to ensure uniformity, involving data cleaning to remove anomalies and normalization to scale data into a comparable range, preparing it for integrated analysis.

Step 2: Integrate Data Through Fusion Techniques

Merge diverse data sets using data fusion, aligning different data types into a unified dataset. This integration creates a holistic view of traffic dynamics, essential for developing a predictive model that reflects real-world conditions accurately.

Step 3: Build Predictive Transportation Models Using Machine Learning

Develop a foundational transportation model based on core traffic and vehicle flow theories and network dynamics, then enhance this model with machine learning algorithms. Techniques like regression analysis for predicting transportation volumes, neural networks for complex pattern recognition, or decision trees for classification tasks will enable the model to learn and improve from data patterns.

Step 4: Validate and Refine the Model for Higher Accuracy

Test the model's predictions against new, unseen data to evaluate its accuracy and ability to generalize across different scenarios. Implement **cross-validation** to ensure the model's robustness, dividing the dataset into parts for iterative training and testing. Enhance the model's precision through hyperparameter **optimization**, adjusting the algorithm's settings to improve prediction accuracy. Lastly, apply **feature selection** to focus on the most impactful data points, streamlining the model for efficient and accurate traffic forecasting.

Step 5: Implement Continuous Learning and Model Updates

Identify and maintain a core set of impactful parameters, and establish a **routine of ongoing data collection and model retraining**. Employ techniques like online learning to allow the model to update in real-time with new data, ensuring it stays relevant and accurate as traffic patterns evolve.

Step 6: Deploy, Monitor, and Optimize Model Performance

Deploy the refined model into traffic management systems for real-time application and strategic planning. **Monitor its performance** continuously, using statistical metrics to quantify prediction accuracy. Periodically **reassess and adjust** the model, incorporating the latest data and possibly newer machine learning approaches to keep the model at peak performance.

2 Leverage Computer Vision on City Assets to Count Vehicles

Several thousand closed-circuit TV (CCTV) and internet-connected cameras and sensors owned by public agencies are currently capturing street-level video feeds within NYC. These encompass a wide variety of hardware, procurements, and operating agreements, and span across agencies, but the majority of deployed camera hardware is technically sufficient for running standard computer vision algorithms to recognize vehicles, pedestrians, and all manner of objects. For transportation analysis purposes, with appropriate privacy & security measures in place these potentially computer vision-augmented cameras can serve as permanent traffic count sources, and are ideal inputs for data fusion tables and digital twin models.

2.1 Conduct Inventory of Publicly-Owned Cameras in the Public Realm for Computer Vision-based Traffic Counts

A first step towards planning to leverage publicly-owned cameras as traffic count data sources is to conduct an inventory spanning City and State agencies, including City and State DOTs, NYC Parks (DPR), NYPD, MTA, the Port Authority, and DSNY. Understanding the potential hurdles in the way of collecting traffic counts will require gathering the specific teams and divisions that own the cameras, operations agreements, and contract limitations on the use of the hardware. On the technical front, the inventory should include details about the cameras themselves–resolution, framerate, connectivity method–as well as the data access and storage procedures used as part of video and imagery capture.

The inventory can be accomplished under the next iteration of the NYC Internet of Things (IoT) survey, and should encompass not only existing installations, but also expected and proposed camera deployments.

2.2 Clarify Citywide PII-Friendly Data Collection Practices

Computer vision's use in sensitive data collection, especially facial recognition and license plate recognition, have potentially been drivers of the siloed deployment of cameras within the City. However, there are many computer vision applications, including traffic counting, that do not necessitate the use of personally identifiable information (PII) as well as practices to ensure the privacy-friendly transmission of data (See Protecting Personally Identifiable Information in Computer Vision).

To promote the more widespread use of insights collected from cameras and sensors, policies should be developed governing the automated collection, obfuscation, anonymization, storage, and processing of potentially sensitive data. This effort aims to set a standard across all NYC agencies for handling data that could impact individual privacy, ensuring that data collection and usage are conducted responsibly and ethically.

Piloting Public Realm Communication Strategies

Pilot innovative techniques for openly communicating about the data being collected in public spaces, similar to initiatives like "Helpful Places[5]." This approach pairs well with increased data collection, and seeks to enhance transparency with the public regarding what data is collected, how it is used, and the measures in place to protect privacy.

5 https://helpfulplaces.com

The Cameras and Sensors of New York City

900 NYCDOT traffic management cameras

500 NYSDOT traffic cameras

110 CBDTP collection points

5,100 MTA Street-level cameras

18,000 Police Department (NYPD)-accessible cameras

250 Department of Sanitation (DSNY) Cameras

350 Microwave sensors

500 Wi-Fi-monitored traffic segments

15,000 NYC Fleet Vehicles with Telematics

20,000 Nexar Dashcams

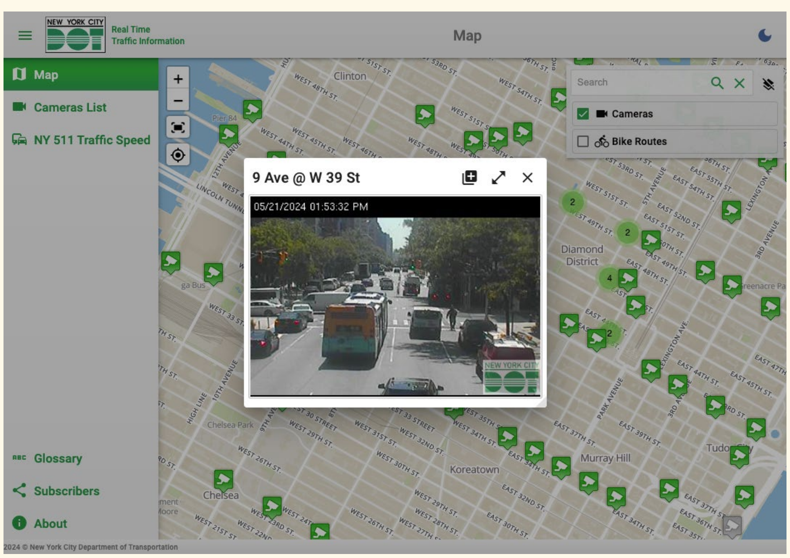
Sources: NYCDOT, 511NY, NYPD, DSNY, NY Daily News and interviews

Traffic camera & microwave sensor

Bus lane camera

School zone speed camera

Photos: NYCDOT

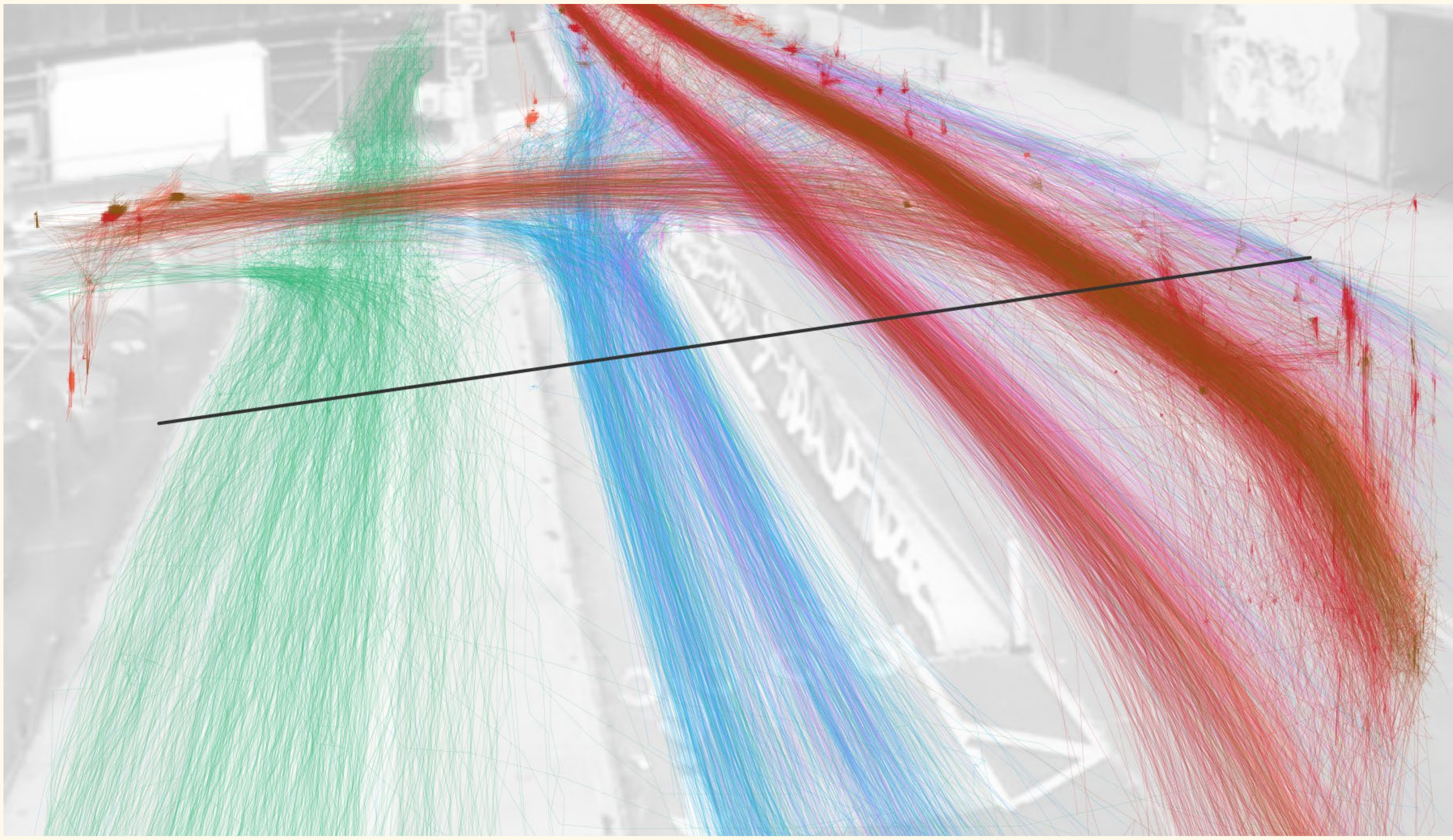


Live Feed from one of the NYCDOT Traffic Management Center's 900 CCTV cameras

Source: NYCDOT

> "Several thousand closed-circuit (CCTV) and internet-connected cameras and sensors owned by public agencies are currently capturing street-level video feeds within NYC."

Protecting Personally Identifiable Information (PII) in Computer Vision

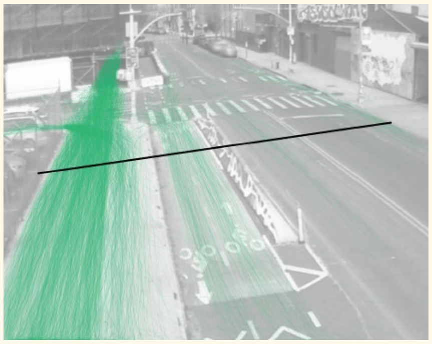


Bicycle
Bus
Car
Motorbike
Pedestrian
Truck
Van

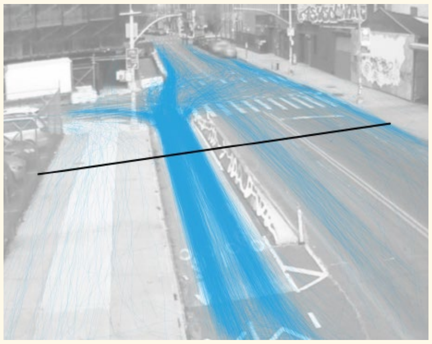
Computer vision algorithms in Numina's sensors recognize the paths of pedestrians, bikes, and vehicles on a street, while discarding other captured data.
Source: Numina

Privacy and security concerns abound with public agency capturing of images and video, namely risks to personally identifiable information, or PII. To protect PII, two key computer vision techniques are commonly used: First, *obfuscation* is the blurring of faces, license plates, or other identifying marks. Computer vision algorithms can automate obfuscation, in real-time or via data sharing applications. Second, *edge processing* houses the actual computer vision algorithms on the camera hardware itself, so that recordings are never transmitted, only the paths, counts, and insights.

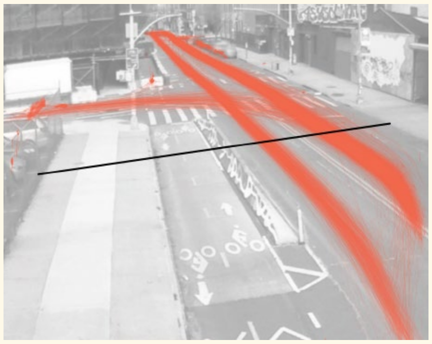
Note: PII protection efforts that translate trips into pathways, as per Numina example, make corroboration against traditional data collection methods highly challenging.



Pedestrians



Bicyclists



Cars

2.3 Formalize Inter- and Intra-Agency Transportation Data Sharing & Processing Pathways

Cameras are but one form of duplicative procurements and infrastructure in the public realm, caused by the real and perceived barriers to sharing across agencies or even within divisions. Cross-agency sharing of data feeds does occur, but usually after lengthy periods of jockeying resulting in open data publication, ideally, or ad hoc arrangements that may be disrupted in the future.

To facilitate future sharing of transportation-related data between divisions, agencies, and jurisdictions the City can develop standardized data-sharing agreements, disclosures, and practices for agency collected, received, and processed data. Where existing transportation data exchange pathways exist between agencies, such as DOT receipt of MTA NYC Transit turnstile counts and Taxi & Limousine Commision (TLC) For-Hire Vehicle (FHV) trip feeds, these relationships and transmissions should be formalized.

Standard Post-Processing Data Steps Aligned with PII-friendly Data Collection Practices and Data Fusion

Key to streamlining the data sharing is the definition of standard steps for post-processing of any transportation data collected to remove identifiable details (PII) as described in "Protecting PII in Computer Vision". These should be designed to occur as default, automated processes by the agency and division collecting the data, ensuring the data sharing is legally defensible whether the recipient is the data fusion database discussed in 1.2, a secured agency process, or the Open Data portal.

2.4 Support Data Standards for Reporting Transportation Counts

Initiate a call for the creation of a comprehensive transportation count data standard that would enable the wide range of forms of transportation sensors and data sources to output and consume data in a common manner. The aim of this standard should be to enable the seamless interoperability of current and future transportation data sources by the public and private sectors, avoiding vendor lock-in and sensor obsolescence while future-proofing infrastructure deployments. Ability to publish according to the eventual data standard should be a requirement for any future transportation data source certification and procurement.

To ensure that any developed standards and practices are broadly applicable, widely accepted, and supported across the industry, this effort should engage with national transportation agencies and industry groups. Suggestions of entities that could lead and provide the necessary backing for this effort include the U.S. Department of Transportation (USDOT), the National Association of City Transportation Officials (NACTO), and the Open Mobility Foundation (OMF).

The initial standard should, at a minimum, distinguish the mode or vehicle type, and communicate the degree of confidence. As with any reputable and well-adopted and maintained data standard, the transportation count data standard would be developed and improved over time with versioning system and governance procedures. Additional modes–mopeds, cargo bikes–and use cases–e.g. vehicle classes–would be added over time with subsequent versions.

Opening Up 'Black Boxes' - Standardized Vendor Reporting and Terminology

Supplemental to any data standard, City agencies should establish clear, standardized measures for big data providers to disclose internal processing details analogous to how pollsters report sample size and methodologies used to address biases. This effort should balance making providers' data collection and processing approaches more understandable to end-users, protecting firms' "special sauce" methods. Suggested measures to include: clarity on the mix of data sources utilized–Connected Vehicle telematics, Location-Based Services (LBS), details on data source calibration and scaling, vehicle details, and levels of confidence. All parties should clearly understand whether data is 'raw', interpolated, estimated, or reported "insights" developed through further analysis.

3 Develop Software to Streamline Routine Agency Procedures

To enhance efficiency in transportation data collection and analysis, New York City should update its policies and procedures. This category focuses on streamlining processes to reduce redundancy of effort, optimize resource allocation, and incorporate modern technologies. Key recommendations include developing seasonal adjustment factors using continuous travel data, fine-tuning transportation analysis factors with the latest data sources, automating the Travel Demand Factor Memo, and centralizing data and assumptions. These measures will ensure accurate and responsive transportation planning, enabling the City to adapt to changing conditions while maintaining high standards of service.

3.1 Develop Seasonal Adjustment Factors Using Continuous Travel Data

Develop adjustment models to enable the authorized collection of transportation data year-round, without "black outs". These adjustments can be simple numeric multiples, lookup tables, or formulas that allow translation of counts collected during currently off-limits days to counts acceptable and ingestible by traffic engineering models. Adjustment factors for the summer and winter holiday seasons should be the highest priority to unblock the longest blackout periods.

Apply data science and machine learning to continuous–i.e. uninterrupted, year-round–data sources from permanent sensors, ground-truthed big data sources, or ideally the data fusion database from 1.2 to construct these factors. This technique can extend the scope of these adjustment factors to a broader range of variables that influence transportation counts: all manner of holidays, special events, day-of-week variations, and precipitation conditions. With this approach, DOT can gain a nuanced understanding of how various factors individually and collectively impact travel behavior.

If the City has already published a transportation model, per 1.1, this step would be unnecessary.

3.2 Fine-Tune Underlying Transportation Analysis Factors Using Latest Data Sources

Pursue development of fine-grained "factors" and "rates" that get plugged into transportation analysis formulas, updating from standard traffic engineering manuals values to better reflect New York City's unique contexts and distinct geographies. This step will help minimize the necessity to use *professional judgment* where there's insufficient data fidelity.

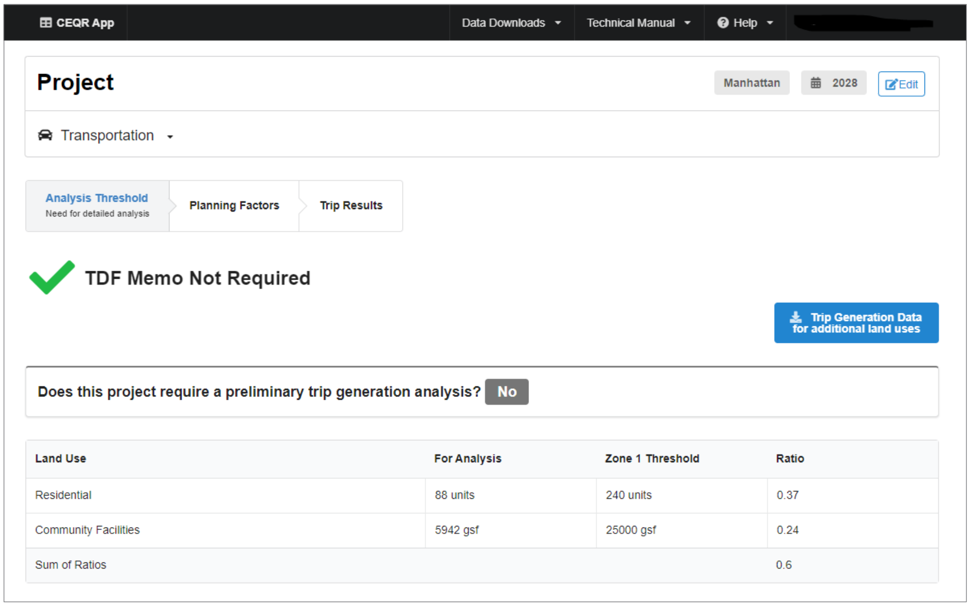
Consider using computer vision & ground-truthed big data from LBS as resources to provide updates to the following, where appropriate distinguished by use and potentially differentiating by geography:

- Trip generation rates
- Mode share
- Temporal distributions
- Vehicle occupancy
- Linked trip credits
- Origin-Destination (O/D) Assignments

3.3 Automate the Travel Demand Factor Memo and Subsequent Transportation Analysis Steps

Develop permanent software or tools that automate the maximal amount of transportation analysis steps. The calculations required for the Travel Demand Factor Memo are ripe for inclusion, as was done with the CEQR App. While that implementation covered residential uses, there's opportunity to broaden the application to other uses and pull from the best available factors from 3.1. Steps should be taken to ensure continuity through sustained funding and staffing resources so that this software avoids the deprioritization experienced by CEQR App.

Beyond the Memo, further Geographic Assignment steps are targets for automation, drawing from soft-



The Department of City Planning's CEQR App automates portions of CEQR analysis, including Step 1 of the Transportation Chapter for residential projects. Source NYCDCP

ware and APIs that suggest optimal traffic routes and alternatives. This a key step towards specifying which intersections require traffic counts. Of course, with the transportation model proposed in 1.1 in place, receiving those counts could be automated as well.

3.4 Publish & Centralize Data and Assumptions

A feature of the CEQR process, not limited to the transportation chapter, is the manual and ad hoc gathering, requesting, or even cajoling to gain access to information necessary to complete analyses from across City agencies and departments, or often State and Federal agencies. In addition to the obvious delays and uncertainties this reality adds, it also provides established and incumbent consulting firms a tremendous leg up in building private data sets of public data. Where possible, these data should be consolidated, standardized, and made accessible. Suggested initial efforts follow:

Create and Share Development Projections and Assumptions

For the transportation analysis process, assumptions about construction projects and developments expected to occur across the City are key inputs in the future conditions section. These are currently compiled for *each* application by consultants from best available information from construction permits and planned projects provided by the Department of City Planning (DCP) and reviewed by DOT. Instead, all parties should be drawing from a single source of future development projects assumptions with their respective estimated date of occupancy, as other cities do.[6] This consolidated list should be limited to only the very largest projects, as future projections are inherently uncertain and small projects are captured in the percentage-based background growth rate.

Consolidate Data for Sensor Installation on Lamppost

NYCDOT must field requests for available space to install cameras and sensors on City infrastructure, which is frequently changing. The City should gather and maintain an up-to-date central map and any necessary associated tools showing what hardware is installed where, the available power draw, and who is responsible for maintaining each element. There are potential security concerns with sharing detailed electrical capacity, so this data may need to remain only accessible internally.

Aggregate Assumptions from Similar Projects

Previous CEQR reports and transportation analyses represent a trove of geographically and contextually relevant data locked in hundreds of thousands of PDF pages, and the minds of the analysts who created

6 http://www.bostonplans.org/3d-data-maps/3d-smart-model/city-wide-3d-model

them. The recent AI explosion in large language models (LLMs) presents an opportunity to catalog the accumulated data findings of years of analysis, and provide an interface for querying that information. New York City or independent researchers should investigate the building of a lightweight system to a system to reference previous studies with characteristics similar to a proposed project, and return their respective assumptions and bespoke adjustments which may be relevant. There are numerous other potential applications of creating a transportation analysis LLM or "CEQR-GPT," and this is but one example.

3.5 Use Big Data to Accelerate and Refine Annual Updates to NYMTC's Best Practice Model (NYBPM)

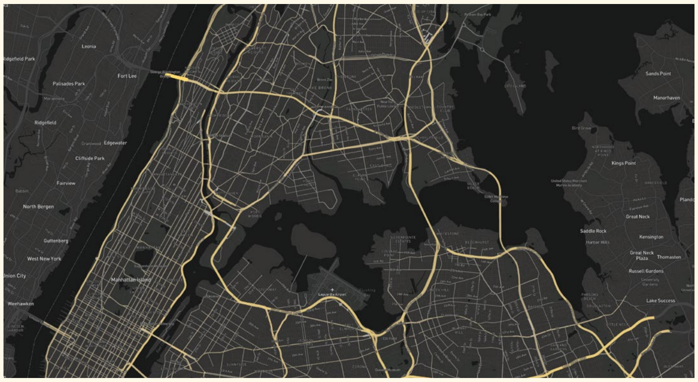
The New York Metropolitan Transportation Council's (NYMTC) New York Best Practice Model (NYBPM)[7] is used for predicting changes in future travel patterns, but requires years to assemble. Improve the reliability and accuracy of the NYBPM by systematically integrating and comparing big data-provided transportation data with model-generated estimates. Start by validating and calibrating the model by aligning trip distribution tables, travel times, and temporal distribution with observed origin-destination (OD) data for various time periods.

Continue model improvements, targeting representations of travel patterns along specific corridors and sub-areas by utilizing targeted OD data from big data providers, which better reveal unique local conditions. Similarly, supplement areas having insufficient traffic counts using inferred data from model estimates and OD patterns, improving traffic analysis coverage. By applying model-derived travel and traffic pattern shifts to enhanced OD data and reassigning these to the roadway network, the NYBPM can dynamically adapt to represent current and evolving traffic conditions more accurately, boosting the utility for traffic management and planning across the State.

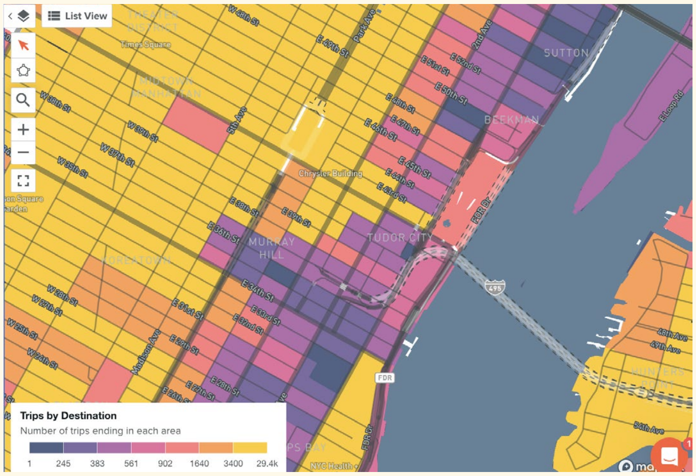
7 https://www.nymtc.org/en-us/Data-and-Modeling/New-York-Best-Practice-Model-NYBPM

Vendor Applications

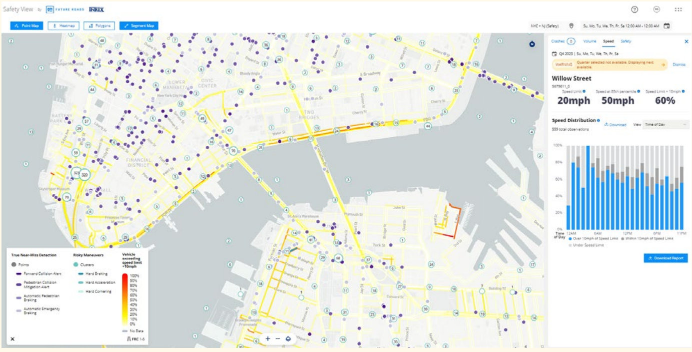
A variety of vendors' applications which use probe data—location-based services and connected vehicle data—as the primary source for up-to-date transportation information



NYC Average Annual Daily Traffic (AADT)
Source: StreetLight



Trip Destination Volume by Block
Source: Replica



Unsafe Driving Location Clusters
Source: Inrix

4 Review Latest Practices and Innovations for Opportunities to Improve Review Analysis Methods

To better align transportation analysis practices and requirements with New York City's public goals, it is essential to improve upon existing methodologies. This set of recommendations includes reviewing historic projects to reassess thresholds for analysis, increasing the use of mitigation measures beyond signal timing, and establishing confidence thresholds for automated data sources. Additionally, it calls for recalibrating the broader environmental considerations of reviews and pursuing tech-enabled improvements to transportation analysis. By updating these practices, the City can ensure that its transportation planning processes continue to support sustainability, efficiency, and equitable outcomes.

4.1 Review Historic Projects to Reassess Thresholds for Analysis

Continuous data sources are a tremendous resource for gaining deeper insights into the manifold effects recent developments, new infrastructure, and operational changes have had on NYC's transportation network over time. In addition to a fascinating research proposition, it is also an opportunity to revisit multiple threshold triggers within the transportation analysis process–from screening out, to defining what constitutes an impact, through the efficacy of various mitigation measures.

Recent research has shown that increasing development density can, at certain increments, actually promote transit use rather than leading to more personal vehicle trips.[8] As a first step of this review, studies to-date that have explored these dynamics should be compiled. The relationships may be non-linear or context dependent, and this effort may also pair well with the identification and definition of neighborhood or area archetypes, such as the '15-minute City' concept, to establish a basis for comparable measures.

Adjusting Thresholds Along Adaptive Signaling Corridors

One initial area to review real-world performance is along adaptive signaling corridors. Recent developments in adaptive signaling allows NYC DOT's Division of Traffic Operations to adjust traffic signal times on-the-fly responding to (near) real-time conditions at key locations. For these intersections, the threshold counts that require further analysis and signify impact should be raised since some amount of adjustment occurs automatically. Similarly, the value of a signal timing adjustment mitigation measure should be questioned.

As the use of adaptive signaling and other intelligent transportation systems (ITS) is expanded across the City, it is essential to develop and maintain a comprehensive map of current and planned adaptive signaling locations and corridors for analysis and planning purposes.

4.2 Increasing Use of Mitigation Measures Beyond Signal Timing

Adjusting traffic signal timing is applicants' preferred method for mitigating impacts of proposed projects. This is despite its sole prioritization of freeflow traffic and ignorance of the potential knock-on effects of more and faster vehicles. Applicants favoring signal timing changes over the other mitigation and Transportation Demand Management (TDM) strategies listed in the CEQR Technical Manual Table 16-16 is understandable

8 See https://www.sciencedirect.com/science/article/pii/S0967070X15300226#s0060 and https://jtlu.org/index.php/jtlu/article/view/2403/1726

due to the offloading of responsibility and cost onto NYC DOT's Division of Traffic Operations.

Tactical Experiments in Traffic Volume Reduction

A range of potential traffic reduction, vehicle network optimization, and infrastructure efficiency upgrade strategies are in use across the country as part of official TDM programs, but are not approached in New York City in the same way, given the City's unmatched transit and walking mode share. Applying these to NYC demands a systematic study of a multitude of TDM strategies and tactical experimentation of them to validate their effectiveness in the New York City context. The data fusion database and digital twin from 1.2 and 1.3 are well-suited to serve as the primary monitoring sources for assessing TDM measure effectiveness. Encouraging applicants to select alternative strategies will require, first, changes to how signal timing adjustments are assessed, second, a clear guide for low-cost measures to integrate into projects, and third, streamlined processes to approve and implement those agreed to measures.

Combined Funding Mechanisms for High-Cost Mitigation Measures

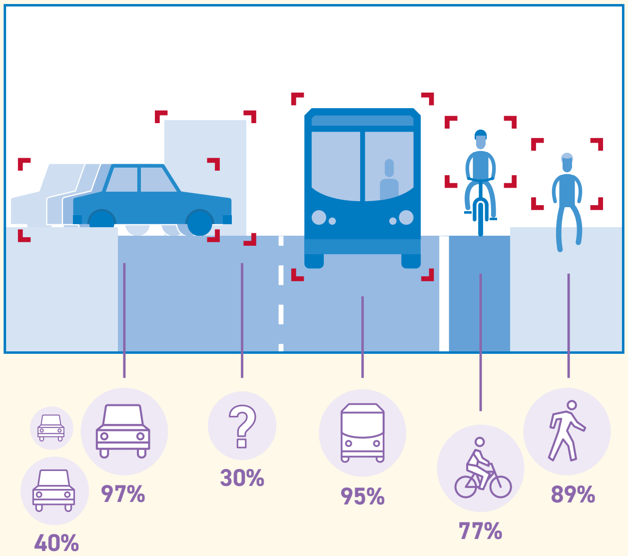
Consider the establishment of a system where mitigation funding from multiple applicants is held in escrow or a similar arrangement in order to implement TDM and other mitigation measures that would not be feasible or appropriate for an individual project. In other municipalities, these are sometimes referred to as Traffic Impact Fees (TIFs) or System Development Charges (SDCs), and their use ensures that funds are available and can be deployed effectively to implement the agreed-upon mitigation measures, providing a financial guarantee for their execution. Such measures could include circulation van programs or other transit improvements that are tied to project-related impacts, street geometry adjustments, or construction of designated transportation facilities.

Computer Vision Detection vs. Accuracy

Understanding the difference between detection and accuracy is crucial for evaluating computer vision systems.

Detection

The overall ability of a system to identify and recognize objects or vehicles within its view.



Accuracy

The system's overall performance in correctly detecting, classifying, and tracking objects, minimizing over- & under-counting and misclassification.

Example of a high detection, low accuracy scenario: *A camera at an intersection successfully detects 98 out of 100 vehicles but classifies 26 of them incorrectly (e.g., SUVs as trucks, cargo bikes as cars), identifies 7 non-existent vehicles due to shadows, and double counts 12 vehicles moving non-linearly.*

4.3 Establish Confidence Thresholds for Automated Data Sources Based on Assessed Needs

Data collection speed and precision is in constant tension, with 100% confidence never fully achieved and diminishing returns when trying to achieve that state. A process map is needed across the different divisions, applications, and data types for respective use cases and types of analysis at DOT. This can be used to identify the appropriate confidence requirements for transportation data sources such as traffic volumes, origin-destination pairs, and Turn Movement Counts (TMCs), and other purposes. For example, origin-destination flows might require a 90% confidence level for planning purposes, whereas traffic safety and operations may demand a higher threshold of 97% accuracy for volumes at intersections.

Current methods' capabilities may also need to be reassessed. Though providers claim to be able to recognize vehicles with over 95% accuracy, translating those detections into counts may reveal lower than expected usability from those numbers (see Computer Vision Detection vs. Accuracy). Improved results from additional data training and technological advancements as discussed in 5.3 (page 36), should allow for the revision of thresholds and requirements on a regular basis.

4.4 Reassessing the 'Environmental' Aspect of Reviews

While federal and state environmental protection acts and their associated review processes were created with the intent of protecting and integrating environmental considerations in the development of significant projects, the environmental review process can have the unintended consequence of delaying environmentally friendly projects. These include transit infrastructure, clean energy developments, and reusing derelict industrial areas as housing. These projects often provide a regional or global environmental benefit that is not captured by the hyper-local and detailed calculations typical of CEQR analysis. Over time, these analysis methods have grown more conservative, often in response to spurious litigation challenges brought by individuals opposed to a project on other grounds.

Expanding Categories for 'Environmental' Exemptions and Adjusted Thresholds

Following on the success of Green Fast Track NYC, explore extending the list of Type II project definitions and categories that do not have significant environmental impacts and therefore do not necessitate detailed traffic analysis, or only require one at a higher threshold. These could be defined by either the current local conditions, for example, at locations with an existing high level of transit mode share, or by the specific type of project action: transit or bike/ped improvements, infill development.

Incorporating Positive Environmental Impacts

Investigate whether an additional qualitative discussion methodology in CEQR and Air Quality (AQ) analysis frameworks can be developed to recognize the potential environmental and social costs of *not* building a proposed project. Often in transit-rich built environments, the absence of a project's implementation prevents improvements to the built environment and environmentally beneficial outcomes that would not otherwise be captured by the current methodology.[9] This approach would acknowledge the beneficial environmental contributions of certain types of projects that promote non-auto use or densification, emphasizing the loss of these benefits if projects are not implemented. Additionally, this presents an opportunity to devise alternatives to the current methodology for assessing local air quality impacts, including more holistic approaches that better reflect the varied effects of urban development and land use changes.

4.5 Pursue Tech-Enabled Improvements to Transportation Analysis

Some of the analysis steps and methodologies within the CEQR Technical Manual are based on previous technical limitations and no longer reflect possibilities afforded by massive datasets, sensor technologies, not

9 I.e. these changes would need to align with NY State's SEQRA review

to mention AI. For transportation analysis in particular, the data fusion database and a digital twin can enable new approaches and baseline requirements within CEQR.

Scenario-Based Analysis Enhancement (with Digital Twin)

The narrow CEQR requirement to produce a single Reasonable Worst Case Development Scenario (RWCDS) reflected previous technical capacity limits and costs associated with running multiple scenarios, but these constraints no longer align with standard practice elsewhere, and digital twins and similar technologies facilitate the examination of hundreds or thousands of scenarios.[10]

Update CEQR guidelines to support the identification and iterative analysis of multiple future scenarios and a menu of transportation improvement measures rather than relying solely on the RWCDS.[11] This expansion of scenarios can be targeted across specific variables such as mode share, trip generation rates, developer decisions, and potential future policies, or open-ended, producing high-level results from a wider range of scenarios.

Providing web-based public access to the results from these scenarios is an opportunity to enhance public understanding and engagement in the CEQR process. These should be explored alongside privacy-friendly methods for sharing the transportation analysis input and output data through the NYC Open Data portal and other mechanisms.

Investigate Improvements Over Baseline Processes

Based on the process mapping exercise discussed in 4.1, determine where big data, sensors, and other technologies & techniques could offer an improvement over current agency practices. Some areas to investigate include abilities to model Citywide actions at multiple scales, decipher hyper-local trends, and forecast disruptive technologies and unanticipated events.

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10 https://urbanland.uli.org/economy-markets-trends/ul-interview-test-driving-delve-a-tool-for-designing-better-more-sustainable-cities

11 Note: any effort to update or restructure CEQR guidelines must include careful documentation of the decision-making process and methodologies employed to ensure that changes are well-founded and defensible.

5 Build Cross-Sectoral Technology Capacity

For New York City to fully leverage emerging technologies in transportation planning, it is crucial to build cross-sectoral capacity. This involves modernizing procurement processes to expedite deployments, targeting upskilling for staff, and developing industry-facing processes to improve confidence in vendor data solutions. Additionally, fostering internal and external collaboration and knowledge sharing will be key. These recommendations aim to enhance the City's ability to deploy and utilize advanced technologies effectively, ensuring that New York City's transportation infrastructure remains at the forefront of innovation and efficiency.

5.1 Modernize City Procurement Processes to Expedite Deployments and Utilize Dynamic Technologies

Standard lengthy and highly-prescribed procurement practices inhibit City agencies from acquiring the most up-to-date technologies and solutions. Innovative and emerging technology firms cannot survive the uncertainty of multi-year processes, requiring signed contracts to raise funding to sustain and grow their businesses. Additionally, these firms typically operate via subscription models, which is not favored by City contracting offices.

As detailed in the Urban Tech Hub report Pilot NYC,[12] challenge-based procurement can accelerate the deployment of new sensors and big data products, enable new capabilities from those deployments, allow other agencies to leverage existing procurements and platforms, and avoid vendor lock-in. Challenge-based procurement perfectly complements the industry-facing processes described in 5.3, where an agency declares a challenge that current off-the-shelf providers cannot easily meet, and more nimble companies using emergent technologies have the potential to provide possible solutions. Given additional calibration time, training data, and agency feedback, those companies are poised to develop solutions meeting agency requirements.

Strategic Procurement and Deployment

To the greatest degree possible, challenge-based procurement and other potential acceleration strategies should be used to expedite the deployment of versatile, high-accuracy sensors at high-value locations. Simultaneously the procured cameras, sensors, and transportation data must be strategically aligned to maximize agency-wide utility and avoid redundant infrastructure.

5.2 Target Upskilling for Staff

Emerging technologies, providing continuous rather than fixed data, melding multiple data sources, and improving capabilities over time, don't fit neatly into the transportation engineer's toolbox. Prioritize enhancing staff capabilities by introducing specialized training programs such as 'Big Data for Traffic Engineers'. This approach aims to directly elevate the skills necessary for managing and interpreting complex data streams relevant to transportation engineering and planning.

Agency-Wide Trainings

Arrange for agency-wide training sessions for DOT staff. One set of these sessions should cover the capabilities and current limitations of data products and platforms, to ensure DOT personnel are well-equipped to utilize these tools effectively and understand the appropriate contexts for their application. These could be organized as part of contracts with big data platforms.

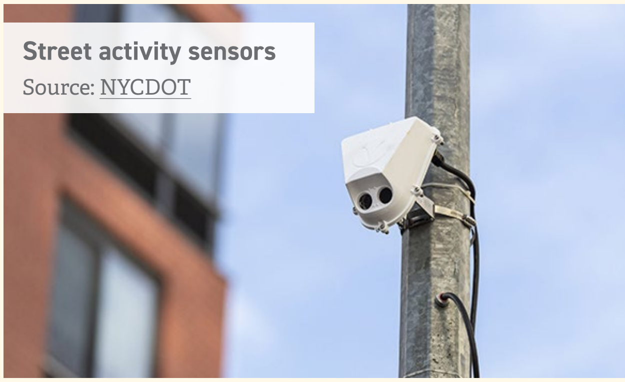
Another set of agency-wide workshops should be focused on the practical aspects of data handling, including secure and privacy-friendly practices per 3.2.

12 https://edc.nyc/sites/default/files/2023-11/Pilot-NYC-Report-11-10-2023.pdf#page=36

NYC Pilots & Procurements on the horizon

NYC Street Activity Sensors

An eight-month pilot program through the Office of Technology and Innovation (OTI) and NYCDOT is collecting street activity with computer vision-enabled cameras installed across four boroughs. Using edge computing, cameras classify and count street users in real-time, discarding the footage. The pilot aims to help City planners understand how people use City streets and inform street redesigns.[1]



Street activity sensors
Source: NYCDOT

Roadway User Detection & Data Analytics

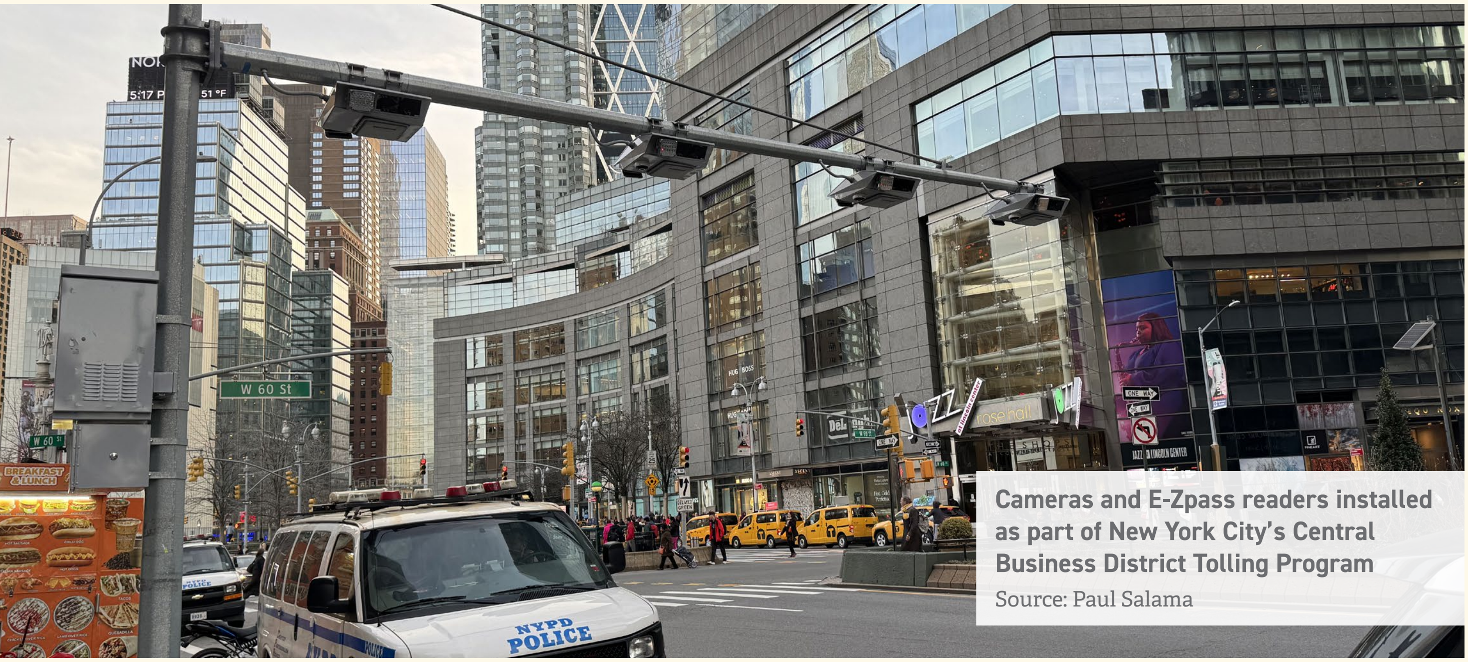
NYCDOT is expected to acquire a Roadway User Detection & Data Analytics (RUDA) system capable of collecting, evaluating, and transmitting transportation data to NYCDOT. The RUDA system will install cameras and potentially other sensors at up to 500 intersections throughout the five boroughs in NYC over 18 months beginning in 2025. The system will have at least the following data points in real-time: traffic conditions, traffic flow, queue lengths

1 More information: https://www.nyc.gov/html/dot/html/about/street-activity-sensor.shtml

Central Business District Tolling Program

The infrastructure to charge a toll to enter Manhattan south of 60th Street, as part of its Central Business District Tolling Program (CBDTP) has been deployed.

Program launch is currently in limbo, but E-Zpass readers and license plate-reading cameras (ALPRs) at 110 locations in Manhattan are currently capturing pre-implementation counts of all vehicles crossing into Manhattan's Central Business District. ALPRs use computer vision algorithms to extract license plate details.



Cameras and E-Zpass readers installed as part of New York City's Central Business District Tolling Program
Source: Paul Salama

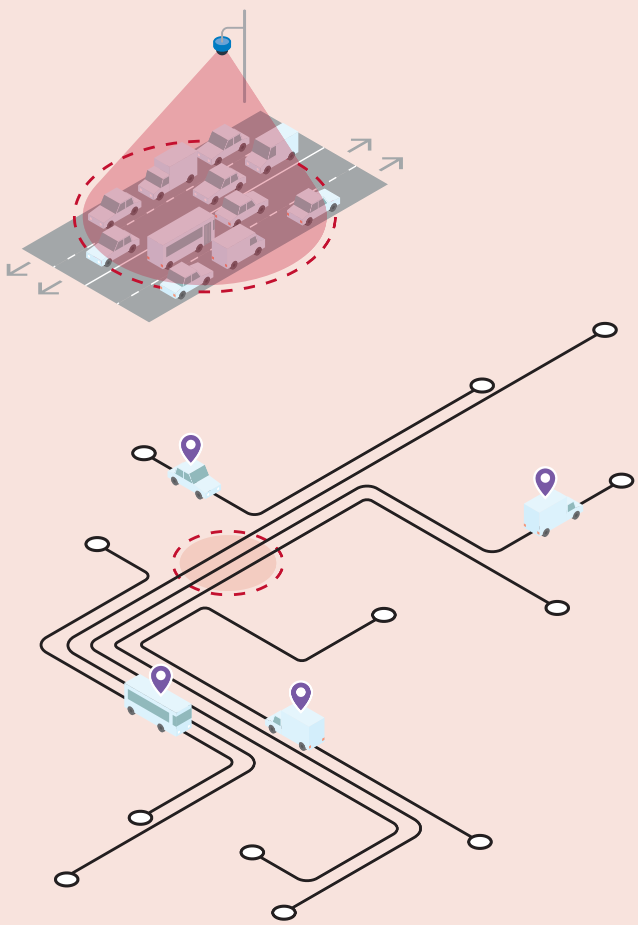
These workshops should aim to improve data literacy across the agency, ensuring that all staff members are equipped with the knowledge to use and publish data appropriately.

University Strategic Partnerships

Set up formal advisory relationships with academic institutions to provide ongoing guidance and support on data science, machine learning, and emerging technologies. These relationships can serve as a valuable resource for learning and adaptation, helping the DOT stay at the forefront of technological advancements in transportation.

Figure 8. Fixed Sensors vs. Probe Data

Fixed sensors capture details at a specific location, while probe data collects trip details



5.3 Develop Industry-Facing Processes to Improve Confidence in Vendor Data Solutions

The quantity of new transportation data sources and techniques has exploded in the past decade, as detailed in Emerging Transportation Technologies. These showcase new analysis tools and fill in significant gaps in the understanding of the transportation system. However, current industry offerings have demonstrated shortcomings in their ability to immediately replace established data collection practices, whether due to insufficient confidence at designated analysis locations, inaccurate results, or misalignment between product outputs and City process requirements.

The promise and benefit of technology vendors is their ability to improve their solutions using the latest artificial intelligence/machine learning practices. With additional training data from City sources, from existing and future data sources (e.g. collected via data fusion per 1.2), these providers should be able to increase their accuracy to be useful for transportation analyses. Given New York City's market significance, there is a win-win opportunity to both increase the overall quality of market solutions available and direct offerings to match City official requirements.

Comprehensive Big Data Ground Truthing Framework

To increase data accuracy and confidence in data streams from big data providers, researchers, and other agencies, establish a framework for granting access to sets of DOT-trusted and PII-friendly historic transportation counts at locations of interest. This data provision is for the purpose of augmenting the overall quality of transportation data and big data models for New York City's unique contexts.

After a set amount of time, data accessees should share their improved outputs based on the ground truthing exercise, including confidence rates and qualitative summaries of changes to their models. The objective for the framework should be to build trust and foster continuous improvement within the ecosystem, suggesting an iterative process, with ongoing adjustments encouraged based on the results. This ground truthing process should be open to any potential provider, researcher, or agency following established procedures to access it and agreements to follow any reporting standards.

Calibration and Certification of Fixed Sensors

Collaborating with fixed sensor providers differs significantly from big data providers, as the number of vendors is orders of magnitude larger and those companies are able to rely on robust and improving open source machine learning models as the basis for object recognition. The overall challenge for fixed sensors then is to be able to recognize a specified set of conditions in New York City's crowded sidewalks and streets with confidence according to established benchmarks, and do so reliably. Existing data collection specifications and standards such as the NACTO guidance, 'Making Bikes Count' should be used where applicable, alongside vetted accuracy requirements from 4.3.

A process needs to be defined for sensors to demonstrate their ability to meet clearly communicated benchmarks. Sensors meeting those defined standards should be certified and added to allowed vendor lists. These standards should anticipate technological refinement, not being considered fixed nor should certifications exist into perpetuity. Instead confidence thresholds would be raised over time as would the expectation to recognize and distinguish additional types of users of the street, reflecting the full spectrum of urban mobility.

5.4 Foster Internal & External Collaboration and Knowledge Sharing:

Set up internal and inter-agency mechanisms to convene and share experiences with sensor and big data solution providers. Highlighting specific challenges, such as the differentiation between vehicle classes or the accurate counting of unique transportation modes (e.g., e-bikes vs. mopeds, or issues with computer vision at night), will help in identifying areas for improvement and innovation that can impact procurements and challenges discussed in 1.5.

NACTO "Making Bikes Count" guidelines

1. Conduct a manual count (4+ hours), broken into 15-minute bins.
2. Calculate an adjustment factor comparing the total automated vs. manual counts
3. Counts are acceptable if, after applying correction factors, more than 80% of the 15-minute bin values are within 20%.[1]

1 https://nacto.org/wp-content/uploads/2022/03/Making_Bikes_Count_FINAL_March31-2022.pdf#page=12

Improve Communication with Data Providers:

Establish a more robust process for communicating with transportation data providers as part of current contracts and separately. This could include specific data needs such as volumes in 15-minute increments, peak hour factors, heavy vehicle percentages, TMCs, and queue lengths. These discussions should extend beyond existing contracts to consider innovative applications for leveraging big data and sensors in areas such as safety, mode shift inducements, and real estate impacts.

4

NYC Transportation Data Connect Symposium

The NYC Transportation Data Connect Symposium, held January 24th-25th, 2024, created a forum for technical experts from within government agencies, transportation consulting firms, and tech companies to circulate the emergent transportation data and technology state of practice. Hosted at the Microsoft Garage in New York City, these key staff members developed a shared understanding of the specific opportunities to leverage and adopt tech solutions for City transportation analyses, modeling, methodologies, procedures, and systems, as well as the connections necessary to implement them.

The Microsoft Garage in New York City

Identifying a need for better cross-sector communication and collaboration, the Cornell Tech Urban Tech Hub and the NYC Mayor's Office organized the Symposium towards achieving the following objectives within NYC transportation planning and analysis:

- Increase confidence in non-traditional sources of transportation data through shared articulation and understanding of data issues and concerns
- Identify use cases where emergent traffic data and technology can improve efficiency in operational planning and traffic impact analysis
- Onboard public & private-sector participants, stakeholders, and decision-makers as collaborators towards the implementation of streamlined solutions
- Establish target thresholds, validation methods, and research questions for accepting, improving, and advancing where big data sources can be accepted and applied
- Identify the limitations of probe data use and acceptable use cases
- Circulate existing and prospective DOT and City work with tech providers/solutions

The Symposium was organized into two days, with the first providing participants a strong understanding of the technology & data landscape, and potential for their use in DOT processes. For the second day, participants broke out into working groups to develop preliminary solutions, validation methods, and further research for progressing DOT adoption. The symposium benefited from the deep cross-sectoral transportation expertise in New York City, and highlighted the need for continued opportunities for gathering and brainstorming across disciplines in the face of continued technology and innovation developments.

Day 1 Proceedings

Over 150 people participated in-person and online from City and State DOTs, data experts at other City agencies, transportation consultants from firms large and small, leaders from probe data and sensor companies, and transportation experts from academia.

Day 1 proceedings were bookended by presentations from industry on how the latest generation of probe data sources are being used for transportation analysis across the country, and from startups and academia on how cameras, sensors, and AI/ML techniques are and can be used in New York City.

In between these presentations, the Mayor's Office hosted a candid discussion with the leading probe data provider companies on the appropriate uses of those technologies, and what's needed to ensure they fulfill their promise as essential tools in transportation planning and analysis. The key technologies and techniques discussed served as a primer for Day 2 attendees, and are detailed in Technology & Techniques Background (page 46).

Paul Salama


Day 1 Symposium Attendees in Microsoft Garage space

Introductory remarks from the Mayor's Office and the Urban Tech Hub provided framing for how the status quo of transportation analysis limits the City's ability to 'Get Stuff Built', and how new sources of data and technology are available and necessary to tackle the next generation of City challenges.

Insight Blasts

Interspersed throughout the Day 1 presentations were 5-minute 'Insight Blasts' from leaders in City operations, regional planning, climate response, and City innovation, who helped frame the cross-sectoral impacts and challenge of the day's discussions.

Alison Landry, CIO of the Deputy Mayor of Operations' Office, dove into some examples of her office's revamping internal government systems and how those non-flashy improvements allowed City employees to be more productive and increased their job satisfaction.

Rachel Weinberger from the Regional Plan Association (RPA) asked attendees to question some of the existing standards of practice in transportation analysis, emphasizing that in many cases "new data collection opportunities are unproven, but old ones are proven to be poor." Further, she pointed the finger at "a legal system preventing us from moving the standard of practice to state of the art."

Ben Furnas from Cornell Atkinson connected the dots between process speed improvements and climate impacts, highlighting the necessity of urgent actions to combat expected warming, and reminding the audience of the unparalleled efficiency of New York City urban living, which should be enhanced to welcome more people.

Paul Rothman from the Office of Technology and Innovation (OTI) brought the audience up to speed on the NYC Smart City Testbed program, emerging technologies being piloted, and welcomed innovators to apply.

Symposium Agenda and Presenters

Introductory Remarks

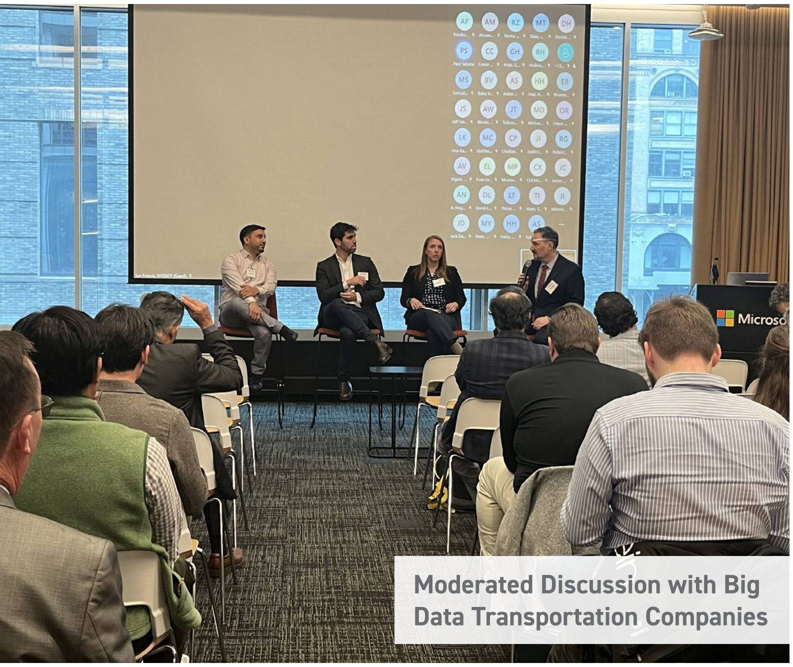
Rob Holbrook, Executive Director of Get Stuff Built, Mayor's Office
Paul Salama, Urban Technology Fellow, Cornell Tech
Doug Priest, Public Transportation Leader, Microsoft Worldwide Government

Insight Blasts & Intros

Alison Landry, Chief Infrastructure Officer, Deputy Mayor of Operations' Office
Rachel Weinberger, Peter W. Herman Chair for Transportation, RPA
Ben Furnas, Executive Director, Cornell Atkinson
Paul Rothman, Director of Smart Cities + IoT, OTI

How Transportation (Big) Data Is Being Used in Other Cities

Ahmed Darrat, General Manager for Public Sector, Inrix
Arthur Getman, Senior Solutions Engineer, Replica
Cat Manzo, VP of Customer Care, StreetLight
Danny Yoder, Engagement Executive, StreetLight
Amir Rizavi, Director of Mobility, VHB



Moderated Discussion with Big Data Transportation Companies

Rob Holbrook

Challenges & concerns from DOT

Matt Lorenz, Director of Engineering Review, NYCDOT
Will Ullom, Deputy Director OPA/CEQR, NYCDOT

Discussion with Big Data Transportation Companies

Ahmed Darrat, General Manager for Public Sector, Inrix
Cat Manzo, VP of Customer Care, StreetLight
Steven Turell, Chief of Staff, Replica

The State & Future of Sensors in NYC

Tara Pham, Founder & CEO, Numina
Nick D'Andre, CEO & Co-Founder, GridMatrix
Wendy Ju, Professor, Cornell Tech
Matt Franchi, Researcher, Cornell Tech
Andrew Smyth, Director NSF Center for Smart Streetscapes, Columbia

Presentation by William Ullom from NYCDOT's Traffic Engineering & Planning team

NYCDOT Challenges & Concerns with Big Data

Halfway through the day, representatives from NYCDOT's Traffic Engineering & Planning team were given the stage to discuss their years of experiences with using and testing probe and big data sources.

Between a lack of observability into providers' unique algorithms, divergent projections between providers, and an overconfidence in results, the DOT team expressed a skepticism in these technologies' ability to be primary data sources.

DOT's concerns about relying on new and emerging technology and data systems that are not currently used as accepted data sources to assess transportation conditions highlights the need to establish standards of reliability and ground truthing as described elsewhere in this report.

NYCDOT Observed Challenges with Using Probe Data

1. Most big data tools only provide transportation data aggregated into 1-hour periods, rather than the 15-minute increments necessary for identification of Peak Hours & Peak Hour Factors
2. Big data sources aren't able to classify vehicles to the specificity necessary to align with requirements, e.g. the number of classes needed for Air Quality analysis
3. Wildly inconsistent results for Turning Movement Counts from Big Data providers, differing from ground truth measurements between 1% to over 30,000%
4. Overall unacceptable correlation between counts, with GEH empirical formula results yielding >18
5. Big data/Probe sources confuse traffic flowing at different elevations and on adjacent/barrier-separated roadways
6. LBS data sources do a poor job discerning between modes (i.e. cars, buses, bikes, and pedestrians) in NYC's slow-speed environment.
7. Clear/observable inaccuracies with Big Data reporting of trips across jurisdictional boundaries. Especially Taxi/FHV at the NY/NJ border
8. Lack of communication from big data providers in how they handle irregular and temporary disruptions to transportation patterns leads to a lack of confidence [i.e. black box!]
9. Overconfidence from providers in ability to replace point counts accurately

Why NYC Is a Unique Case in Transportation Planning

New York City is the greatest City in the world, and unique across multiple dimensions. These differences from cities in the U.S. and abroad warrant caution when applying transportation methods, solutions, and technologies that have been demonstrated elsewhere.

1 Extreme Pedestrian Volumes

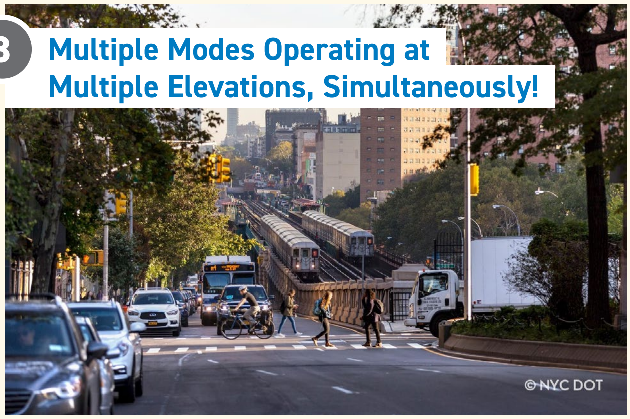
New York City's sidewalks and public spaces handle an extraordinarily high number of pedestrians daily, reflecting its dense urban environment and vibrant street life.

2 High Levels of Transit

The city's extensive public transportation network, including subways, buses, and commuter trains, accommodates millions of riders each day, serving the most transit trips of any City in the Western Hemisphere.

Photos: NYCDOT

3 Multiple Modes Operating at Multiple Elevations, Simultaneously!



From underground subways to elevated trains and street-level buses, New York City uniquely operates transportation systems across various elevations, often simultaneously, to maximize space and efficiency.

4 Congested Facilities of All Types Are At or Beyond Capacity

Whether it's roadways, subway platforms, or bike lanes, nearly every transportation facility in NYC is used to its maximum capacity, frequently leading to congestion and delays.

5 Substantial Number of Temporary Closed or Restricted Streets

Whether it's roadways, subway platforms, or bike lanes, nearly every transportation facility in NYC is used to its maximum capacity, frequently leading to congestion and delays.

Day 2 Proceedings

Transitioning from Day 1's information exchange and level-setting on the technologies reshaping transportation analysis, Day 2 harnessed attendees' collective expertise and insights garnered from Day 1. In a confidential setting that encouraged open dialogue and innovative thinking, participants were charged with the critical task of identifying actionable steps and setting tangible near-term objectives for leveraging technology to enhance transportation analysis and streamline review processes. This approach not only aimed to foster collaborative problem-solving but also to lay the groundwork for meaningful advancements and connections across sectors.

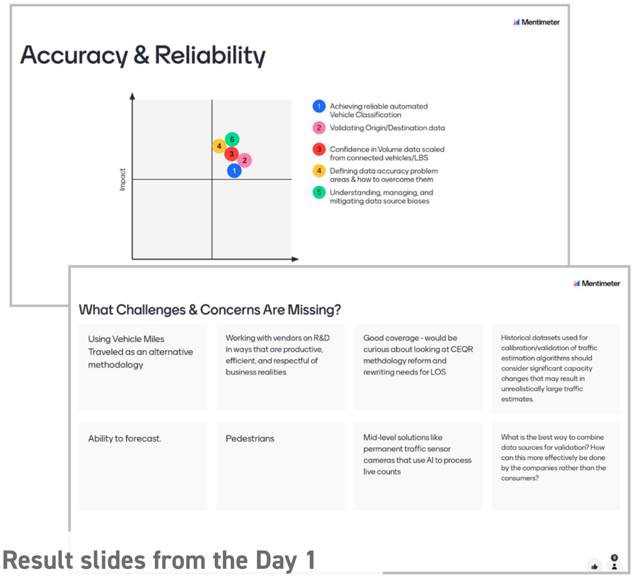
Table Breakouts

The core of Day 2's agenda was centered around facilitated working groups diving deep into challenges identified the previous day. This was structured to encourage preliminary solutions, establish validation strategies, and pinpoint areas necessitating further research. This setup had additional benefits of establishing new agency-industry connections, and set a possible template for future events.

Facilitators, who brought a broad understanding of the transportation, review, and technology topics at hand, guided each group, ensuring that discussions remained focused and productive. Participants were strategically distributed across 8 tables, fostering a dynamic exchange of ideas and perspectives from various sectors of the transportation industry.

In preparation for the Symposium, organizers conducted interviews with stakeholders from across the transportation sectors to collate their primary concerns and potential opportunities. These insights formed the basis of challenges presented on Day 1, which were then prioritized through an interactive polling exercise using Mentimeter. This preparatory work ensured that Day 2 participants were well-informed about the specific issues each table was to address, setting the stage for targeted and impactful discussions.

Day 2 working group discussions



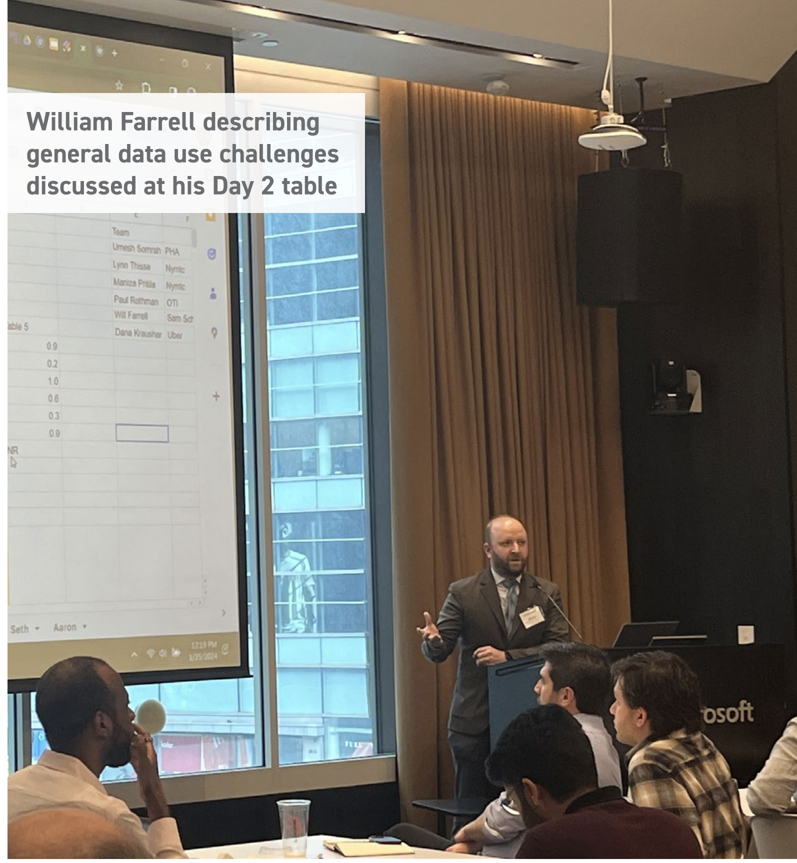
Result slides from the Day 1 interactive polling exercise

Challenges Tackled

The symposium participants quickly settled into their assigned tables and embarked on clearly articulating a specific challenge to tackle. The targeted challenges were as follows:

1. How should DOT combine the variety of different data sources to get reliable data?
2. How much ground truth is needed to reliably scale data to develop accurate turning movement counts?
3. How can legal and institutional roadblocks be reduced or eliminated to enable meaningful data sharing?
4. How can the quality and accuracy of probe data be ensured to increase trustworthiness?
5. How can new data sources be used to identify trip purposes and modal split, including emerging modes?
6. How can adjustment factors be established or automated to overcome delays in DOT count collection blackout periods?
7. How can DOT improve upon existing CEQR/environmental mitigation measures in a way that aligns with the City's policy goals?
8. How can impact analyses be restructured to use non-traditional methods in a legally defensible way?

Table facilitator Alex Moscovitz presenting the findings on impact analyses



William Farrell describing general data use challenges discussed at his Day 2 table

From Discussion to Action: The Output Collection Process

Post-challenge identification, the facilitators guided each group through a structured discussion encompassing three critical areas: potential solutions identification, a comprehensive analysis of the preferred solution, and envisioning a future marked by successful implementation. The outputs of these discussions were documented, culminating in presentations by volunteers from each table, sharing their group's insights and proposed solutions.

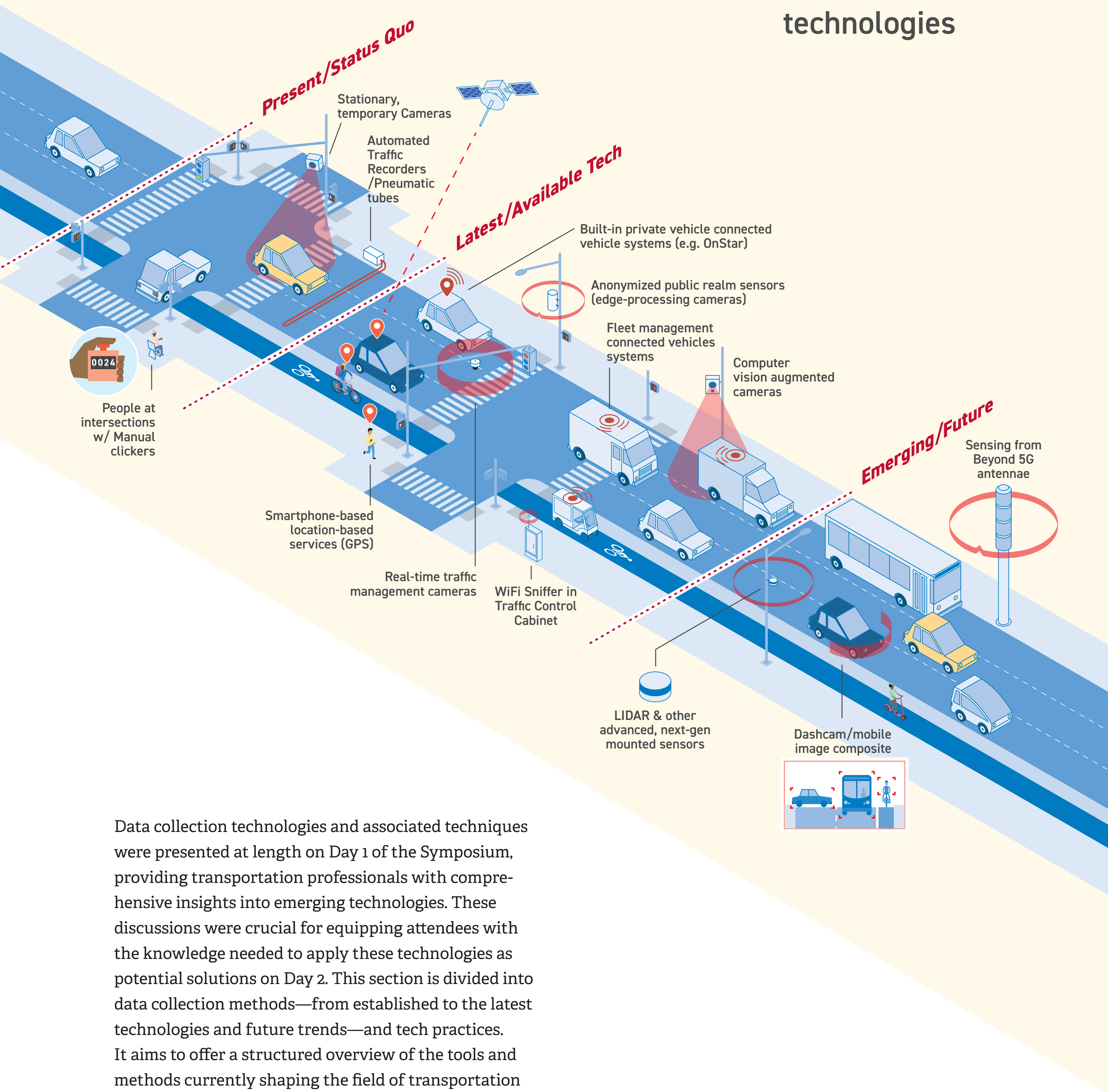
In the aftermath of the symposium, the collective wisdom and recommendations were aggregated, categorized, and synthesized. This repository of knowledge and proposed action steps has been distilled into a set of recommendations to help guide the future of transportation analysis and review processes in New York City.

5

Technology & Techniques Background

Figure 7

Data collection technologies



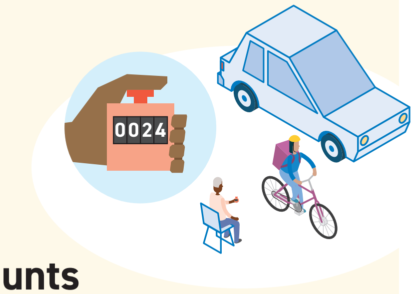
Data collection technologies and associated techniques were presented at length on Day 1 of the Symposium, providing transportation professionals with comprehensive insights into emerging technologies. These discussions were crucial for equipping attendees with the knowledge needed to apply these technologies as potential solutions on Day 2. This section is divided into data collection methods—from established to the latest technologies and future trends—and tech practices. It aims to offer a structured overview of the tools and methods currently shaping the field of transportation analysis, emphasizing both the advancements and practical applications of these technologies.

Transportation Data Collection Methods

Present Day

For transportation engineering purposes, the established data collection paradigm is built around collecting counts of vehicles and users at specific locations for short durations of days or weeks. This data is primarily collected either manually in-person, through pneumatic tubes, or by cameras. These can target one or more types of users for counting, including cars, trucks, bicycles, and pedestrians traveling through a line (in space) during a set window of time.

Each of these methods has costs and operational limitations, and are subject to on-the-ground conditions such as weather. The field in general, and NYCDOT in particular, is moving towards the more automatic end of solutions, though all of these methods are still in use as either primary or secondary data sources. While present day collection practices and their merits were not discussed at the Symposium, they were understood as background for the expert attendees, and are presented here for reference and comparison.

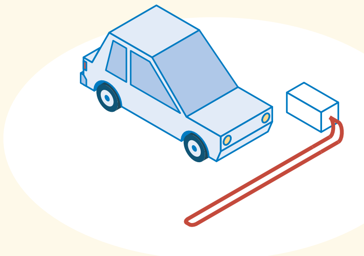


In-person counts /manual clickers

Having junior engineers stand (or hopefully sit) and count passing cars at specific analysis locations is a longstanding traffic engineering practice. The counter individual or team counts every vehicle, bicycle, and/or pedestrian passing through an intersection or along a roadway, utilizing a hardware manual clicker or smartphone/tablet counter app. Human error is expected, especially in areas of high congestion or high speeds, when high volumes pass and are not all captured by the counter.

This method is still used to do spot checks on data and to get a general idea of a location's operations, but in most cases of collecting data for analysis it has been supplanted by temporary cameras.

Manual Traffic Counter
Photo: NYCDOT



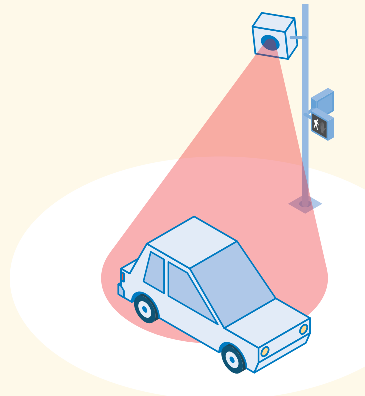
Automated Traffic Recorders

With automated traffic recorders (ATRs), pneumatic tubes are placed on the ground across roadways to capture data on vehicles traveling through travel lanes, with the ATR device on one end. Typically, these tubes register vehicles by counting puffs of air that are created by vehicles crossing over the tube. By analyzing the time and duration of the disruption of air in the tube, the ATRs can count vehicles, estimate vehicle type, and register vehicle speeds.

ATRs perform data logging onboard, with raw data downloaded from the device directly. Analysis on ATR data is done after the data collection period. These low-cost devices are typically deployed over periods of time 2 weeks or longer and used to identify cyclical patterns in vehicle flow and peak hours.

ATRs can undercount high volumes of traffic, ignore smaller vehicles such as bicycles, and fail for extended periods if a vehicle is parked on the tube. Also, ATRs and tubes are often torn up on busy roadways, requiring maintenance checks and repairs.

Automatic Traffic Recorder
Photo: Paul Salama



Temporary Cameras

Temporary cameras are routinely used for recording vehicle counts. These are typically installed on lamp-posts or other infrastructure, able to record images or video that's used to capture vehicles, bicycles, and pedestrians traveling through the field of vision. After the specified recording period, which is limited by the on-board battery and video recording storage, the camera is taken down with the video viewed at 2.5-3X speed at a later date by a staff member or consultant.

Increasingly, vendors are utilizing computer vision algorithms to process the footage to detect vehicles, classify them by type, and track their speed and movement, extracting count data without the need for a person to view the footage. Installing these cameras usually requires a permit from DOT and deployment is limited by battery capacity.

The cameras have the potential for errors in data collection. In times or locations of high density, they can have trouble detecting every single vehicle or pedestrian passing through. Camera lenses can get blocked by water, snow, or fog in times of bad weather. And strong winds or construction near installation locations can move cameras from their original field of vision.

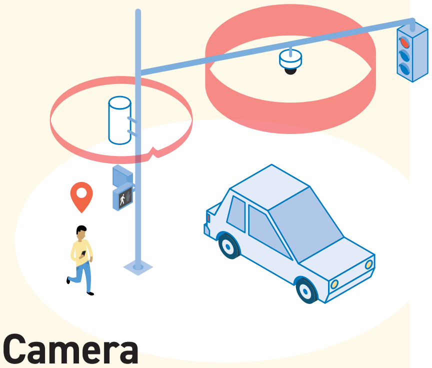
Temporary Camera at Intersection
Photo: NYCDOT

Big and Continuous Data Collection

Groundbreaking technologies are revolutionizing the way we understand and analyze transportation. The past two decades have seen an explosion in the capabilities of hardware and software, unlocking unprecedented insights into mobility patterns through the continuous data collection of advanced GPS, connected vehicle platforms, and a plethora of other location-based services. Together, these technologies offer the opportunity to transcend traditional data collection methods, offering a comprehensive view of transportation dynamics that was once unimaginable.

Probe data is an umbrella term that encompasses location and other data collected from GPS-equipped vehicles, smartphones, and other connected devices. Data collected typically includes location, direction, speed, and a timestamp. When collected from multiple sources, this data can provide insights into traffic dynamics, travel patterns, and congestion levels. Probe data can be useful for real-time traffic monitoring, incident detection, and predictive analytics.

It's important to note that probe data is usually privately owned, affected by device makers' changes to security policies, and subject to shifting privacy laws and public perceptions. Further, managing, analyzing, and validating the probe data will require different skills and resources from agencies.



Continuous Camera and Sensor Data

A wide variety of cameras and sensors are increasingly common in urban environments, providing constant, real-time information. This includes connected and wireless devices like cameras, vehicle monitoring systems, and environmental sensors at strategic locations. Cameras capture continuous video footage of roadway conditions, traffic flow, and incidents, crucial for traffic operations. Data from this footage, processed via computer vision or manual inspection, is invaluable for historical analysis and pattern identification.

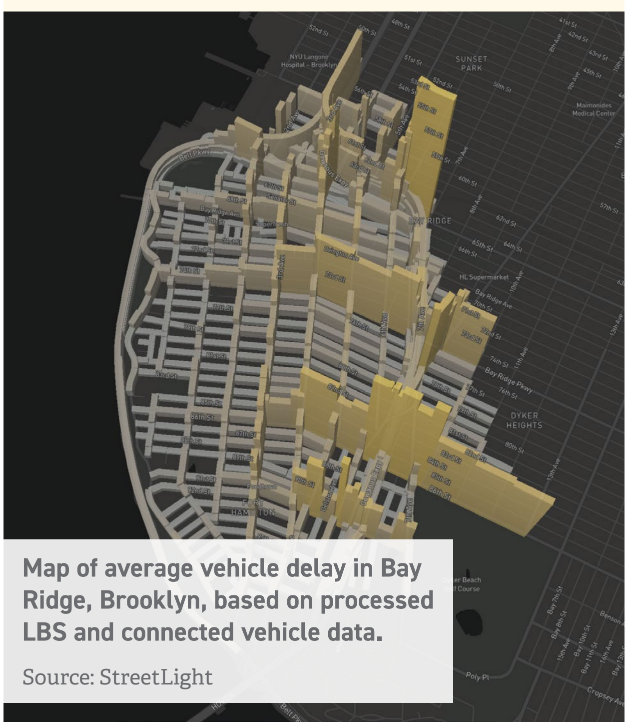
Complementing these cameras, sensors such as microwave, Bluetooth, radar, RFID, and WiFi detect vehicle and pedestrian presence and speed, operating effectively in various weather conditions and times of day. Environmental sensors collect data on air quality, temperature, and weather conditions, impacting transportation patterns and safety.

Many of these sensors, initially deployed for other purposes like E-Zpass tolling, also provide transportation data. However, deploying these technologies requires consideration of data privacy, significant storage capacity, and potential data overload, ensuring their integration is strategic and beneficial.

Location-Based Services

Location-based services (LBS) is a general term for software services, typically present or installed on mobile devices, that use the device's location to provide services or information to users. These apps or services bundle and sell anonymized user location information. For transportation applications, LBS can extract travel patterns, traffic and pedestrian volumes, origin-destination patterns, and transport mode choice from anonymized and aggregated data of millions of smartphones.

Based on the specific technology used to collect the locations, the precision of LBS data ranges from approximately 10 to 100+ meters. At the lower end, LBS can determine the exact road a vehicle is on. But on the higher end, it can mean difficulty in determining which side of a roadway or even mischaracterize a car trip as walking or biking.



Map of average vehicle delay in Bay Ridge, Brooklyn, based on processed LBS and connected vehicle data.

Source: StreetLight

Connected Vehicles

Connected vehicle technologies facilitate communication from the vehicle to infrastructure, cellular network (Telematics), or even other vehicles using wireless protocols. These on-board systems measure and calculate a vehicle's location, speed, driving style and dozens of other insights.

Connected Vehicles come in two forms–embedded, such as GM's OnStar System, and add-on systems. Prevalence of connected vehicles on City streets is increasing precipitously, with nearly all new vehicles in the U.S. having some form of connectivity or telematics embedded.[13] Substantial segments of commercial and fleet vehicles, and all yellow and green taxis have add-on or plug-in systems for their services and can be used for the management and maintenance of those fleets, in addition to reporting vehicle locations. Within New York City's fleet, 15,000 vehicles use on-board telematics for tracking, monitoring, and maintenance.

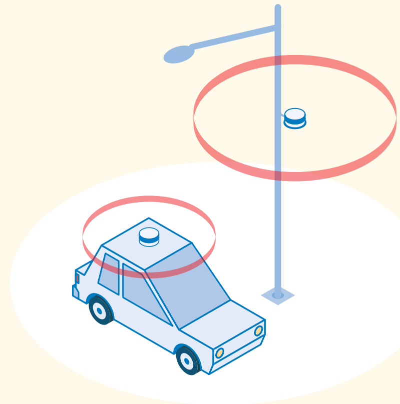
Connected vehicle data has noted advantages over LBS, due to the one-to-one relationship with a vehicle and higher accuracy location data, potentially enabling lane-level precision. But it is less pervasive, doesn't cover pedestrians, transit, or bicycles, and skews to newer and more expensive vehicles.

13 https://www.prnewswire.com/news-releases/the-connected-car-market-will-endure-a-15-shipment-decline-flat-revenues-in-2020-sales-return-on-trend-early-2022-301100761.html

Emerging/Future Technologies

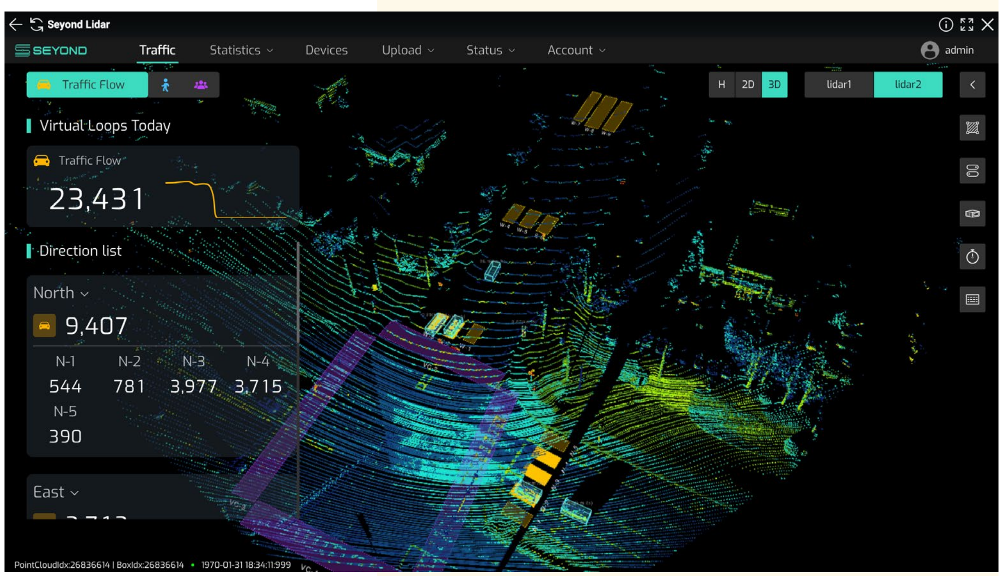
Acknowledging that the landscape of transportation technology is continually evolving, the following subsection explores three cutting-edge technologies discussed and presented on Day 1 of the Symposium. While not an exhaustive list of potentially relevant technologies for the future, these examples illustrate key trends in the field.

These trends include demonstrated technologies becoming more affordable, new applications of existing data sources and technologies, the development of expected standards, and academic research pushing the boundaries of technological capabilities. These advancements are expected to play a significant role in the future of transportation data collection, analysis, and management.

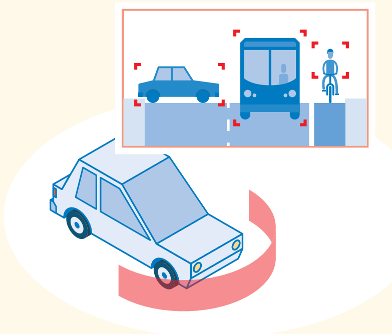


LiDAR

By emitting laser pulses and measuring their reflection, LiDAR (Light Detection and Ranging) creates precise 3D representations of environments, such as roadways and streetscapes. This technology often surpasses traditional imaging in accuracy and reliability, especially under challenging weather or lighting conditions. In the context of transportation, LiDAR-equipped fixed infrastructure or moving vehicles can monitor traffic flows and congestion with minute detail, offering insights that drive improvements in road safety and efficiency. Using deep learning approaches analogous to computer vision, LiDAR sensors can detect & classify pedestrians, and different types of vehicles.



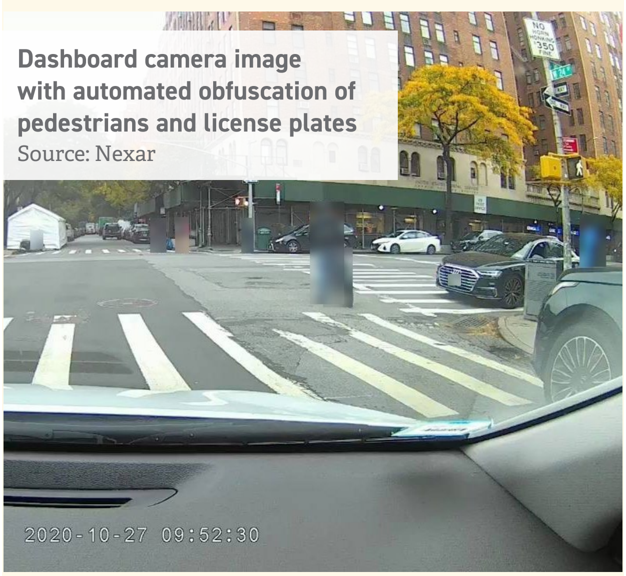
Visualization of LiDAR data captured from an intersection.
Source: Seyond



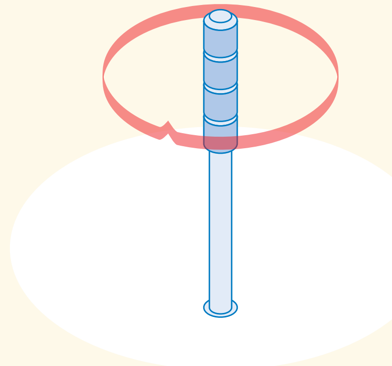
Dash Cam / Mobile Imagery

Dashboard cameras are increasingly common in New York City transit, for-hire, and private vehicles, providing accountability in recording traffic incidents, collecting millions of images each day. For transportation analysis purposes, these mobile imagery sources can provide timely measurements and conditions that stationary cameras and sensors cannot. With proper privacy measures in place, the thousands of cameras can be combined to give insights at multiple levels within New York City's urban realm.

[Caption] Nexar dashboard camera image with automated obfuscation of pedestrians and license plates



Dashboard camera image with automated obfuscation of pedestrians and license plates
Source: Nexar



Sensing in Beyond 5G Networks

The latest generation of cellular antennae hold a surprising potential. In addition to high data speeds, low latency, and support for a large number of connected devices, the thousands of 5G installations popping up in cities can also act as Radars, constructing 3D images of objects and environments. Positioned near intersections, these antennas can be used for capturing vehicle and pedestrian counts, without any additional hardware.

Research is ongoing to validate performance on NYC streets, but potential is great, especially with over 4,000 LinkNYC 5G towers expected in the next few years, followed by even more accurate, next-gen 6G radar towards the end of the decade.

LinkNYC 5G tower
Photo: Paul Salama

Tech Practices

The integration of cutting-edge machine learning and artificial intelligence (AI) with new hardware and software has revolutionized the collection and analysis of transportation data, offering deeper insights into mobility metrics.

Big Data & Data Science

Big data refers to extremely large, and frequently diverse, datasets. Today, transportation data from sensors is continuously collected at high volume and velocity, creating evergrowing datasets. The promise of big data in transportation is to enable monitoring and anticipating traffic patterns based on a mixture of sources, between mobile probe data and fixed sensors such as traffic cameras and E-Zpass readers.

Processing and analyzing such large and complex data sets requires advanced techniques, i.e. data science and statistical algorithms, which are used to collect insights from big data. With data collected from a subset of vehicles and at key locations within the built environment, the data can be processed and scaled using data science methodologies to infer real-time and historic speeds, volumes, and other transportation metrics for an entire transportation network.

Machine Learning

Machine learning (ML) is a field of AI that gives computers the ability to learn from data without being specifically programmed. It uses statistical methods to make predictions or classifications based on algorithms trained from data. Based on input training data, an algorithm tries to find patterns and determine relationships. Models are rerun iteratively, improving the algorithm and accuracy with additional training data.

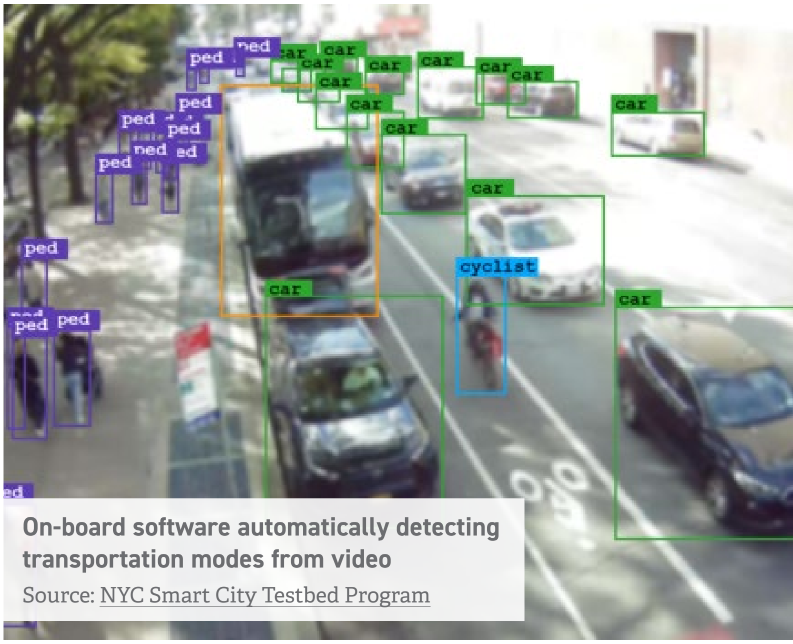
In transportation analytics, machine learning can develop predictive models from big data. After gathering data from various probe sources, machine learning algorithms can forecast future travel patterns and traffic conditions based on transportation data and other relevant factors. Models trained on historical data can identify patterns and correlations that can be used to anticipate traffic congestion, identify areas for capacity improvements, and scenario plan for changing conditions.

Computer Vision

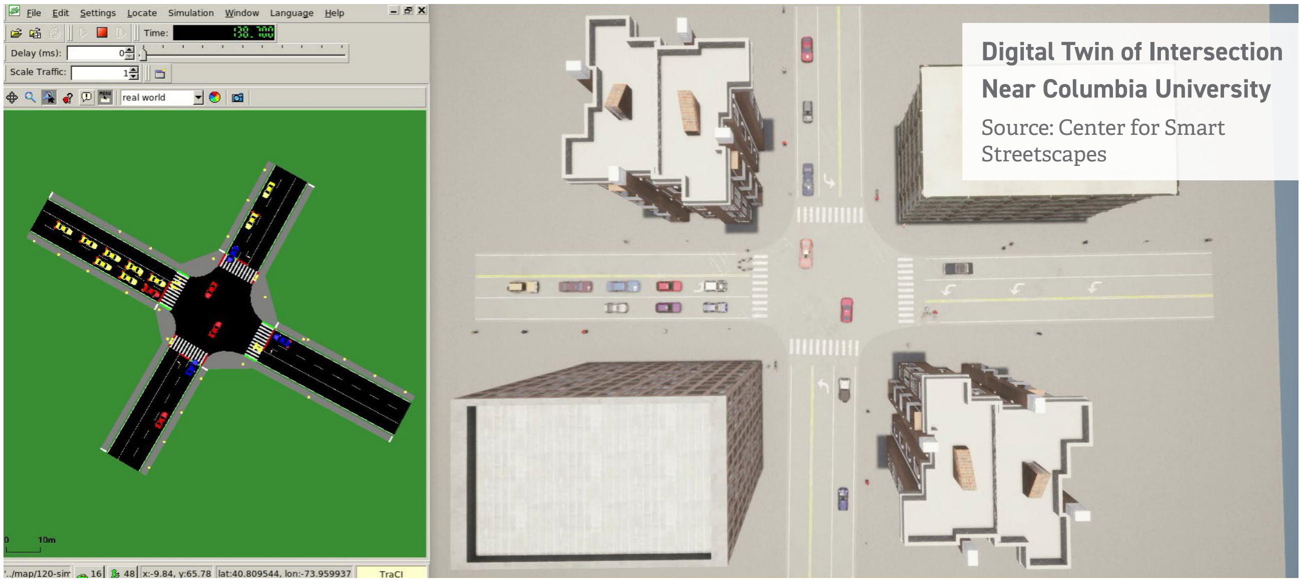
Computer vision is a field of machine learning where computers learn from visual data, like images or videos. This technology utilizes algorithms trained on vast datasets of images and videos to automatically recognize, classify, and track objects based on their visual characteristics. Computer Vision techniques are augmenting capabilities in diverse fields from cancer research to exoplanet searches.

In the urban transportation context, computer vision can be used to analyze the video feeds from cameras mounted anywhere to detect and classify cars, trucks, buses, bicycles, and pedestrians based on their size, shape, and movement. These have real-time applications for monitoring congestion, identifying incidents, and catching violations, and planning applications for measuring traffic flow, counts for all street users, and more abstract measures of safety, health, and dynamism.

The continuous learning aspect of computer vision ML algorithms means that, in general, the more data points, locations, and sources the system is exposed to, the more accurate and efficient it becomes at recognizing



On-board software automatically detecting transportation modes from video
Source: NYC Smart City Testbed Program



Digital Twin of Intersection Near Columbia University

Source: Center for Smart Streetscapes

and predicting transportation assets and patterns. This is especially valuable first, in developing models for local contexts that might differ significantly from generic patterns, such as New York City's uniquely high transit usage in the U.S., and second, for adding appropriate capabilities over time, like confidently distinguishing between bicycles and mopeds.

Data Fusion

Combining transportation data across data sources and formats requires data fusion. Data fusion may occur across sources of the same type (e.g. cameras), with each source potentially differing based on hardware capabilities, capture rate, data formatting, or across different types (cameras, probe data, ATRs). Data fusion algorithms, including statistical methods, geometric transformations, and machine learning models, extract relevant data from the varying sources and combine them into a unified database, generating as complete a picture of transportation activity as possible and ensuring standardized access to the data.

Digital Twins

Digital twins serve as specific digital representations of real-world activities. Models of complete physical systems, such as transportation networks, are calibrated with data collected through sensor measurements, including probe data and IoT. With digital twins, analysts can inspect and interrogate system behaviors and performance at many points and scales, from turning movement counts at individual intersections, to mode splits along a corridor or freight patterns throughout the region.

Integrating ML into digital twins transforms these virtual replicas from static into dynamic models. By continuously feeding ML algorithms with up-to-date and historical data, digital twins become predictors of future states, simulating outcomes across a spectrum of scenarios. The digital twin allows planners to make changes to one aspect of the transportation–like changing a bus route–and evaluate the effect on surrounding network links, transit ridership, and general mobility patterns. There is a synergy between digital twins and machine learning: data from the physical system informs the digital twin, while ML algorithms analyze this data to forecast future conditions and behaviors. As the physical system evolves, so does the digital twin, updated by real-time data, and refined by ML-driven insights.

Glossary of Terms

Artificial Intelligence: computer systems designed to replicate human problem-solving and decision-making processes.

Blackout Day: a day when transportation data collection is suspended due to atypical travel patterns, such as federal holidays or school recesses.

Central Business District: commercial or business center of a city; in NYC, Manhattan below and including 60th Street

Continuous Data: systems or devices that continuously collect and transmit data over time, providing real-time information for analysis and decision-making.

Edge Computing: processing data close to where it is generated, such as through traffic cameras and vehicle sensors, to minimize the transmission of raw and potentially sensitive data.

Global Positioning System (GPS): a satellite-based network providing continuous vehicle location data, enabling the analysis of movements, speed, and traffic patterns.

Intelligent Transportation System (ITS): the integration of advanced technologies, sensors, communications, and analytics into transportation infrastructure and vehicles to improve the efficiency, safety, and sustainability of transportation networks.

Internet of Things (IoT): encompasses an expansive world of wirelessly (or web-) connected devices, everything from smart thermostats and smart watches, to combined sewer overflow monitors.

Mode Split/Modal Share: percentage of travelers using each particular type of transportation mode.

Network Balancing: the process of distributing transportation demand evenly across a network.

Obfuscation: the deliberate alteration of data to protect sensitive information, such as blurring faces in images or hiding start/end points of GPS trips.

Origin-Destination: trips occurring between an (OD) pair of origin and destination geographic locations.

Peak Hour Factor: a ratio that measures the variation in traffic volume within the busiest hour of the day, indicating the consistency of traffic flow during that hour.

Telematics: the use of vehicle telecommunications and informatics to collect, transmit, and analyze data from vehicles to enhance their operation, maintenance, and management.

Traffic Density: number of vehicles in one lane over a specific length at a point in time, measured as vehicles per mile.

Traffic Volume: number of vehicles passing through a section of a road, measured in vehicles per hour.

Transportation Demand Management: programs and initiatives designed to reduce transportation demand, typically vehicle travel, by reducing the overall number of trips, promoting alternative work hours, or shifting vehicle trips to different modes of transportation.

Travel Demand Model: model used to forecast future travel patterns, both by transportation mode and trip volumes, based on current travel behavior.

Turning Movement Count: count taken at an intersection identifying vehicles by each direction and movement.

Agencies and Processes in NYC and Beyond

City Environmental Quality Review (CEQR): The process by which agencies of the City of New York review proposed discretionary actions to identify the effects those actions may have on the environment.

Department of Buildings (DOB): The City agency responsible for ensuring the safe and lawful use of the City's buildings by enforcing codes, issuing permits, and conducting inspections.

Department of City Planning (DCP): The City agency responsible for setting the framework for the City's physical and socioeconomic planning, including zoning regulations, land use, and urban design to promote orderly growth and sustainable development.

Department of Citywide Administrative Services (DCAS): The central agency within City operations, managing hiring, City property, and procurement.

Department of Transportation (DOT): Refers to the transportation departments at various levels of government—NYCDOT, NYSDOT, USDOT—that fund and manage transportation infrastructure and set transportation policies.

NYC DOT Division of Traffic Operations: Manages traffic flow, traffic signals, and parking and curbside regulations.

NYC DOT Division of Transportation Planning and Management (TPM): Responsible for ensuring the safe, efficient, and environmentally sustainable movement of people and goods on City streets. TPM oversees the planning, design, and implementation of key projects like bus and bicycle lanes, freight movement, traffic engineering, and safety studies. It also handles crash analysis, environmental review, geometric design, and intersection control, including through its Traffic Engineering & Planning (TEP) sub-division.

Office of Technology and Innovation (OTI): The City agency responsible for providing the technological infrastructure and support necessary for City services, managing IT policies, and fostering innovation across City departments.

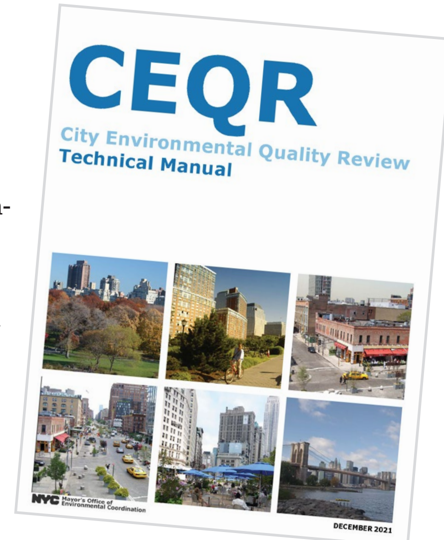
Taxi and Limousine Commission (TLC): The City agency responsible for licensing and regulating the City's yellow taxis, green cabs, for-hire vehicles, commuter vans, and paratransit vehicles.

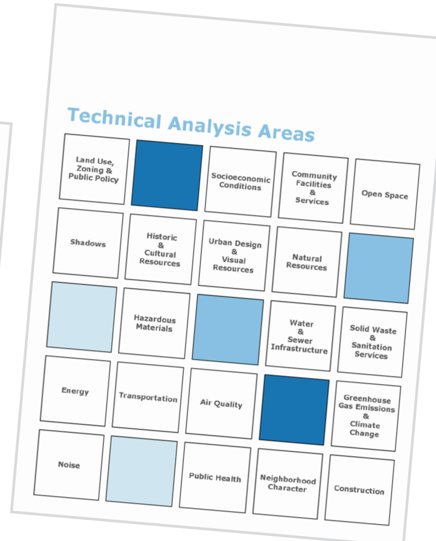
Uniform Land Use Review Procedure (ULURP): The City's standardized, multi-step procedure for applications affecting land use, comprising review by the Community Board, Borough President, City Planning Commission, and City Council.

6

Appendices

Appendix A: Description of CEQR Transportation Analysis





The CEQR Technical Manual is established and semi-regularly updated by local government agencies to provide guidance on how to conduct analysis to meet the regulatory requirements for disclosure and mitigation of potential significant adverse impacts to the environment obligated by New York State Environmental Quality Review Act (SEQRA) when public agencies take discretionary actions. In addition, projects subject to Federal agency approvals may be subject to additional analysis as directed by state and federal authorities. Finally, local transportation agencies often conduct an analysis of a proposed change to the transportation system to inform community engagement during the early planning stages of a project.

The CEQR process of transportation analysis starts with a screening out of projects of established small sizes (CEQR Technical Manual Table 16-1[14]) or particular action types (Type II action lists adopted by State[15] agencies) to identify whether those actions may have significant adverse impacts on the environment. Each level of the screening process aims to minimize the need for extensive transportation analysis for smaller-scale projects. It helps lead agencies, applicants, and their consultants efficiently screen out projects that do not require further detailed analysis, thereby reducing overall time and effort.

Step 1: Project Assumptions

The next screening threshold, Tier 1, is determined by producing a Travel Demand Factor (TDF) memoranda, which includes a project description Using established or reasonable and defensible assumptions, TDF memos project the future changes to transportation activities and induced travel behavior near a project site. By using trip generation rates, modal and temporal splits and vehicular occupancies for each proposed use or activity type (often national standards adjusted for local conditions and behavior) a project will generally exceed the first screening threshold if the project generates more than 50 vehicular trip ends or 200 pedestrian or transit users in the peak hour. These travel behavior factors that are fundamental factors in this analysis are obtained using either Table 16-2,[16] data sources such as the US Census, past projects in similar contexts or new survey information from similar existing uses. Often professional judgment is used to adjust these factors for a particular project with oversight and signoff from the local agency responsible for reviewing the analysis.

14 https://www.nyc.gov/assets/oec/technical-manual/16_Transportation_2021.pdf#page=3

15 https://govt.westlaw.com/nycrr/Document/I4ec3a767cd1711dda432a117e6e0f345

16 https://www.nyc.gov/assets/oec/technical-manual/16_Transportation_2021.pdf#page=5

Step 2: Geographic Assignments

If the first tier screening threshold is exceeded, the second tier screening threshold involves geographically assigning projected travel activities into the existing transportation network . The threshold for further detailed analysis is generally exceeded if any individual intersection is projected to experience an additional 50 vehicles or a transit or pedestrian element would experience an additional 200 people in a peak hour period; however, in highly congested areas detailed analysis may be appropriate at intersections with less than assigned 50 project-related vehicles. Projects that do not directly generate additional transportation demand, such as capital reconstruction or operational changes, will consider locations where system capacity may be reduced or where existing demand is diverted to new locations. The assignment process is also subject to professional judgment with oversight by local agency experts. Finally, detailed analysis may be appropriate where there is a history of safety issues or increased conflicts between vehicles and other street users may be introduced.

This analysis, after agency concurrence, determines if and where a detailed analysis is needed and informs the establishment of the appropriate study area. The standard agency service level for review and concurrence with each of these steps of analysis is 30 days for each step.

From the 2021 CEQR Technical Manual:

> Definition of an appropriate traffic study area is probably the single most critical decision to be made, and the one in which hard guidelines are most difficult to formulate…
>
> The traffic study area may be either contiguous or a set of non-contiguous intersections. The traffic study area could extend from a minimum of one to two blocks from the site to as much as one-half mile or more from the site. It is defined by the logical direct routes along which traffic proceeds to and from the site, and typically includes major arterials and streets along the most direct routes to the project site as well as significant alternate routes. Multi-legged intersections and other problem locations along these routes should generally be incorporated into the traffic study area. It is difficult to outline the number of analysis locations encompassed within the study area for a detailed traffic analysis. It should be noted that each project is different, and the appropriate number of intersections to study should be based on the Level 2 Screening Assessment trip assignments.

At this point after agency approval of the geographic study area and scope of analysis an extensive data collection effort begins.

Step 3: Collecting Data

The first step of existing conditions data collection is obtaining traffic and pedestrian volume counts during the peak hour for analysis. There are several methods currently used for obtaining these volume counts. Previously collected data may be used if the data is less than 3 years old and no major changes in development or traffic patterns have occurred in the area. More often new data must be collected along with field observations to quantify existing conditions, including vehicular traffic volume of each lane and possible movement through an intersection (turning movement counts) , vehicle classifications breaking down total volume by auto, taxi, truck or bus, and in some cases queue length and travel speeds.

New data are typically obtained using one of, or a combination of, several methods. Visual human observations can be made by standing at an intersection during the period of analysis and tabulated manually. Automated Traffic Recorders (ATRs) are a legacy technology using pneumatic tubes temporarily installed in a travel lane location that can quantify vehicular activity over longer time frames, but cannot characterize the type of vehicle nor count non-vehicular travel.

Within the past decade video recording and battery technology has developed sufficiently to allow temporary installation of video cameras on nearby signal and light poles that can capture all travel activities over an entire intersection for a significant observation period. Those videos can later be reviewed to tabulate turning movement volumes and classifications. Video recordings also provide a higher level of confidence in the accuracy of the data tabulation as they allow for repeat viewing. In addition, video recording can be used to observe vehicle interactions that contribute to calibration of traffic models. The permitting required to install these temporary cameras on street poles typically takes approximately a week to obtain from City agencies. In some intersections, camera installation locations on existing signal or street light poles may be limited or unavailable.

Turning movement counts are collected in 15 minute increments, for example a peak hour period may begin at 4:45 PM to capture commuting patterns of workers departing early to avoid congestion. Data collection is not allowed during holidays, Mondays or Fridays, inclement weather or unusual conditions such as major construction projects. Each year a schedule of "blackout" periods for data collection is published by NYCDOT (Appendix B) precluding new data collection during a significant period of each year. Typically, nine days of ATRs are collected along with one mid-week day and one weekend day, however several days of turning movement count data may be collected and averaged to be considered representative. That requires capturing three consecutive mid-week days or two consecutive weekend days.

After data is collected, tabulated, and mapped, observed volume counts are "balanced" to establish logical and consistent volumes between the multiple intersections in a study area for each analysis hour.

Step 4: Determining Potential for Adverse Impacts

After balanced existing conditions volume maps are complete, analysis can continue by projecting future conditions volume maps. Existing volumes are grown with an annual growth factor, ranging from 0.25% to 1% compounded depending on location. In addition to the growth rate, traffic and pedestrian volumes from known background development projects are assigned to the analysis intersections in the study area based on the accepted travel demand factors appropriate for the program of each background project (repeating steps 1 and 2 for each background project). This establishes the Future No-Action condition volumes for each peak analysis hour. Those volumes and a physical inventory of street geometry are used to calculate a volume to capacity ratio (v/c), average control delay and Level of Service (LOS) for each lane group at each intersection in the study area. The methodology for determining these expressions is established in the Highway Capacity Manual (HCM), developed by the Transportation Research Board (TRB), which includes different procedures for signalized and unsignalized intersections.

Several options are available for software platforms that have been developed to assist in the analysis including: Highway Capacity Software, Synchro, CORSIM, SimTraffic, Aimsun, and VISSUM. The more advanced software modeling solutions provide a variety of complexity and functions, including micro-simulation, that can provide more nuanced and sometimes more appropriate modeling; however, significant coordination is required with the reviewing lead agency and DOT before the use of modeling software. Sensitivity analyses are then sometimes performed to explore variations in With Action scenarios.

Following the development of the Future No-Action Condition maps the original project's volumes, established in step 2, are layered-on to create the Future With-Action Conditions. A complete tabulation of total projects volumes, v/c, and LOS for each lane group in each analysis period is compiled.

A comparison of the Future No-Action Condition to the Future With-Action Conditions in each lane group in each analysis hour is made to determine the incremental change caused by the project. The CEQR Technical Manual establishes specific incremental delays, specific to New York City, that should be considered significant adverse impacts based on the LOS found in the No-action Condition. Generally less congested areas have a greater tolerance for additional delay than areas of higher congestion.

Similar comparisons between future no-action v/c ratios and with-action v/c ratios are conducted for transit facilities. Criteria for determining if a change of service levels constitutes a significant adverse impact is provided by the CEQR Technical Manual for each of these areas of study.

A simplified analogy for this analysis is to imagine the transportation network as a glass of water. The existing traffic (as measured through data collection methodologies) is the water already in the glass, and the proposed project adds more water, representing the additional congestion. If the water overflows, that overflow represents the adverse impact that must be mitigated in the next step.

However, this process becomes more complex because the size and shape of the glass (i.e., the transportation network in the study area) can change based on projections of how the area and its transportation demands will evolve. The process could be significantly expedited if data collection (measuring the water level) were instantaneous, regardless of the glass's shape or size.

Step 5: Developing Mitigation Measures

When significant adverse impacts are identified the environmental review process obligates the development and implementation of measures to mitigate impacts to a level below the established significance thresholds "to the greatest extent practicable"[17].

Transportation mitigation measures can range from low to high cost measures. On the lower end of that range are street operational changes such as adjusting signal timing or modifying on-street parking regulations to provide increased vehicle or transit capacity. The higher end of the cost range could identify sidewalk widenings, constructing new streets or new highway ramps. Travel Demand Management (TDM) measures are also acknowledged as viable mitigation that could shift expected travel patterns away from most likely travel modes, encourage higher occupancy vehicle use or shift travel demand times. TDM measures can include programs to encourage carpooling, telecommuting and off peak hour work or delivery schedules, and investments to encourage alternative mode use such as bicycle facilities or shuttle buses to transit centers.

Where practicable measures that fully mitigate impacts cannot be identified, a disclosure of unavoidable adverse impacts must be summarized and presented in a separate chapter of an Environmental Impact Statement. Finally, the future mitigated conditions of the Transportation analysis are used as a data input to the Mobile Air Quality (AQ) and Noise analysis of any environmental review.

17 NYC CEQR Technical Manual Chapter 2 - 600. DETERMINING IMPACT SIGNIFICANCE

Appendix B: Traffic Count Blackout Days

NEW YORK CITY DOT

Department of Transportation

Ydanis Rodriguez, Commissioner

NYC Department of Transportation

2024 Traffic Count Data Collection Calendar

Date	Day	Collection Status	NOTE
1-Jan	Mon	X	HOLSEA
2-Jan	Tue	X	HOLSEA
3-Jan	Wed	OK	
4-Jan	Thu	OK	
5-Jan	Fri	X	
6-Jan	Sat	W	
7-Jan	Sun	W	
8-Jan	Mon	X	
9-Jan	Tue	OK	
10-Jan	Wed	OK	
11-Jan	Thu	OK	
12-Jan	Fri	X	
13-Jan	Sat	W	
14-Jan	Sun	W	
15-Jan	Mon	X	MLK
16-Jan	Tue	OK	
17-Jan	Wed	OK	
18-Jan	Thu	OK	
19-Jan	Fri	X	
20-Jan	Sat	W	
21-Jan	Sun	W	
22-Jan	Mon	X	
23-Jan	Tue	OK	
24-Jan	Wed	OK	
25-Jan	Thu	OK	
26-Jan	Fri	X	
27-Jan	Sat	W	
28-Jan	Sun	W	
29-Jan	Mon	X	
30-Jan	Tue	OK	
31-Jan	Wed	OK	
1-Feb	Thu	OK	
2-Feb	Fri	X	
3-Feb	Sat	W	
4-Feb	Sun	W	
5-Feb	Mon	X	
6-Feb	Tue	OK	
7-Feb	Wed	OK	
8-Feb	Thu	OK	
9-Feb	Fri	X	
10-Feb	Sat	X	Chinese Year[1]
11-Feb	Sun	X	Chinese Year[1]
12-Feb	Mon	X	
13-Feb	Tue	OK	
14-Feb	Wed	OK	
15-Feb	Thu	OK	
16-Feb	Fri	X	
17-Feb	Sat	W	
18-Feb	Sun	W	
19-Feb	Mon	X	PRESIDENT
20-Feb	Tue	X	SCHOOL BREAK
21-Feb	Wed	X	SCHOOL BREAK
22-Feb	Thu	X	SCHOOL BREAK
23-Feb	Fri	X	SCHOOL BREAK
24-Feb	Sat	W	
25-Feb	Sun	W	
26-Feb	Mon	X	
27-Feb	Tue	OK	
28-Feb	Wed	OK	
29-Feb	Thu	OK	
1-Mar	Fri	X	
2-Mar	Sat	W	
3-Mar	Sun	W	
4-Mar	Mon	X	
5-Mar	Tue	OK	
6-Mar	Wed	OK	
7-Mar	Thu	OK	
8-Mar	Fri	X	
9-Mar	Sat	W	
10-Mar	Sun	W	
11-Mar	Mon	X	
12-Mar	Tue	OK	
13-Mar	Wed	OK	
14-Mar	Thu	OK	
15-Mar	Fri	X	
16-Mar	Sat	W	
17-Mar	Sun	W	
18-Mar	Mon	X	
19-Mar	Tue	OK	
20-Mar	Wed	OK	
21-Mar	Thu	OK	
22-Mar	Fri	X	
23-Mar	Sat	W	
24-Mar	Sun	W	
25-Mar	Mon	X	
26-Mar	Tue	OK	
27-Mar	Wed	OK	
28-Mar	Thu	OK	
29-Mar	Fri	X	
30-Mar	Sat	X	EASTER
31-Mar	Sun	X	EASTER

Date	Day	Collection Status	NOTE
1-Apr	Mon	X	
2-Apr	Tue	OK	
3-Apr	Wed	OK	
4-Apr	Thu	OK	
5-Apr	Fri	X	
6-Apr	Sat	W	
7-Apr	Sun	W	
8-Apr	Mon	X	
9-Apr	Tue	OK	
10-Apr	Wed	X	SCHOOL OFF
11-Apr	Thu	OK	
12-Apr	Fri	X	
13-Apr	Sat	W	
14-Apr	Sun	W	
15-Apr	Mon	X	
16-Apr	Tue	OK	
17-Apr	Wed	OK	
18-Apr	Thu	OK	
19-Apr	Fri	X	
20-Apr	Sat	X	SRING RECESS
21-Apr	Sun	X	SRING RECESS
22-Apr	Mon	X	SRING RECESS
23-Apr	Tue	X	SRING RECESS
24-Apr	Wed	X	SRING RECESS
25-Apr	Thu	X	SRING RECESS
26-Apr	Fri	X	SRING RECESS
27-Apr	Sat	X	SRING RECESS
28-Apr	Sun	X	SRING RECESS
29-Apr	Mon	X	SRING RECESS
30-Apr	Tue	X	SRING RECESS
1-May	Wed	OK	
2-May	Thu	OK	
3-May	Fri	X	
4-May	Sat	W	
5-May	Sun	W	
6-May	Mon	X	
7-May	Tue	OK	
8-May	Wed	OK	
9-May	Thu	OK	
10-May	Fri	X	
11-May	Sat	W	
12-May	Sun	W	
13-May	Mon	X	
14-May	Tue	OK	
15-May	Wed	OK	
16-May	Thu	OK	
17-May	Fri	X	
18-May	Sat	W	
19-May	Sun	W	
20-May	Mon	X	
21-May	Tue	OK	
22-May	Wed	OK	
23-May	Thu	OK	
24-May	Fri	X	
25-May	Sat	X	
26-May	Sun	X	
27-May	Mon	X	MEMORIAL
28-May	Tue	OK	
29-May	Wed	OK	
30-May	Thu	OK	
31-May	Fri	X	
1-Jun	Sat	W	
2-Jun	Sun	W	
3-Jun	Mon	X	
4-Jun	Tue	OK	
5-Jun	Wed	OK	
6-Jun	Thu	X	SCHOOL OFF
7-Jun	Fri	X	SCHOOL OFF
8-Jun	Sat	W	
9-Jun	Sun	W	
10-Jun	Mon	X	
11-Jun	Tue	OK	
12-Jun	Wed	X	SHAVUOT[2]
13-Jun	Thu	X	SHAVUOT[2]
14-Jun	Fri	X	
15-Jun	Sat	W	
16-Jun	Sun	W	
17-Jun	Mon	X	SCHOOL OFF
18-Jun	Tue	OK	
19-Jun	Wed	X	SCHOOL OFF
20-Jun	Thu	OK	
21-Jun	Fri	X	
22-Jun	Sat	W	
23-Jun	Sun	W	
24-Jun	Mon	X	
25-Jun	Tue	OK	
26-Jun	Wed	OK	
27-Jun	Thu	X	SUMMER
28-Jun	Fri	X	SUMMER
29-Jun	Sat	X	SUMMER
30-Jun	Sun	X	SUMMER

Date	Day	Collection Status	NOTE
1-Jul	Mon	X	SUMMER
2-Jul	Tue	X	SUMMER
3-Jul	Wed	X	SUMMER
4-Jul	Thu	X	INDEPENDENCE
5-Jul	Fri	X	SUMMER
6-Jul	Sat	X	SUMMER
7-Jul	Sun	X	SUMMER
8-Jul	Mon	X	SUMMER
9-Jul	Tue	X	SUMMER
10-Jul	Wed	X	SUMMER
11-Jul	Thu	X	SUMMER
12-Jul	Fri	X	SUMMER
13-Jul	Sat	X	SUMMER
14-Jul	Sun	X	SUMMER
15-Jul	Mon	X	SUMMER
16-Jul	Tue	X	SUMMER
17-Jul	Wed	X	SUMMER
18-Jul	Thu	X	SUMMER
19-Jul	Fri	X	SUMMER
20-Jul	Sat	X	SUMMER
21-Jul	Sun	X	SUMMER
22-Jul	Mon	X	SUMMER
23-Jul	Tue	X	SUMMER
24-Jul	Wed	X	SUMMER
25-Jul	Thu	X	SUMMER
26-Jul	Fri	X	SUMMER
27-Jul	Sat	X	SUMMER
28-Jul	Sun	X	SUMMER
29-Jul	Mon	X	SUMMER
30-Jul	Tue	X	SUMMER
31-Jul	Wed	X	SUMMER
1-Aug	Thu	X	SUMMER
2-Aug	Fri	X	SUMMER
3-Aug	Sat	X	SUMMER
4-Aug	Sun	X	SUMMER
5-Aug	Mon	X	SUMMER
6-Aug	Tue	X	SUMMER
7-Aug	Wed	X	SUMMER
8-Aug	Thu	X	SUMMER
9-Aug	Fri	X	SUMMER
10-Aug	Sat	X	SUMMER
11-Aug	Sun	X	SUMMER
12-Aug	Mon	X	SUMMER
13-Aug	Tue	X	SUMMER
14-Aug	Wed	X	SUMMER
15-Aug	Thu	X	SUMMER
16-Aug	Fri	X	SUMMER
17-Aug	Sat	X	SUMMER
18-Aug	Sun	X	SUMMER
19-Aug	Mon	X	SUMMER
20-Aug	Tue	X	SUMMER
21-Aug	Wed	X	SUMMER
22-Aug	Thu	X	SUMMER
23-Aug	Fri	X	SUMMER
24-Aug	Sat	X	SUMMER
25-Aug	Sun	X	SUMMER
26-Aug	Mon	X	SUMMER
27-Aug	Tue	X	SUMMER
28-Aug	Wed	X	SUMMER
29-Aug	Thu	X	SUMMER
30-Aug	Fri	X	SUMMER
31-Aug	Sat	X	SUMMER
1-Sep	Sun	X	SUMMER
2-Sep	Mon	X	LABOR
3-Sep	Tue	X	SUMMER
4-Sep	Wed	X	SUMMER
5-Sep	Thu	OK	
6-Sep	Fri	X	
7-Sep	Sat	W	
8-Sep	Sun	W	
9-Sep	Mon	X	
10-Sep	Tue	OK	
11-Sep	Wed	OK	
12-Sep	Thu	OK	
13-Sep	Fri	X	
14-Sep	Sat	W	
15-Sep	Sun	W	
16-Sep	Mon	X	
17-Sep	Tue	OK	
18-Sep	Wed	OK	
19-Sep	Thu	OK	
20-Sep	Fri	X	
21-Sep	Sat	X	UN WEEK[3]
22-Sep	Sun	X	UN WEEK[3]
23-Sep	Mon	X	UN WEEK[3]
24-Sep	Tue	X	UN WEEK[3]
25-Sep	Wed	X	UN WEEK[3]
26-Sep	Thu	X	UN WEEK[3]
27-Sep	Fri	X	UN WEEK[3]
28-Sep	Sat	X	UN WEEK[3]
29-Sep	Sun	X	UN WEEK[3]
30-Sep	Mon	X	

Date	Day	Collection Status	NOTE
1-Oct	Tue	OK	
2-Oct	Wed	OK	
3-Oct	Thu	X	ROSH HASHANAH
4-Oct	Fri	X	ROSH HASHANAH
5-Oct	Sat	W	
6-Oct	Sun	W	
7-Oct	Mon	X	
8-Oct	Tue	OK	
9-Oct	Wed	OK	
10-Oct	Thu	OK	
11-Oct	Fri	X	YOM KIPPUR
12-Oct	Sat	X	YOM KIPPUR
13-Oct	Sun	X	
14-Oct	Mon	X	
15-Oct	Tue	OK	
16-Oct	Wed	OK	
17-Oct	Thu	X	SUKKOT[2]
18-Oct	Fri	X	
19-Oct	Sat	W	
20-Oct	Sun	W	
21-Oct	Mon	X	
22-Oct	Tue	OK	
23-Oct	Wed	OK	
24-Oct	Thu	X	SHEMINI ATZERETH[2]
25-Oct	Fri	X	
26-Oct	Sat	W	
27-Oct	Sun	W	
28-Oct	Mon	X	
29-Oct	Tue	OK	
30-Oct	Wed	OK	
31-Oct	Thu	OK	
1-Nov	Fri	X	SCHOOL OFF
2-Nov	Sat	W	
3-Nov	Sun	W	
4-Nov	Mon	X	
5-Nov	Tue	X	ELECTION
6-Nov	Wed	OK	
7-Nov	Thu	OK	
8-Nov	Fri	X	
9-Nov	Sat	W	
10-Nov	Sun	W	
11-Nov	Mon	X	VETERANS
12-Nov	Tue	OK	
13-Nov	Wed	OK	
14-Nov	Thu	OK	
15-Nov	Fri	X	
16-Nov	Sat	W	
17-Nov	Sun	W	
18-Nov	Mon	X	
19-Nov	Tue	OK	
20-Nov	Wed	OK	
21-Nov	Thu	OK	
22-Nov	Fri	X	
23-Nov	Sat	W	
24-Nov	Sun	W	
25-Nov	Mon	X	
26-Nov	Tue	OK	
27-Nov	Wed	OK	
28-Nov	Thu	X	THANKSGIVING
29-Nov	Fri	X	THANKSGIVING
30-Nov	Sat	X	THANKSGIVING
1-Dec	Sun	X	THANKSGIVING
2-Dec	Mon	X	
3-Dec	Tue	OK	
4-Dec	Wed	OK	
5-Dec	Thu	OK	
6-Dec	Fri	X	
7-Dec	Sat	W	
8-Dec	Sun	W	
9-Dec	Mon	X	
10-Dec	Tue	OK	
11-Dec	Wed	OK	
12-Dec	Thu	OK	
13-Dec	Fri	X	
14-Dec	Sat	W	
15-Dec	Sun	W	
16-Dec	Mon	X	
17-Dec	Tue	X	HOLSEA
18-Dec	Wed	X	HOLSEA
19-Dec	Thu	X	HOLSEA
20-Dec	Fri	X	HOLSEA
21-Dec	Sat	X	HOLSEA
22-Dec	Sun	X	HOLSEA
23-Dec	Mon	X	HOLSEA
24-Dec	Tue	X	HOLSEA
25-Dec	Wed	X	CHRISTMAS
26-Dec	Thu	X	HOLSEA
27-Dec	Fri	X	HOLSEA
28-Dec	Sat	X	HOLSEA
29-Dec	Sun	X	HOLSEA
30-Dec	Mon	X	HOLSEA
31-Dec	Tue	X	HOLSEA

Notes:

1) This holiday will affect data collection within area of influence. For example, Chinatown and Flushing neighborhoods. Data can be collected in areas other than influence areas. Please check with TEP before collecting any data during this holiday.

2) These holidays will affect data collection within area of influence. For example, Borough Park and Williamsburg neighborhoods. Data can be collected in areas other than influence areas. Please check with TEP before collecting any data during these holidays.

3) Specific timing of UN Week would be confirmed closer to event. UN week will affect data collection within the area of influence. Data can be collected in outer boroughs and other parts of Manhattan. Please check with TE&P before collecting any data during UN week.

Legend

OK	Weekday Counts Allowed
W	Weekend Counts Allowed
X	No Counts Allowed
HOLSEA	Holiday Season

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Source: NYCDOT