Addressing Air Quality and Mobility in Milan, Lombardia, and the Po Valley Region

Sol Price School of Public Policy
The University of Southern California
June 2016
EXECUTIVE SUMMARY

Milan is a metropolitan area with more than 1.35 million residents located in the Po Valley region of Italy. Existing environmental and transportation policies in the City of Milan are geographically limited and, therefore, fail to reduce pollution and improve mobility in the greater Po Valley. This is because governance and associated policies are centralized in Milan. In addition, more than 1 million people pass through the Milan daily, contributing to high levels of traffic congestion. Distinct environmental agencies attempting to combat local pollution and enhance mobility without a formal governing body responsible for coordination has been another challenge. Therefore, it is crucial to introduce a regional planning organization to facilitate sustainable mobility plans in the Po Valley and to align regional, provincial, and local policies.

By integrating innovative environmental and transportation policy recommendations and governance strategies, traffic congestion can be managed in real-time with technological advances and creative use of existing road infrastructure. Policy recommendations include Active Demand Management, Active Traffic Management, and Dynamic Parking Management strategies working together for highly effective outcomes. Exhaust and non-exhaust sources contribute almost equally to traffic-related air pollution made up of PM$_{10}$ emissions. Among the non-exhaust sources, tire and brake wear can be a significant PM$_{10}$ contributor, particularly within high traffic density areas with frequent brake use. Thirteen percent of all PM$_{10}$ pollution in Lombardia and 23 percent of all PM$_{10}$ in Milan comes from tires and brakes. Fifty-seven percent of all NOx pollution in Lombardia and 63 percent of all NOx in Milan comes from diesel cars. Thus, it is imperative to implement programs aimed at solving these problems. Strategies include incentivizing the use of more eco-friendly automotive parts and electric vehicles through rebate programs, promoting automotive battery and tire recycling, and developing solar batteries for vehicles.

Milan is a leader in urban greening with 11.9% of the city being green, compared to 2.7% in other large municipalities, and should continue its urban greening efforts in conjunction with promoting energy efficient buildings. It is imperative that public-private partnerships are created to encourage developers to build energy efficient structures. Part of this strategy will include developers offering tenants (students, residents, businesses, etc.) subscriptions to bicycle and car-sharing services as buildings account for more than 40 percent of emissions in Milan.

Utilizing communication and marketing strategies that have been shown to be effective in similar situations will promote the effective cultural shifts necessary to successfully implement the recommendations presented. A customized campaign will identify the demographics of the target audience and tailor materials to this population.
BACKGROUND

Italy has become a European leader in environmental policy by developing congestion and pollution control policies, which have resulted in significant reductions in traffic congestion, GHG emissions, and local air pollution. In 2010, the rate of vehicle motorization for the country was one of the highest in all of Europe (62 vehicles per 100 people). The Italian national government has supported and enhanced progressive emission reduction policies through legislation that increased taxes on greenhouse gas emissions.

Regionally, Lombardia is working to develop measures to address its congestion, air pollution, and mobility problems. Home to approximately 10 million people, Lombardia is one of Italy’s most populated regions and is made up of 1,544 municipalities. Lombardia is also an industrial hotspot that contains approximately 20% of the nation’s industry, which results in high levels of air toxics and GHGs that threaten human health and the environment. In 2013, the Lombardia government developed the Regional Plan of Action on Air Quality, a strategic plan to reduce local air pollution. Directives from the plan include restrictions on Euro 0 gas engines and Euro 3 diesel engines as well as dropping vehicle registration fees to motorists who purchase vehicles with clean engines.

The City of Milan is home to approximately 1.35 million residents, with roughly 3.2 million people residing in its surrounding metropolitan area. These inhabitants are highly mobile, making 5.3 million person trips per day, with approximately one million people commuting in and out of the city. The City Council of Milan created a Sustainable Urban Mobility Plan (SUMP) to guide efforts to improve transportation. The plan aims to reduce congestion, local air pollution from transportation, and GHG emissions by prioritizing shared mobility services over private transportation. The plan consists of an information campaign targeted toward Milan residents and meetings between authorities, stakeholders, and citizens. Milan’s SUMP also includes projects to expand public transit networks and creates a low emissions zone (LEZ), Area C, in the center of the city.

These projects have been highly effective at reducing congestion and pollution in the Milan metropolitan area. However, their outcomes are geographically limited, and therefore fail to significantly decrease emissions and improve mobility in the greater Po Valley region. The Po Valley is made up primarily of the Lombardia region and consequently large quantities of industrial smog get trapped within the high walls of the Alps and the Apennine Hills. Accordingly, the European Union (EU) Institute for Environment and Sustainability (IES) has identified the Po Valley region as a pollution hotspot that remains problematic despite the current European air pollution and emissions reductions legislation.
GOVERNANCE RECOMMENDATIONS

Recommendation 1
Create Lombardia Regional Planning Organization (RPO) using the Southern California Association of Governments (SCAG) as a reference model.

One of the primary challenges in Lombardia has been the distinct nature of separate environmental agencies attempting to combat climate change without the necessary coordination among local actors. For example, the Milan City Council, the Milan Transportation Agency (ATM), the Milan Agency for Mobility and Territory (AMAT), ARPA Lombardia, Legambiente Lombardia, and various bike and ride-sharing initiatives all operate independently from one another. Lombardia would be better served if it developed a local coalition comprised of representatives from these groups and other independent actors. This coalition would be a non-governmental organization responsible for collecting data, monitoring mutually agreed upon policy goals, and integrating environmental policy initiatives among agencies within Milan and other municipalities in the Po Valley. While Milan’s SUMP succeeded in bringing together these governmental agencies, community members, and other local associations, it did not create a permanent framework for collaboration. It is critical for air pollution and mobility policy solutions to be constantly innovating, evolving, and recalibrating to new and emerging environmental problems.

Our policy proposal recommends that Lombardia create an RPO using the framework established by the state of California and SCAG. A regional environmental coalition would create the infrastructure necessary for community-based collaborative planning and problem solving that is fundamental to developing a robust policy strategy and leverages the strengths of each coalition member. Because of the nature of its formation and dispersion, pollution inherently cross city and geopolitical boundaries. The most effective coalition will not only encompass representative agencies and community groups from across sectors such as transportation and air quality management, but will also incorporate cross-regional agencies outside of Milan and include municipalities throughout Lombardia. Bordering localities should be included in the coalition because their citizens commute to and from Milan, and thus impact pollution issues and contribute to congestion problems.

Political and ideological disparities often create gridlock and inherent challenges for coalition building. Lombardia and Southern California are not immune from this. SCAG has alleviated this political stalemate by having both appointed and elected officials serve in the coalition. The appointed officials are politically neutral, serving a consultancy and technical role. For SCAG, appointed officials serve as nonpartisan mediators to the elected officials with political interests.

The following section borrows the coordination and collaboration framework implemented in California, in which each region has its own planning authority responsible for integrating a multifaceted policy approach integrating transportation, land-use, and housing initiatives into a community-tailored, long-term environmental strategy.

The high demand for transportation networks in the Milan metropolitan area have created a need for strategic transportation planning that includes consideration of the city’s problems with road congestion, the efficient use of public space, and local air pollution. An integrated approach
to urban planning that balances environmental, social, and economic needs is critical for Milan’s future. Studies show that Southern California has similar atmospheric conditions to the Po Valley as large plumes of local air pollution remain concentrated by mountains throughout the state.\textsuperscript{xii} Southern California is addressing similar congestion, air pollution, and emissions problems through Senate Bill 375, which focuses on soft mobility and compact development. SB 375’s implementation strategy employs a top-down approach, with the California Air Resources Board (CARB) setting emissions reduction targets that are then carried out by 18 regions throughout the state.

Each of the 18 regions has a Metropolitan Planning Organization (MPO) that is responsible for developing a Sustainable Communities Strategy (SCS). An MPO is a federally-mandated regional transportation planning agency that is in charge of creating long-range regional transportation investment plans (RTP) and many of the representatives on MPOs are comprised of local government officials.\textsuperscript{xii} The SCS is a plan that sets regional goals for land use, infrastructure development, and transportation efficiency with the overarching aim to meet the GHG reduction targets set by CARB. After the MPO drafts its SCS, it submits the SCS to CARB, which reviews and approves the proposal for implementation. The local government affiliated with each MPO is then responsible for implementation of the SCS.

Lombardia’s environmental policymaking and implementation challenges are inherently distinct from Southern California, and therefore require unique inter-organizational collaborative solutions in order to effectively address local air pollution and mobility issues. For example, the primary difference between these two regions is the decentralization of businesses and economic activity in Southern California. This contrasts with Lombardia in which the economy and wealth are generally consolidated in Milan’s city center. For Lombardia, this creates challenges for establishing an RPO because it disincentivizes surrounding community groups and localities from wanting to collaborate.

There are several solutions that could alleviate this infrastructural challenge. First, Lombardia could create tax-sharing policies between communities that incentivize collaborative and sustainable land-use, housing, and transportation projects. Second, despite intrinsic economic, social, and political disparities among potential RPO members, each municipality could have equal representation at the table for policy discussions and negotiations. Once the Lombardia Regional Planning Organization (LRPO) is established and the collaborative framework proves successful, regional planning organizations should be imitated and expanded to other Po Valley regions. Details of this approach are discussed in the following recommendation.

**Recommendation 2**

**Establish LRPO as a model planning organization for later expansion into additional Po Valley regions.**

Establishing the LRPO as a model planning organization would set a precedent for an environmental coalition that could later be expanded into other localities within the Po Valley, and eventually throughout Italy. This approach has the potential to be successful in the Po Valley because it unites regions to reduce congestion, local air pollution, and GHG emissions on a larger, more integrated scale. Milan has shown that expanding soft mobility can effectively reduce emissions and congestion on a micro-scale, but the whole Po Valley has not experienced similar outcomes. Evidence of collective action on a regional level is insufficient,
and representatives from ARPA Lombardia agree that regional integrated action must occur to permanently reverse the air pollution problems in the Po Valley.

RPOs in Italy would create the infrastructure required for regional transportation plans and the problem solving capacity that is essential for macro-level sustainable development and enhanced transportation mobility. Representatives from the municipalities would make up the RPOs, and they would also provide information, public notice, and access to key decisions to the public to facilitate their involvement in developing plans to meet their targets. The RPOs major functions include serving as a regional forum for cooperative decision-making and planning by local governmental officials and ensuring that the regional sustainable mobility plans and programs are in conformity with the Po Valley, Italian, and European air quality and emissions reduction plans.

While Lombardia differs from other regions in Po Valley, solutions similar to those suggested in Recommendation One, such as tax-sharing policies across regions, can be used to incentivize the creation of RPOs and the collaboration of communities and regions across Po Valley. Additionally, just as each municipality would have equal representation within an RPO, each RPO would be equally represented during discussions and negotiations. If RPOs are created across regions, collaboration between these organizations could significantly reduce air pollution and enhance mobility throughout Po Valley.

One example of a tax-sharing mechanism that may incentivize distinct governments and associations to come together is for a given percentage of sales tax revenue generated in Milan to be reinvested in sustainable transportation infrastructure development outside of the city. The benefits for Milan would be two-fold: First, Milan’s businesses would have access to a larger pool of skilled employees. This would increase economic productivity within Milan. Second, if infrastructure investments are strategically selected, it could increase the number of person-trips into Milan, while decreasing or holding constant the number of car trips into the city.
POLICY RECOMMENDATIONS

Recommendation 3
Establish a Vehicle Kilometer Traveled (VKT) fee.

In order to internalize Milan’s congestion and pollution externalities, the first-best policy option is a dynamically adjusted fee assessed per vehicle kilometer traveled (VKT). A dynamic VKT fee takes into account changing traffic conditions, so that drivers pay a fee nearly equal to their marginal contribution to congestion (which changes in time as roadways become more or less congested) and their vehicle’s GHG emissions. Both congestion costs and costs associated with GHG emissions from transportation are closely correlated with VKT. Therefore, these externalities should be the basis for determining the size of the fee per vehicle kilometer traveled. A fee per vehicle kilometer traveled most accurately assesses each vehicle and driver’s contribution to traffic congestion and GHG emissions and charges drivers accordingly.

Implementation of a VKT fee requires that governments track vehicle kilometers traveled. Reliable collection of VKT for specific vehicles, or methods for the imputation of distance traveled by individuals in their vehicles is necessary for accurate assessment of fees. Several pilot programs in the United States and Europe have begun exploring different methods for collection of VKT information using GPS transponders and insurance information.

Governance Considerations
A VKT fee should be implemented at a regional level to most effectively internalize congestion and GHG externalities and reduce personal vehicle use. No single municipality in Lombardia has the ability to effectively impose a VKT fee. Design of the tracking system and creation of a fee structure based on the relevant external costs are best handled by a regional body. The explicit cost of design and implementation should be shared among affected municipalities. Successful implementation requires cooperation between municipalities that are employment hubs, population centers, and those that host transportation infrastructure. An equitable revenue sharing plan is also necessary for successful implementation.

Policy Considerations

Dynamic Pricing
A VKT fee that includes congestion should be dynamically priced and take into account changing roadway congestion. Dynamic pricing, rather than a flat fee based on the average cost per vehicle kilometer, would most accurately reflect driver’s contribution to congestion and GHG emission externalities.

Italian law currently precludes the possibility of implementing a dynamically adjusted VKT fee. Municipalities are required to explicitly state the per-kilometer fees to be charged to drivers, implying that fees cannot vary with road conditions. Implementation of a dynamic pricing system would require updating the letter of the law.
Fee Variation by Vehicle Type
Because VKT fees include the cost of GHG emissions per kilometer traveled, fees may be differentiated by vehicle type.xvii Higher Euro standard vehicles may be charged lower fees per VKT, reflecting their lower GHG emissions.

Long-Term Considerations
To date, most municipalities have explored VKT fees as alternatives to excise taxes on fuel. VKT fees may play an increasingly important role as upward pressure on fuel standards erode fuel tax revenues.xviii As fuel efficiency improves, and electric vehicles proliferate, regions and municipalities will lose a crucial revenue stream, and will require another method by which they can influence the behavior of drivers.

Case Study
The State of Oregon’s OReGO Program
In 2015, the State of Oregon began a pilot program (OReGO) to explore the possibility of implementing a VKT fee as an alternative to excise taxes on fuel.1 OReGO, among the first VKT programs to target personal vehicles, uses GPS transponders plugged into each car’s data port to track distance driven and assess fees for drivers. The travel data collected is also displayed on a mobile application, so that participants may track their driving habits, fees owed, and gasoline rebates.1 Designed to be revenue neutral, OReGO charges drivers 1.5 cents per mile driven, and gives drivers a $0.30 per gallon rebate for gasoline purchased.1 The program, currently in progress, should yield interesting results on the behavioral impact of such a fee and elucidate challenges to wider implementation. Though Oregon is focused on a VKT fee as an alternative to fuel taxes, a program very similar to OReGO could be implemented to change the behavior of drivers in Lombardia.
Recommendation 4
Expand Area C.

In conjunction with a VKT fee, the City of Milan should consider the expansion of Area C as a method for further reducing congestion within the city. The possibility of extending Area C to the second circle road exists within the SUMP for Milan.\textsuperscript{xx} Currently, it is unclear whether the expansion of Area C would be beneficial if undertaken alone.

Governance Considerations
Expanding Area C falls under the authority of the Milan City Council and the Zona a Traffico Limitato. These institutions, as well as the Milan Agency for Mobility and Territory, would conduct a cost-benefit analysis on the expansion of Area C. The analysis could consider the impact of expansion with and without a VKT fee. The transition from Ecopass to Area C was possible with the support of citizens using a bottom-up referendum process.

Theoretically, the expansion of Area C could include adding an additional ring with different price points associated with the ring boundaries. Under this scenario, the inner ring would have higher prices and the outer ring lower prices. There are several implications associated with this expansion. First, it could induce drivers to park between the two rings and walk into the city center. Second, having a double ring instead of a single ring would help encourage drivers to not take additional trips once they have crossed the outer ring. One negative impact that should be considered is the possibility of increased congestion between the two rings.

Policy Considerations: Lessons from London

Several lessons can be taken from the London congestion charge and it can serve as an example for the City of Milan. The congestion charge in London began in 2003 and there have been a few modifications since then. One major alteration is the extension of the zone to the west. In 2004 a revision of the extension zone was sent to public consultation and in 2007 the zone was extended.\textsuperscript{1} There was a fair amount of opposition from the public and stakeholders for the extension of the zone and their opposition depended on how the congestion charge would affect them individually.

Although, the London congestion charge achieved the goal of reducing the number of vehicles entering the zone, the benefits from the extension zone were generally lower than the original zone because residents in the extension zone paid a discounted rate of 90 percent.\textsuperscript{1} Since residents within the extension zone were charged a lower rate, there was not enough incentive to lessen the amount of trips. One inefficiency from the London congestion charge is that the fixed daily fee for driving within the zone does not depend on driving time or distance, therefore the drivers do not have incentive to limit their driving once they entered.\textsuperscript{1}
Recommendation 5
Employ various Active Transportation and Demand Management (ATDM) strategies to mitigate congestion.

ATDM is an innovative approach to optimizing the performance of the entire trip-chain, from travel demand to traffic flow, through the use and communication of real-time data to travelers. The main objectives are to maximize the capacity, efficiency, and effectiveness of the existing transportation network’s infrastructure. While Milan may deploy a single ATDM approach to meet a specific objective, it is recommended that the city implement multiple strategies in tandem to reap benefits across the entire transportation network. Implementing these strategies requires the cooperation of multiple agencies and a shift in primary focus from constructing and expanding upon infrastructure to managing what exists.

ATDM covers the entire trip-chain a driver may take, from when to depart, which route to take, and where to park. It consists of three primary components: Active Demand Management (ADM), Active Traffic Management (ATM), and Active Parking Management (APM). ADM strategies are designed to redistribute travel demand by influencing drivers’ choices of mode, route, and time of travel. The intent of ATM is to actively control traffic using shoulder use, dynamic merging and metered ramping, and speed harmonization. Lastly, APM strategies, such as dynamic parking fees, influence the distribution and availability of parking throughout the city, and can be varied spatially.

Governance Considerations
In order to maximize the impact of ATDM strategies in curbing traffic congestion, it is crucial that the city’s centralized traffic control facility collect and utilize data on traffic conditions and incidents as they occur, adjust the specific ATDM strategies employed as needed, and then relay those responses back to travelers. For example, Athens’ Attiki Diadromes operates a traffic management center 24 hours a day, seven days a week for the Attiki Odos freeway that uses aforementioned technology, roadside telephones regularly spaced every 100 meters, and trained personnel at the facility and on the road who respond to incidents. Another Greek freeway, the Egnatia Odos, is managed by a traffic management center that employs a complex four-step incident management strategy consisting of incident detection, verification, response, and clearance. These types of central traffic control facilities are imperative in achieving effectiveness with ATDM strategies.

Policy Considerations
An essential aspect of active transportation and demand management is the need for real-time data on the times that people drive, traffic volumes and speeds, parking availability, and any possible incidents on the road. Collecting this information requires the deployment of various technologies throughout the transportation network that constantly collect this information and that can detect obstructions and pinpoint the specific location of incidents as they develop. Examples of these monitoring technologies include strategically placed CCTV cameras, pavement and microwave sensors, inductive loops, and telemetry software. Equally important
to the process of ATDM is technology that can relay appropriate information back to travelers, such as alternative routes, changes in lane designations and/or speed limits. Such technology usually consists of electronic dynamic messaging signs (DMS), web applications, or smart parking meters that can be automatically updated to provide real-time information regarding prevailing demand, traffic, and parking conditions.xxiv

Active Demand Management
Prominent examples of ADM strategies include:

- Dynamic Fare Reduction
- Dynamic Pricing
- Dynamic Ridesharing
- Dynamic Transit Capacity Assignment
- On-Demand Transit
- Predictive Traveler Information
- Transfer Connection Protectionxxv

While the specific strategies employed will depend on various factors, peak-hour avoidance incentives and predictive traveler information are to innovative and effective policies that should be considered.

Case Study: Peak Hour Avoidance
Netherlands

In the Netherlands, the Dutch Ministry of Transport, Public Works and Water Management experimented with peak hour avoidance incentives by providing financial subsidies of between two and seven Euros per day for travelers who avoided travelling at peak times.¹ License plate detectors were installed along predetermined routes to identify which cars were on the road during the peak period.¹ Initial results from Zoetermeer, Gouda, Moerdijk Brug, and Hollandse Brug areas suggest the incentives were effective in encouraging a 20-50% reduction in vehicle trips at peak travel times as a result of participants changing their departure time, switching routes, or shifting to another transport mode.¹

Due to the costs and nature of the program, peak avoidance incentives would be better served as a temporary strategy during short-term events, such as road construction or a large event, or as a complement to the VKT fee and existing Area C toll rather than as a standalone policy. Furthermore, coupling this program with public transportation incentives would further influence a modal shift.
Case Study: Predictive Traveler Information
San Francisco, United States

The San Francisco Bay Area traveler information service is the most comprehensive and well-used system in the United States with an average of 500,000 calls and 2 million web sessions a month as of 2007.¹ The Metropolitan Transportation Commission (MTC), in partnership with the California Highway Patrol and the California Department of Transportation, provides up-to-date information on traffic conditions, incidents and driving times, as well as schedule, route, and fare information for public transportation services through the “511” telephone dialing code. While it initially started off as a telephone service whereby travelers could call for transportation-related assistance, it has evolved to include dissemination of traffic information via a mobile-friendly website and broadcast media as well as rideshare guidance.¹

In a user survey conducted by MTC, 35-37% of participants said information they received from 511 caused them to change their travel plans: 5% delayed their trip, 20% changed their driving route, 9% altered their transit trip, 1% moved from car to transit and 1% from transit to car.¹

The implementation of a similar traveler information system in the City of Milan would require certain considerations. First, because the efficacy of the service is dependent on the quality and consistency of the data, it is vital for the different transit providers to communicate and make available information about incidents and service changes. Secondly, while this type of service would not be used by daily commuters, making the information available in multiple languages would benefit visitors new to the city and extend the reach and impact of the service.
Active Traffic Management
Prominent examples of ATM strategies include:

1. Shoulder Use
2. Speed Harmonization
3. Queue Warning
4. Dynamic Merge Control
5. Dynamic Rerouting
6. Truck Restrictions
7. Construction Site Management

Case Study: Shoulder Use
United Kingdom

The Highways Agency of England piloted a program that incorporated multiple active traffic management strategies on the M42 motorway in 2007, with a focus on temporary use of the shoulder as a travel lane during times of peak congestion. Inductive loop detectors, spaced every 100 meters, feed continuous information to a central traffic control agency, while additional information on traffic conditions and incidents are obtained through CCTV cameras with automatic plate-recognition capabilities. This information is used to determine when to open the shoulder to vehicular traffic. That decision is then relayed to travelers using overhead dynamic messaging signs (DMS) on gantries that display a dynamic speed limit as well as a brief description such as “Congestion -- use hard shoulder.”

The temporary shoulder use is only employed between exits, so that the shoulder operates as a weaving auxiliary lane. The striping pattern for the shoulder lane marking, a solid line, is the same as that for ordinary shoulders on British motorways that are not open to vehicular traffic. Rumble strips are diminished in intensity and raised pavement markers demarcate both sides of the shoulder lane to avoid surprising drivers who enter the shoulder. Additionally, emergency refuge areas are spaced every 500 meters along the motorway with pavement sensors able to detect incidents.

Ultimately, the combination of temporary shoulder use during peak travel times with speed harmonization and DMSs providing traveler information helped to reduce average trip time for drivers, increasing the throughput of traffic volume, travel time reliability, and the overall capacity of the roadway. Average travel time was reduced by 26% on the northbound side of the motorway and by 9% on the southbound side. Travel time reliability increased by 27% on northbound lanes and by 34% in southbound lanes. Additionally, emissions per vehicle were reduced during peak travel times and the environmental impact and added costs of expanding the motorway were avoided, saving an estimated £270 million.
Case Study: Dynamic Merging and Metered Ramping
Germany

Germany has been a leader in pioneering and implementing ATM strategies since the 1970s. More recently, Germany has been experimenting with junction control, another name for dynamic merging, that also involves metered and lane-controlled ramps. The German model involves installing control signals over lanes upstream of and adjacent to merges. Priority is then given to the source of higher-volume traffic, with lanes dropped as needed ahead of the merge.

Metered ramps were added as a part of junction control starting in 1999 in five pilot projects on Autobahn 40. The ramps relay congestion information to a traffic control center switching on static signs or DMS when traffic volume on the ramps exceeds 1,000 vehicles per hour. In the pilot project, congestion decreased by approximately 50% during peak travel periods, while traffic incidents at on-ramps decreased by 40 percent. Additionally, average vehicle speeds increased by 10 km/h during peak travel periods.
Active Parking Management
Dynamic parking management will help regulate and utilize parking facilities in the most effective manner. Parking technology and flexible pricing it will influence drivers to use different modes of transportation depending on the availability of parking. Dynamic parking management will help to control travel demand by creating a system that will indirectly decrease emissions at peak congestion times while promoting lower-emission, alternative modes of transportation. A collection of U.S. cities have created dynamic parking management systems that have thus far been successful.

Case Study: Real-Time Parking Management
San Francisco, United States

San Francisco has created a real-time parking management system called SFpark, a federally funded private project created in 2010. The program is designed to leave at least one available parking space per block within eight of San Francisco’s busiest locations. The system reduces the time individuals spend driving and looking for parking and lowers the risk of road blockages and accidents by ensuring that at least one parking space is always free near major destinations.

SFpark uses smart parking meters installed near each parking space that detect when the parking space is occupied. Drivers can check parking availability on the program’s website, its mobile application, or through text message. Based on the availability at their time of travel they can choose the best mode of transportation. Time limits can be extended remotely, making the process easier for drivers and preventing them from receiving parking tickets. SFpark has also partnered with city-owned parking garages that are near these meters so that rates can be adjusted in the garages when meter parking is busy so they can offer an attractive alternative. Parking rates are adjusted once a month based on demand and never increase more than 50 cents. Heavily populated parking areas will continue to increase until there is one space available most of the time while less populated areas will continue to decrease until most of the parking spaces fill or until they bottom out at 25 cents an hour. In San Francisco parking rates are determined by the time of day and availability of parking.

SFpark makes paying for and finding parking easier. SFpark was designed to help people plan ahead when making their travel plans. It also helps people to make informed decisions regarding optimal travel times and modes of transportation, prevents cars from double parking, and ultimately keeps the roads clearer and safer.
Recommendation 6
Extend Public Transit Infrastructure through RPO and public-private partnerships.

One of the most important variables essential to increasing business investment and attracting new companies is transportation accessibility. Within Milan’s city center, there are various modes of public transportation available; however, few extend beyond this demarcation, cutting short the area of economic activity. With a view towards increasing regional mobility, these transportation services should be extended, bringing increased financial gains across the Lombardia region. This regionalism manifests itself through public and private enterprises. In Toronto, Canada, a $50 billion 25-year regional transportation plan titled “The Big Move” is overseen by the regional transportation body, Metrolinx. This is supported by the “Places to Grow” policy enacted in 2005-06, which ties together political powers through focused land development, both within the urban center and suburban areas beyond. The focus on internal connectivity highlights the region’s dependence on logistics as an attraction factor for businesses and for decisions-makers in overcoming the usual antagonistic obstacles. This, in combination with the authority it has been empowered with has allowed Metrolinx to play a major role in planning across the Toronto region.

An example of this is the Viva BRT network established between the Toronto Regional Municipality of York and York Consortium. This is an example of the public-private partnerships needed to extend public services by allowing the municipality to maintain ownership and the ability to determine fares, while the operations are outsourced. This then gains the expertise of private corporations.

Another example of public transportation extension is the encouragement of building more bike infrastructures. Expanding bike infrastructure does not equal business losses; rather it can result in increased frequency of visits, with a greater total spent over time.

Much like the current operators of the railways—ATM, or bike-sharing companies like BikeMi, the expansion need not rest on the shoulders of individual municipalities alone. Instead, these actions can be undertaken through an agency like the RPO, which will foster these partnerships between the multiple municipalities and private investments. For example, in Portugal, extension of existing infrastructure led to an integrated ticketing system with a 65 percent increase in passengers.
Recommendation 7
Create temporary subsidies to encourage the use of the technological advances.

Milan and Lombardia could further reduce local air pollution and improve the average fuel economy of the personal vehicle fleet by subsidizing the purchasing of higher quality tires, brakes, and batteries. Temporary subsidies modeled after the United States’ Energy Star Program would encourage consumers to invest in these technologies.

The Energy Star Program
To better promote energy efficient appliances, the Italian government can follow the U.S. example of the Energy Star Rebate Program and formulate tailor-made legislations to achieve emission reductions. While the rebate program in the U.S. primarily aims at encouraging the use of efficient household appliances, the Italian government can carry out a rebate program specific for environmental-friendly car batteries, tires, and brakes. Direct EU funding, government tax breaks, and green bonds for energy efficient appliances will contribute to market proliferation of eco-friendly products.

The United States shifted the culture of its appliance manufacturers and their consumers through the United States Recovery and Reinvestment Act of 2009. The legislation invested roughly $300 million into a program that promoted rebates for the replacement of energy inefficient appliances to efficient Energy Star rated appliances. The Energy Star program requires that appliances meet a minimum energy efficiency rating to earn the Energy Star seal. As a result, a proliferation of energy efficient appliances emerged in the marketplace. The Energy Star Rebate program incentivized manufacturers through the potential of high sales volume. The seal was used as a branding tool to market to consumers these energy efficient appliances through various media platforms and create awareness of the Energy Star Rebate program.

The rebate program was successful because it specifically targeted residential customers and prohibited any upstream or mid-stream buydowns. Rebates were based on purchase and installation of Energy Star appliances and were as low as $20 and as high as $700. In 2010 there were a total of 689,000 rebates paid, representing $98 million in rebate funds spent. The total annual savings in pounds of CO₂ was 177,438,431.39

In addition, other sectors also benefited and were critical to the success of the program through matching costs, providing additional rebates, and recycling services for non-efficient units. Administered at the state level, programs were tailored to specific state needs. The Energy Star Rebate program was designed to be phased out once the funds had been exhausted.

The Italian government can achieve lower emissions by replicating this program in the automotive sector and through the use of eco-friendly car parts such as batteries, tires, and brakes as well as electric vehicles.xxxiv
**Batteries**

Many researchers have been critiquing whether the transformation from gaseous vehicles to hybrid and purely electric cars is effective due to the ecological impact hybrid and electric batteries.\textsuperscript{xxxvi} With new innovations being made constantly, the true analysis dwindles down to the marginal cost and benefit of these technologies.

While hybrid vehicles emit fewer emissions, they also produce their own type of pollution. Moreover, the decomposing process of hybrid batteries is slow and thus adds to pollution. Hybrid vehicle batteries are made primarily out of nickel which requires much more energy than the standard alkaline battery.\textsuperscript{xxxvi} The evolution of electric car development provides consumers with a more ecological and efficient alternative to their gas and hybrid counterparts.

Researchers at The Ohio State University performed a study where they observed the redox flow of a rechargeable lithium-oxygen (Li-O\textsubscript{2}) battery and developed a solar flow battery. Their proposed charging process improves the previous method by linking stored solar power to chemical energy via the electrolyte which allows the battery to recharge using less energy. The amount of energy used to recharge the battery is reduced to 2.9 volts compared to 3.6 volts in standard batteries. This technological advancement makes the aqueous solar flow battery better in terms of performance, cost-effectiveness, and eco-friendliness.\textsuperscript{xxxvii} This innovation paired with the development of a subsidy program can incentivize Milanese citizens to adopt the solar flow battery.\textsuperscript{xxxviii}

**Tires**

The U.S. EPA estimates that tires make up two percent of all municipal solid waste and on average, there are about 400,000 tons of tires thrown away each year in Italy and only half are recycled.\textsuperscript{xxxix} The County of Los Angeles serves as a successful example for tire recycling. There are waste-tire events in different areas of the county where residents can drop their waste-tires for free. Collected tires are then recycled and used for amenity construction to benefit the community.\textsuperscript{xl} If the Italian government can incorporate the idea and collaborate with environmental agencies and advanced tire disposal plants, environmental problems caused by waste-tires will be largely reduced.

Decreasing emissions from tire rubber and brake wear is necessary for local air pollution mitigation. In November 2012, a tire labeling system was created to rank pollution levels from Category A to Category G.\textsuperscript{xli} Through the labeling system, the EU aimed to raise consumer awareness and focus on the issues of fuel consumption, safety, and noise emissions. Tires from Category A to Category C are low-energy consumption products with optimal performance. Category A, the lowest level emitter, reduces fuel consumption by five to seven percent, but they are the most expensive. Because the higher performance tires are more costly, it is recommended that Milan offer subsidies to entice citizens to buy more expensive, but better performing tires.
High Performance Brakes
In urban environments, pollution emitted by tires and brakes is correlated to congestion. While environments with higher ambient temperatures are more likely to increase the occurrence of brake pollution, the brake wear and emission rates largely depend on the behavior of the driver, brake frequency, and severity of braking.\textsuperscript{xlii}

High performance brake systems provide advantages like stable and reliable coefficients of friction, braking efficiency, and appropriate operating temperatures which reduce the amount particulates emitted.\textsuperscript{xliii} Thus, high performance brakes with high quality materials and capacities should also be subsidized because their superior performance reduces pollution effects.\textsuperscript{xliv}

Recommendation 8
Incentivize LEED v4 certifications and partnerships with transportation sharing services.

Integration measures are necessary between green building and mobility for maximum efficiency. There is an opportunity for public-private partnerships between developers and real estate owners in Milan to invest in sustainable mobility. As a leader in urban greening, Milan should continue its urban greening efforts in conjunction with promoting energy efficient buildings. Part of this strategy will include promotion of the LEED v4 certification through the current and new tax subsidies.

The U.S. Green Building Council’s (USGBC) LEED v4 certification incorporates measures designed for sustainable mobility.\textsuperscript{xlv} The following sectors can receive location and transportation credits for implementing any of these measures: new construction, core and shell, schools, retail, data centers, warehouses and distribution centers, and hospitality.\textsuperscript{xlvi}

Some potential benefits include reduced vehicle use, enhanced walkability, increased bicycle storage near public transit and high traffic buildings.\textsuperscript{xlvi} While the GBC Italia is excited about the new LEED v4 rating and is actively promoting it, there are currently no projects in Milan with this rating.\textsuperscript{xlvii} Continuation of these tax credits should remain while a careful review and restructure of the application process would be beneficial.

It is important to collectively address local air pollution by turning to related mitigation techniques. There are several creative options to choose from when it comes to the integration of green building and sustainable mobility in the urban setting. Emphasizing the integration of

<table>
<thead>
<tr>
<th>LEED v4 Measures include:</th>
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<tr>
<td>● LEED for Neighborhood Development Location</td>
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<tr>
<td>● Surrounding Density and Diverse Uses</td>
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<tr>
<td>● Access to Quality Transit</td>
</tr>
<tr>
<td>● Bicycle Facilities</td>
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<tr>
<td>● Reduced Parking Footprint</td>
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<tr>
<td>● Green Vehicles</td>
</tr>
</tbody>
</table>

19
shared mobility options with green building practices is an effective strategy. More specifically, key partnerships between LEED certified buildings and mobility sharing services such as BikeMi, Enjoy, and Share’N Go, have the potential to build mutually beneficial relationships that would promote sustainable living space and sustainable mobility, as well as boost business in each of these markets.

**BikeMi and LEED Partnership**

In exchange for running ads on bikes for green living, retail space, and green university campuses, the LEED certified buildings may offer tenants, employees, and students free trial memberships to BikeMi or car sharing services, and ongoing discounts thereafter for creating accounts with the respective services. The same model has the potential to work with any sustainable mobility subscription service.

Naturally, the convenience of using these services will make them more appealing to customers. For example, the closer the BikeMi station is in proximity to the LEED certified building, the greater the chances it may be used by the resident, customer, or student. BikeMi currently does not permit the installation of stations inside private property since they cannot intermingle with the inventory at other public stations. However, if private funds are used, the city will allow the installation of stations just outside of LEED certified buildings on public property. If the building owner wanted to invest in the building’s exclusive system of shared bikes, they may do so, but they would not be able to dock the bikes throughout the city. Even so, this could be useful for those commuters who essentially only go to and from home to work or school, and back.

Furthermore, a LEED certified residential, commercial, or school campus building can also create preferred parking spots for those who are using car or bike sharing services. One variation of this may be the arc model for bike storage. These overarching bike racks, while vertical, are easy to use, allowing for quick docking and undocking. They also save street space, which can be utilized for car parking. The arc model would allow the citizens of Milan to retain their street parking, while creating space-saving bike storage all over the city, including residential, commercial, and university areas.
COMMUNICATION STRATEGY

Recommendation 9
Develop and implement a micro-targeted communications strategy to promote the use of modern mobility infrastructure by those who underutilize current services.

Identify Target Audience/ Messaging
It is fundamental for policy actors to frame or re-frame policies, particularly unpopular ones, in a manner that will resonate with the community’s pre-existing norms, values, and expectations. This requires a community outreach plan that goes beyond merely communicating the general policy and instead focuses on promoting specific, tangible benefits of the policy to a targeted audience in a simple, accessible way. Research has consistently shown that self-interests motivate decisions more than socioeconomic ones. This requires an outreach strategy that focuses on communicating the potential individual benefits in order to mitigate any potential individual losses, most notably through taxes or restrictions. The framing of policy options can therefore greatly impact the public’s perception of the potential benefits of change and, conversely, the costs of maintaining the status quo.

In presenting the calculus of a policy change to the public, there are several messaging options. The first is a shock campaign that attempts to promote behavioral change through the use of provocative or controversial images or messages. Studies have revealed that these campaigns tend to be most effective in instances where the public is unaware that a specific behavior is harmful.

A second tactic is a campaign that seeks to compel individuals or companies to change their behavior through public or private “shaming.” This approach has proven successful in campaigns targeting corporations that are forced to react to the specter of bad publicity; however, when shame campaigns have targeted individuals there has, at times, been an adverse reaction to, and a rejection of, the campaign’s message.

A third approach is one that promotes or reinforces good behavior rather than punishing bad behavior. By encouraging the desired behavior rather than stigmatizing the negative behavior, this strategy bears less risk of a psychological reaction to a message that can lead to policy resistance. Evaluations of several public health campaigns have shown this approach to be the most successful in contributing to positive, long-term behavioral changes.

Based on these general findings, the following section will present strategies to promote acceptance of pollution mitigation policies through a variety of public outreach methods.

Demographic
It is important to reiterate that each demographic group will require separate communication strategies catered to the specific needs of the group. Likewise, each of these demographic
groups may be targeted for specific policy recommendations, such as increased use of public transit or public support of the VKT.

The major target demographic is a geographic one - people living in the municipalities directly surrounding Milan must be encouraged to use more public transit. In order to reduce the overall air pollution of the Lombardia region, Milan needs to create effective communication strategies to reach those living outside of its boundaries in order to encourage public transit both into and around Milan.

Example Campaign
Milan Fashion Week

Milan Fashion Week presents a unique opportunity for the fashion industry of Milan to partner with public transit in order to bolster and to increase the use of the various forms of public transportation that Milan has to offer. By partnering with designers who are showcasing collections during the annual Milan Fashion Week, it would be possible to incorporate public transportation in a unique way, such as a runway walk at Milan Central Station. During this week, attendees coming from outside the city can be encouraged to use the various modes of public transit by highlighting the city’s diverse and dynamic range of services on the tickets and pamphlets for the various shows and events. The Spring 2016 Gucci fashion show was held at the Scalia Farini, a former train station in Milan. This is an example of how the fashion industry can utilize train stations and public transit spaces to bring public transportation into the mainstream conversation in Milan and the greater Lombardia.¹

The second target group is adults aged 45 to 64. While younger generations are already prioritizing public transportation instead of purchasing personal cars, the older generations are still relying on private vehicles. Culturally, adults in the Lombardia region continue to value and prioritize ownership and usage of motor vehicles. This behavior will need to be changed as Milan prioritizes local air pollution mitigation. Behavioral change through promotion of alternatives such as car-sharing or use of public transit will improve air quality in the region. Because Milan has an aging population with close to a third of the population between the ages of 45 and 64, this group must be targeted for behavior change associated with car use.⁴ Education and encouragement towards increased use of ride-sharing technology or use of public transportation will be most appropriate for this group.
Senior Citizens
Senior citizens should also be targeted to encourage use of public transit. In particular, senior citizens may not be aware of new public transportation options or they may be wary of using new ride-sharing technology. With 21.65% of the population of Milan aged 65 and older, this group’s utilization of public transportation would be very beneficial. Mass transit will provide elderly populations the independence and self-reliance needed to navigate the Lombardia region. Targeted education and additional support through family-oriented meetups or pairing senior citizens with youth volunteers will improve the understanding of new transportation technologies and options.

Example Campaign
Promotion through Art

A fund can be made available to promote collaboration between local artists, art galleries, art institutes, and public transportation in order to create an environment of vibrancy, community, and stimulation on the metros, tramways, and buses. This unique utilization of the spaces of public transportation can draw attention to them in positive ways and encourage their use by way of special attraction.

Example Campaign
Senior Citizen Technology and Smartphone Application Outreach

Establish a social and educational program for the elderly population that resides outside of Milan city center in order to equip them with the training and ability to navigate the various public transportation, ride-sharing, and car-sharing options. This proposal recommends developing outreach programs in partnership with local community-based organizations that work with senior citizens and middle-aged populations in order to improve technological literacy. Such partnerships may even exist in the form of students from local schools who can host workshops for seniors. This program would contribute to creating an engaged and technologically equipped community that can eschew private car ownership in favor of public transportation options.
Modes of Communication
An implementation strategy that takes advantage of a variety of communication platforms is highly recommended. These modes of communication include traditional and unique methods of information transmission. Each can be separate or complementary, although some are more suited for particular audiences or particular messaging.

- **Traditional** - Traditional messaging using radio advertisements or billboards along the major driving routes into Milan will target people who live outside Milan, but who work or travel to Milan frequently by car. This group will most likely consist of adult populations who commute for work or on weekend social occasions.
- **Non-Traditional** - Non-traditional messaging includes utilization of alternative mediums to change public opinion or excitement around public transport, such as special events or social-life highlights created in tandem with public transportation. This messaging is meant to raise the use of public transportation in the public mind as fun, innovative, and a social experience. Providing small funding opportunities for local artists to showcase their art on tramways or public buses is one such idea.
- **Educational** - Educational messaging will promote workshops, special events, or formal information to teach people to use new technology linked to public transportation. In particular, the demographic groups we suggest targeting may need extra encouragement and clarification about mobile device application use, or new forms of transport such as ride-sharing.
- **Web and Social Media** - Web and social media is one of the fastest peer-to-peer sources to outreach to people are social media platforms and web search engine use. Social media platforms can be used as informative tools with no feedback or can be used for specific campaigns including microtargeting by age, geographical location, political affiliation, education, etc.
- **Smartphone applications** - The consulting firm Deloitte recently conducted a survey on global mobile consumerism and reported that 58 percent of Italians aged 65 and older owned smartphones, with an additional 28 percent planning to purchase a smartphone in the next 12 months. As an aging population becomes more familiar with smartphone technology, the need to provide apps specific to their level of familiarity and capability is paramount in increasing the rate at which they leverage apps to find and use public transportation.
- **Microtargeting** - Microtargeting campaigns often target very localized geographic areas or groups, such as particular neighborhoods with high levels of car use. Microtargeting campaigns can be effective but it essential they are done correctly or they can have adverse effects such as if used as a shaming, pressure or coercive tool. Relevant to Milan and the Lombardia region and its sustainability through mobility and pollution reduction, effective letter writing campaigns can be implemented through microtargeting. Characteristics of a letter writing campaign should include: plain language (research has shown that people react better to plain language that is informative but concise), a call to action, and preferably a contact back source. See Appendix A for proposed microtargeting letter writing campaigns for Milan.
Metrics
An outreach campaign should be determined with specific objectives and outcomes to be attained at the conclusion of each campaign. For example:

- To increase ridership among seniors or persons over age 60
- To increase ridership among persons of age x, in a specified area in Lombardia
- To increase awareness and ridership among persons with disabilities

In any event, all campaigns, however macro or micro, need an initial assessment before commencing. This step is meant to identify effectiveness at the conclusion of each campaign and whether goals were met through key performance indicators (KPIs). Metrics should include pre and post campaign reports including data.

Measuring the success of a public outreach campaign is integral for accountability of the public’s trust, and to measure return on investment (ROI) of the public’s money. Depending on the type of campaign, tools available to track success of an outreach/advertising campaign can be used, for example:

<table>
<thead>
<tr>
<th>Campaign Type</th>
<th>Description</th>
<th>Measuring Tool</th>
</tr>
</thead>
<tbody>
<tr>
<td>Incentivised Response Required/Call to action</td>
<td>Accessible viewing/tracking tool available to stakeholders</td>
<td>Coupon, discounts, point-based-earnings</td>
</tr>
<tr>
<td>Print ads</td>
<td>Print advertising, letters or handouts</td>
<td>QR code, designated call to tel number,</td>
</tr>
<tr>
<td>Web based platform</td>
<td>Measure before and after users or subscribers</td>
<td>Advanced bitly embedded links or similar tools$^x$</td>
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CONCLUSION

While Milan has implemented policies that have effectively reduced congestion and air pollution within the city, existing environmental and mobility policies in Milan are geographically narrow and fail to reduce emissions in the overall Po Valley region. The different levels of governance and wide range of stakeholders provide a unique opportunity for Milan to lead the way in creating policy solutions that reduce emissions and congestion, while promoting sustainable development and mobility. It is important for Lombardia to create an RPO responsible for sustainable planning within the region, and eventually additional RPOs throughout Po Valley. Coalition building across local agencies in Milan, as well as regional planning authorities will help align regional, provincial, and federal policies and create cohesion across interest groups. Mobility, congestion, and air pollution issues require constant and immediate policy solutions that a permanent, collaborative RPO framework would help facilitate.

Short-term and long-term policy recommendations include a VKT fee, an expansion of Area C, the implementation of active transportation and demand management, changes in infrastructure, integration of new technology and green building measures. These strategies require targeted communication campaigns to help promote effective changes within the city and outside regions.

The importance of public support and input for these measures should not go understated. Involving key stakeholders in the decision-making process can give policymakers greater ability in designing successful implementation strategies. These policies and recommendations will be fundamental in tackling issues of air pollution and mobility in Milan and Po Valley.
AUTHORS

Adler, Kaitlyn
Baron, Kevin
Butts, Kristin
Cudd, Robert
Evans-Goldstein, Anna
Flood, Colette
Garcia, Angelica
Gomez, Cristina
Gong, Chengcheng (Abby)
Hong, Jenny
Hu, Yanran
Lele, Safa
Lindberg, Tyler
Mayilyan, Ani
Mendoza, Sandra
Park, Diane
Silva, Susannah
Syed, Omair
Schafer, Bret
Thomas, Jared
Ungureit, Sarah
Vasquez, Shelbie
Volkmann, Abby
Weaver, Jamaul
Yao, Mengjia
ACKNOWLEDGEMENTS
Special thanks to our colleagues at Bocconi University: Francesca Casalini, Niccolo Cusumano, and Veronica Vecchi for the robust schedule of expert presentations and for their gracious hospitality.

A very special thanks to Dr. Antonio Bento for his leadership, enthusiasm, and guidance during the research and formation of this report.
APPENDIX A

Active Demand Management Strategies:

Dynamic Fare Reduction
Dynamic Fare Reduction involves reducing fare for public transit in a particularly congested corridor. The fare would be adjusted based on real-time data and historic congestions levels. The goal is to encourage a modal shift to reduce traffic volume.

Dynamic Pricing
Dynamic Pricing entails varying the tolls in response to differing congestion levels. This would

Dynamic Ridesharing
Dynamic Ridesharing utilizes advanced technology, such as smartphones and social networks, to find an rideshare space on short notice. Dynamic carpooling allows for more flexibility while still reducing the amount of vehicles on the road.

Dynamic Transit Capacity Assignment
Dynamic Transit Capacity Assignment uses real-time demand patterns to reorganize transit schedules to over the most crowded sections of the network. It can also help predict changes needed to the transit operations to make it more effective.

On-Demand Transit
On-demand transit allows transit riders to make real-time requests for services based on their individual needs. To be effective, the transit system would need to have flexible routes and schedules.

Predictive Traveler Information
Predictive traveler information employs real-time and historic data to predict travel conditions and disseminate that information to travelers before and during their trip. Incorporating it into a variety of other traveler information mechanisms (e.g., 511 systems, dynamic message signs, and trip planning systems) would be most effective.

Transfer Connection Protection
Transfer Connection Protection ensures reliability of the transit system for transfers by linking the arrival time of one transit system to the departure of another. For example, either holding the bus or providing an additional bus service for a train that is running late to ensure that travelers do not miss their transfer.

Active Traffic Management Strategies:
Shoulder Use
Shoulder use is a tactic that involves expanding roadway capacity during times of heavy traffic flow by temporarily allowing vehicles to drive on the road shoulder as if it were an ordinary lane of travel. Both the left and right shoulders can be opened to vehicle traffic, though it is generally discouraged for both shoulders to be opened concurrently, so that space may be left for
managing vehicle breakdowns and to accommodate emergency vehicles. Shoulder use may be opened for all vehicles, or shoulders may be opened only for transit vehicles, such as buses. Transit-only shoulder use allows for more reliable transit schedules during times of peak traffic congestion without drastically altering existing infrastructure, and the same measure can also be applied to parking lanes on major roads that are not limited-access freeways.

Generally, decisions to open shoulder use to travel are triggered when data collection systems detect that traffic volume has increased and/or speed has decreased to a certain threshold. These decisions are relayed to the public using dynamic messaging signs that operate on gantries over the roadway and indicate when the shoulder is closed or open to travel as well as where shoulder use is approaching an endpoint and drivers should prepare to leave the shoulder. Additionally, when operating shoulder use for vehicles, it is important to assess that the pavement has sufficient strength to accommodate heavy vehicle traffic.

**Speed Harmonization**
Speed harmonization, alternatively known as variable or dynamic speed limits, is when speed limits are automatically adjusted in response to data indicating that set congestion thresholds have been reached and that queue formation is imminent. The goal of speed harmonization is to reach a homogenous traffic speed and maintain a steady flow of vehicles for as long as possible to avoid breakdown as well as to avoid incidents from emergency braking. Speed harmonization can be employed during incidents of weather-related congestion or during typical, recurrent traffic congestion.

Changes in speed limits can be communicated to drivers using dynamic messaging signs placed on overhead gantries. To ensure compliance with changing speed limits, it is important that communication with the public occur effectively and that the reasons behind the changes in speed limits are apparent.

**Queue Warning**
Queue warning simply involves alerting drivers to the formation of traffic queues upstream on the roadway using dynamic messaging signs and flashing lights placed on overhead gantries. This strategy allows drivers to anticipate braking and lowers the amount of erratic driver behavior and collisions. Queue warning systems work best when used in combination with other strategies and when the signage used is left blank during times of ordinary traffic flow so that they are more likely to be noticed.

**Dynamic Merge Control**
Dynamic merge control, alternatively referred to as dynamic junction control and similar to ramp metering, involves dynamically metering or closing specific lanes upstream of an interchange or highly-used access point on the freeway to manage access-based demand on the system. Dynamic merge control is utilized when the sum of traffic on general purpose lanes and merging lanes is higher than what downstream lanes can accommodate. Static solutions for dynamic merge control involve dropping an outside lane of travel or merging two inside lanes together to accommodate access-based traffic demand.
In order to work effectively, dynamic merge control must be carefully executed and accompanied by appropriate signaling and signage that gives drivers advance notice of lane shifts, closures, and upcoming freeway access points. Additionally, shoulder use can be used in tandem with dynamic merge control to increase roadway capacity, or, shoulder and/or closed lanes can be designated for emergency vehicle use only.
## Proposed Micro-targeting Approach to Letter Writing Campaigns

<table>
<thead>
<tr>
<th>Letter type</th>
<th>Purpose</th>
<th>Message Description</th>
<th>Geographical area</th>
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</table>
| Neighbor-to-neighbor       | Community leader peer pressure with positive message | This is your neighbor, this month x many of us rode the train helping reduce x pounds of pollution…  
  - can further elaborate on scientific meaning  
  - use plain language  
  - will you join us?  
  - to find out the most convenient public transport travel, call us! | Hot spot areas with high traffic coming into Milan                                                                                                                                                 |
| Elected official to constituent | Informative                                    | This is your representative, this month x many residents in your neighborhood helped reduce pollution by using public transport.  
  Give data in plain language or infographics\(^\text{\textsuperscript{xii}}\) | Suburb area that uses public transport most                                                                                           |
| Environmental NGO to constituent | Thank you                                     | This month x many people in your area helped reduce x many pounds of pollution.  
  Use infographic to depict health, environmental, use of public transport positive effect.  
  Call to action - help further reduction by x many pounds or by a certain date. | Suburb area that uses public transport least                                                                                              |
| Transportation authority to constituent | Thank you                                     | Because of people in your neighborhood who use public transportation (days of the week, hours, etc.), they helped reduce pollution - emphasize positive effect on health, environment, traffic congestion, etc. | Wider suburbs(s) area(s) highlighting service frequency and options of transport  
  Highlight other benefits to riding the train (reading, listening to music, rest not stress, etc.)}
RESOURCES

1. Milanes plan for sustainable, efficient and innovative mobility (Italy). (2015, August 28).
2. Ibid.
3. Ibid.
10. Euro 0 and Euro 3 are defined under European emissions standards, which describe acceptable limits of vehicle exhaust for cars sold in the EU.
11. Oblique View, Air Pollution in Po River Valley, Italy. (n.d.).
22. Ibid.
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