Integration and analysis of data across mixed-density suburban communities: lessons learned from a case study in Pittsburgh

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Abstract

Dormont and Mount Lebanon are two adjacent and critical municipalities in the southern suburbs of Pittsburgh, which happen to share parking, transit, traffic signaling, and congestion management challenges across a shared Business Rt 19 corridor.

This project sought to work collaboratively with them over time to develop innovative solutions in a shared corridor, with an initial focus on parking data analysis and management. The outcomes of this project were not achieved, and this report largely discusses reasons for this result, and discusses lessons learned from the project to help other municipalities to better prepare them for future project success.

Overview of Municipalities and Project Goals

Dormont and Mount Lebanon are adjacent municipalities in the southern suburbs of Pittsburgh. They comprise a significant portion of domiciled commuters to the city, but also share portions of a key commuting corridor to downtown - business US Rt. 19 (aka West Liberty Avenue / Washington Rd) - that is used by many residents in the south hills. Business Rt. 19 spans approximately one mile across the two communities, and following its name, is owned by the state of Pennsylvania, thus decisions on its management are made by the Pennsylvania Department of Transportation (PennDOT).

The two municipalities also have geographic and demographic profiles that are promising for such a project. Business Rt. 19 bisects each community, and Dormont has density on par with downtown - with about 9,000 residents in 0.7 square miles. Mount Lebanon is much larger and has a density similar to Dormont on the adjacent end but is more suburban as Business Rt. 19 progresses towards the south. In both communities, Business 19 forms the core central business district of the community. Table 1 summarizes key statistics of the two neighborhoods and Figure 1 shows a map of the Rt 19 corridor of this project which also shows transit links as well as helps to show their comparative densities. Of note is the proximity of the Port Authority trolley ("T") line that crosses under Business Rt 19 as well as three T stations within 2 blocks of the path of the road.

	Dormont	**Mount Lebanon**
Area (square miles)	0.76	6
Est. Population (2018)	8,319	32,124
Median family income	$52,000	$80,000

Table 1: Summary of Municipal Statistics (Source: Wikipedia)

This one-mile stretch has approximately 20 signalized intersections, and varies from one-lane bidirectional traffic with shoulder parking on both sides to two-lane bidirectional traffic. Parking in both communities is at a premium during various times of the day, leading to additional traffic problems for both residents as well as visitors. The two communities at the time of the initial project start used different vendors for parking payment and data collection services (i.e., Cale, MeterFeeder and Streetline). They also have different technologies and vendors for their existing signal management efforts. This diversity of data and technology vendors was an interesting and intriguing motivation for the project.

The Business Rt 19 corridor is highly congested during morning and afternoon rush hours, which also disrupts the efficiency and patronage of local businesses. There is relatively high use of public transit (20-30% in the two communities), of which there are 5 existing "T" light rail stations near or along Rt. 19. The presence of this existing infrastructure creates compelling reasons for data-driven analysis in this corridor.

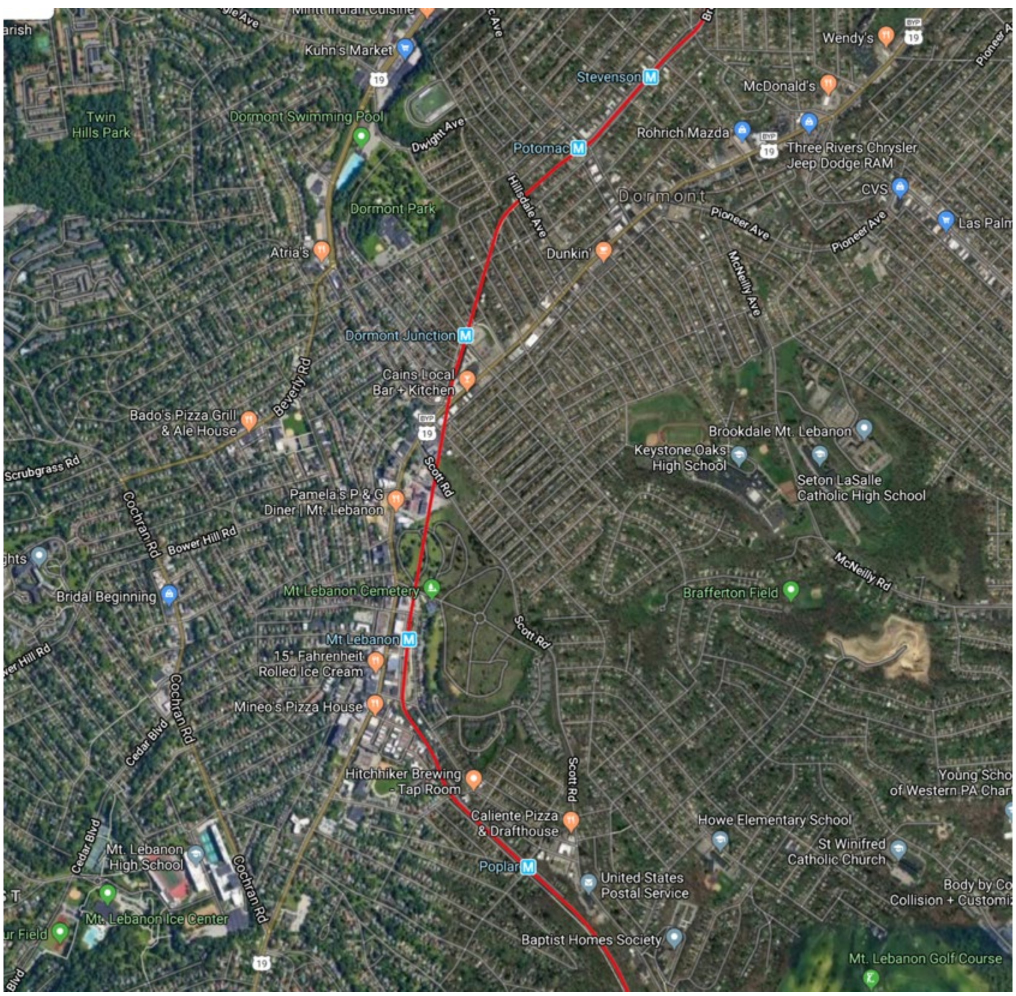

Figure 1: The US Rt. 19 corridor through Dormont and Mount Lebanon in the southern suburban are of Pittsburgh (source: Google maps)

A final justification for the social aspects of this project is that both Dormont and Mt. Lebanon, given their history and size, are walking communities. Many school students in Dormont walk to elementary schools, and all students in Mt. Lebanon from K-12 walk to school (no bus service is provided) with most of the schools located on or very close to the corridor. Beyond adding to the “walking community” aspect, this means that any changes to the transportation system in this corridor must ensure that public safety is maintained, i.e., that vehicular speeds are not increased as a result of increasing efficiency.

Figures 2 and 3 are still shots from google streetview video that are intended to show the diversity of the corridor. Figure 2 is close to the northernmost point of the Business Rt 19 corridor in Dormont, and shows a business district with some onstreet parking lanes and 2-4 vehicular lanes of traffic (depending on time of the day and parking usage). Figure 3 shows the southernmost point of the corridor of interest, as it is exiting the Mount Lebanon business district and becoming a 4-lane highway through suburban neighborhoods and acting as a connector to other southern suburbs in Pittsburgh.

Figure 2: Business Rt 19 in mid-day through Dormont (note no cars parked in either curb lane). Source: google streetview

Figure 3: Business Rt 19 in mid-day through Mount Lebanon
(note cars parked in southbound curb lane, a middle school on the left, and end of commercial district in the distance). Source: google streetview

Overall, the Business Rt 19 corridor represents an excellent testbed for data-driven studies on mobility. With the two municipalities being very interested in smart mobility projects, there are many opportunities to have an impact and to spread the message to other interested partners in the area.

Initial Project Plan

Initially, we envisioned a smart mobility challenge (SMC) project as a first step in a longer-term collaboration between CMU and the two municipalities to address parking, traffic signals, transit, and other aspects that could have revolutionary effects on managing the Business Rt. 19 corridor and that could be leveraged to other municipal corridors. We decided to begin with parking.

We chose this because there was a diversity of parking technologies and data providers involved, and each municipality said they were able to access multiple years of historical data on parking usage. We sought to create a web-based tool that could be used by residents of or visitors to Dormont and Mt. Lebanon to be able to access aggregations of historical parking data which would be useful in making decisions about parking locations for different times of days and/or days of the week. When real-time parking data can be shared, a web-based tool can incorporate algorithms to make real-time parking occupancy predictions and thus make real-time recommendations of parking locations for local residents or visitors. In some cases, there was similar summary data available. However, a novelty of this project was to be the fusion of the disparate data sources so that all available parking in both municipalities were provided to travelers along Rt 19. For example, since the two communities are both situated along the busy Business Rt 19 corridor, someone looking to park near a business at the border of the two communities would likely be interested in historical parking information for both communities. This would mean likely availability as well as pricing (which is not the same in both communities). It was likely that users would find nearby parking in the other municipality recommended to them that also happened to be cheaper than in their original location. This information was to be visualized and represented in various useful ways via smartphone app or other systems.

Generally, though, the system would be able to predict or identify available spots, even if the parking exists "across the municipal boundary". We also planned to perform detailed analyses of parking supply and demand to estimate whether increases or decreases of parking rates during peak or off-peak times might lead to better utilization and/or increased revenue to the municipalities. This may also include "jump rates" where the first N minutes are at a certain rate, but increase as vehicles remain in the same spots (to dissuade drivers from staying for long periods).

To accomplish these goals, we planned to leverage and improve upon an existing web-based parking information system that visualizes parking availability and predicts availability, as we believe this will be the most suitable initial solution for a project aimed to be realized within one year. We would also perform data analytics on historical data for the economic and finance aspects of the project.

The Reality and Lessons Learned of the Initial Plan

While the goal of the initial plan was straightforward (and similar to past work done by CMU's Mobility Data Analytics Center for other clients such as the City of Pittsburgh), the parking data available ended up being substantially different than originally planned. Despite various approaches from both the project faculty as well as the municipalities, neither of Dormont's parking services vendors (i.e., Cale and MeterFeeder) were able to provide any data over the first year of the project.

Similarly, while Mount Lebanon was able to access past data from Streetline, it was very aggregate compared to what would be needed for the type of predictive application envisioned in the original project. As an example, the most detailed data available from the Streetline system was hourly totals for an entire segment that spans a few long blocks.

Without any MeterFeeder data, more time-resolved Streetline data as well as for particular spaces, as well as without any data for Dormont, the initially envisioned project was not possible to achieve.

An Alternative Project

After the issues with the initial project plan, we began discussions of a suitable alternative project with the two municipalities that would keep the team intact but with a different focus. After some discussion, we settled on a timely project related to PennDOT's 2018 announcement that it would undertake re-signalization work in the Dormont Rt 19 corridor. This project would mirror a recently completed project along Rt 19 in Mount Lebanon. In 2017, PennDOT upgraded the signals at most of the intersections along the Rt 19 corridor, updating them to new technology and also adjusting the signal timings, and in some cases restriping the intersection markings and crosswalks. The main goal of PennDOT's investment in the corridor was to further improve mobility – but with a focus on moving vehicles through more quickly. However, various parties in Mount Lebanon have claimed that safety seems to have been compromised in terms of pedestrian and bicycle activity in the corridor.

For an alternative project, our high-level goal was to try to consider how to best position Dormont's stakeholder interests in advance of PennDOT's subsequent investment in re-timing signals and changing intersections, using the same types of inputs and designs as they did in the Mount Lebanon project. This would try to ensure resident, customer, and pedestrian mobility would not be compromised in favor of improving throughput. This perspective was adopted because while Mount Lebanon was generally pleased with the outcome of their re-signalization project, there were some residual concerns in the community that vehicles had been given undesirable priority over pedestrians and non-motorized vehicles that are prevalent (i.e., it is a walking community as noted above). We sought to ensure that the same types of effects might be avoided in the case of the Dormont component of the project.

The project would require input of data from various sources and types into a software model to be calibrated against the Mount Lebanon case and then consider the same inputs to reasonably estimate effects in Dormont. The types of data flows needed for such a project include:

- Time series data (including before and after project):
    - Traffic Counts
    - Turning Movements
    - Signal timing for all legs of intersections
    - Pedestrian Counts
    - Locations of pedestrian crossings

- Past and proposed intersection layout and geometry
- Proposed signal timing plans for Dormont

We reached out to potential agency or industry sources of data, including the municipalities themselves as well as the local owning PennDOT district office. The municipalities did not own any copies of the input or output from previous PennDOT (or consultant) studies. Likewise, we were unable to receive permission to access the required information from PennDOT (who did the projects). Fortunately, we were able to acquire the requisite data and information from the Southwestern Pennsylvania Commission (SPC), a regional transportation coordination agency interested in overall mobility in a multi-county region that had previously received the information from PennDOT.

The files provided by SPC were for the "Synchro" software tool from Trafficware that has been used by PennDOT for many years to consider issues such as signal timing for the connected system along Business Rt 19 in Mount Lebanon and that would be used again in Dormont. The files provided by SPC had been created by PennDOT between 2002 and 2008. We sought to use the information to study how alternative signal timings and design might be done to better protect pedestrian and non-vehicular traffic flows. Figure 4 shows the type of analysis available in software tools such as Synchro, where the geometry of an intersection is first designed, and available data on traffic signal timings, flow rates, etc., are available and mathematical models are built behind the scenes to estimate how well the provided volumes would flow through the network. Such software also allows "what if" type analyses to consider whether changes in the design of individual timings or intersection designs would affect the overall throughput of the network. This creates the possibility to experiment with multiple options for individual intersections, for example to create different geometries or signal timings for pedestrians.

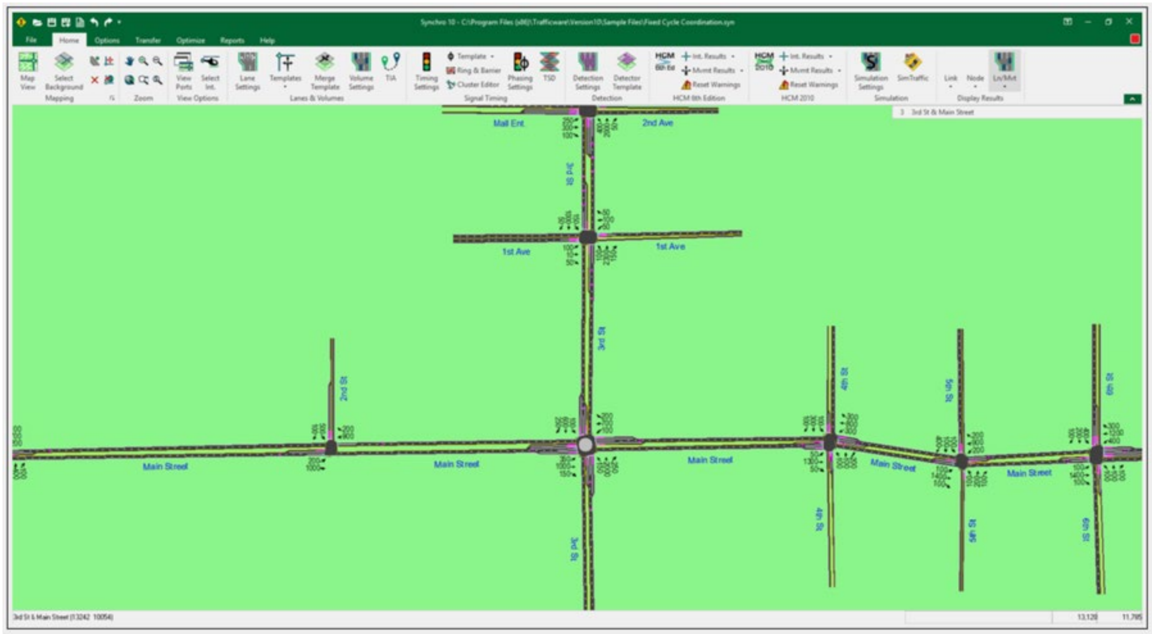

Figure 4: Screenshot of Traffic Signal Simulation Software like Synchro
(Source: https://www.trafficware.com/blog/synchro-10-features9657564)

Plan B Project

While the Synchro files were received from SPC, they were from a Windows XP version of Synchro that is no longer supported and not available for download. In working with colleagues at Trafficware it was deemed that PennDOT has used the software about ten years ago with a no-longer supported version of the project (and also that many of the traffic volumes and signal timings had been further changed between the time of the creation of the Synchro models and the time of the re-signaling project). Information could be extracted from the Synchro files, but overall, using them would require more time than would be worth the effort to subsequently update and change them to the timings relevant right before the project (and, as noted above, those data were not able to be located).

More importantly, the proposed signal timing plan and the respective design changes to those relevant intersections were unavailable. The team could speculate some possible changes, but the assessment of safety and mobility implications are likely to be overwhelmingly dictated by the proposal. Since both PennDOT and the local municipality had little information regarding the strategies and plans, it would be challenging to provide practically realistic implications.

In the end, it was deemed too difficult to leverage PennDOT's Synchro data for further analysis in the project, and no additional modeling was possible. This meant that we had hit a dead end on trying to partner with the communities on a Smart Mobility Challenge (SMC) project.

Lessons Learned

As we do not have a tangible product to show at the end of the project, we agreed that a useful output of the project would be to discuss lessons learned in attempting this project so as to help frame expectations and scopes for future projects.

Overall, this project taught and reinforced several key concepts related to the challenges faced by municipalities trying to improve mobility.

1) Who owns the mobility data for a municipality and how easily is it accessed?

When it comes to data from third-party contracted services such as kiosk or smartphone-oriented technology providers, municipalities should be aware of their rights to access data from their activities and at what resolution.

In this project, not only was data not easily available (and there were no mechanisms in place to automate or make the data directly accessible), but the data that had previously been made available was useful and appropriate for the usual needs of a municipality, but not so useful for a data-driven modeling exercise.

2) Is the data resolution appropriate for the envisioned project?

In this project, a municipality had access to low-resolution data on parking utilization at the block level. However, armed with only this high-level overview of the use of parking, only limited insights are able to be gleaned from the data.

3) Does the relevant stakeholder have prior strategies to the change in design, operation or planning of systems?

In this case, both municipalities had interests in understanding the performance of near-future transportation systems, but connecting these to research questions and data or model access was very challenging. Having engineering consultants to help municipalities provide those specific guidelines and strategies may be able to help and mitigate the potential risk of SMC projects.