Transportation Analytics
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Transportation—the effective movement of people and things—has long been critical to economies and qualities of life worldwide. Inefficiencies cost money, increase pollution-causing emissions and take time away from people’s lives. The problem is, the supply of transportation infrastructure grows more slowly than demand. Cars can be built more quickly than roads. Cities grow faster than highways can be expanded. Even if there were a limitless supply of money and personnel for road construction, many areas are already built out. That is why the transportation industry is turning to business analytics to find smarter ways to use the resources that exist, reduce congestion, and improve the travel experience. Just think of how monumental the impact would be if every person could get where he or she needed to go, or find a parking spot, five minutes faster each day.

Clearly, organizations that put to use their existing data are the ones that can uncover new ways to operate more efficiently and sustainably, and improve the quality of life for the people they serve.

Understanding the Trends

The transportation industry is no newcomer to the world of business analytics or the collection of data, but, until recently, the data sources were not connected. Transit executives could determine how many people took a bus or train on any given day, but didn’t know anything about the individual rider. Was this a regular route? Did he or she also drive a car on occasion? They didn’t have access to this type of information that could help improve route design or increase ridership levels. Each form of transportation operated within a standalone system, which made it difficult to achieve a big picture view.

In recent years, many cities have moved toward a multi-modal system, which enables seamless travel between each of the various transportation modes, including bus, train, bicycle, and motor vehicle. In addition, the use of new transportation modes, like car and bicycle sharing, is growing steadily. As new, improved payment systems reduce the friction between transportation modes, this adoption will continue to increase. They are taking a more connected view of the different ways people get from place-to-place, so each mode can fill an optimal role in the overall transportation system.

Such multi-modality requires comprehensive data collection. As more pieces of a transportation system are integrated, and new, unstructured data sources, like cameras, car sensors, and in-vehicle GPS and geo-location technology become readily available.

Transportation analytics will need to cover this diverse data ecosystem in order to release the potential of multimodal transportation systems.

The consumerization of technology has also had a massive impact on the transportation industry. Smartphones—and their companion data plans—are now available and affordable for nearly every person on every socio-economic level. The phones, themselves, become information sources and vehicles for pushing out messages on scheduling and mass transit arrival times, or as electronic wallets for payment.

More importantly, mobile computing and personal communication devices generate tons of consumer data in near real time—on where individuals are, where they’re going and how they feel about the experience. When mined, this data enables agencies to provide better, more targeted services that reduce costs by making better use of the available infrastructure.

Finally, concern for the future of the environment has put the spotlight on energy conservation and pollution control. By using analytical data to understand driver behavior, agencies can find creative ways to persuade drivers to take public transportation or to reduce roadway and parking lot congestion; protecting the environment while offering more convenience to their customers.
Clearly, analytics has moved from the backroom to the forefront of the transportation industry, providing real-time forecasting methodologies, consumer insight and a means for seamless, sustainable mobility. The data is there. The challenge is using it effectively.

**Open payment opens new opportunities for data mining.**

Transit agencies in the U.S. have a dilemma: budgets are tight, and because their “job” is to provide an affordable way for people to get from place to place, they’re limited as to how much they can charge for fares. So, the agencies never really bring in enough fare revenue to run their operations. Instead, they have to find ways to manage their operations more efficiently.

This need propelled the movement from paper tickets to smart cards and, to the current open payment systems, where riders can get on a bus, tap the credit card of their choice on the payment machine, and take their seats. This system not only provides customer convenience and eliminates paper ticket expense, but also collects basic data like time, location, card number, and mode of transportation. However, if open payment is also used for train, light rail and parking, and the data from the multiple travel modes are consolidated, the transportation agencies can analyze that data to get a clearer picture of who the individual riders are and how they use specific services.

If 30 percent of people ride the bus or train to work three times a week, but use their car to that destination (as evidenced by paid parking) two times a week, agencies can create special offers to change that behavior. For example, it can offer discounted parking for anyone in this group who takes mass transit four days a week, or some other incentive. If an agency uses its existing data to understand the people who use its services, it can find creative ways to change those individuals’ behaviors to increase ridership, reduce congestion, and decrease pollution.

The European market has high mass transit adoption, but faces a similar need to reduce congestion and schedule routes efficiently. The whole infrastructure is more complex, with many more transit options than exist in most U.S. cities. Riders not only compare the more traditional forms of public transportation, but weigh these against the options of walking, biking or renting a motor scooter. By tying all of these elaborate means of transport together and analyzing the data, operators better understand the needs of their prospective users and under what conditions, for example, they choose to walk nine blocks versus some other option.

**Optimizing public transport using existing fare data.**

Public transit operators must continuously look for ways to increase capacity and optimize the use of infrastructure—adjusting routes, service frequency, and stop locations. By using analytics to determine how people are using mass transit—and why—agencies can garner the insight to make route adjustments that optimize available resources. For example, instead of three partially full busses running back-to-back, maybe one bus could handle the route.

Metro stations sell one-way and two-way tickets; this may not always reflect the ridership’s needs. Through analytics, one station manager discovered that 20 percent of the station’s riders were actually traveling in a triangular pattern. This discovery lead to the introduction of a three-way ticket.

It’s important to note that a variety of factors influence an individual’s decision to use mass transit, ranging from travel time and price, to weather conditions, the purpose of the trip and the availability of transportation options. To create an accurate analytic model, transportation agencies have to consider all of these influences and be able to factor in the inherent randomness of life.

**Supporting the growth of sustainable modes of transportation.**

One of the fastest growing trends in the global transportation industry, public transport multi-modal systems, is working solely on the availability of advanced analytics. These systems enable cardholders to access bicycles, electric cars or some other type of transportation from one of many “pods” throughout the city, and return it to another pod within a designated timeframe. Program adoption completely depends on having the right number of vehicles available at the right place at the right time. This is where analytics come into play.
Consider the shared bicycle program in a European city designed primarily for people riding to and from work. Although the program was well embraced, one important fact hadn’t been considered. The uneven terrain of the city. So, instead of riding bikes to and from their offices, program participants only used the bicycle one way—the part of the route that was downhill. That left an uneven distribution of bicycles, and lines of disappointed riders waiting at empty pods.

By using advanced analytics, program managers identified where the bicycles were and where they needed to be in near real time. Throughout the day, electric vehicles were used to redistribute the bikes to the various locations, based on that day’s use and other patterns. As the availability of shared vehicles—ranging from bicycles to electric cars—continues to increase, analytics will play a key role in the success of these programs by forecasting demand in near real time.

**Keeping Drivers Moving**

Of course, there will always be people who prefer to drive. In many cases, agencies can’t afford to build or expand highways—or, there’s literally no available space to do so. Now, with the availability of real-time analytics on roadway congestion, agencies can ease that congestion by opening high-occupancy toll (HOT) lanes. Agencies monitor traffic using intelligent transportation systems. If congestion is imminent, they can dynamically adjust pricing on specific lanes in minutes, with electronic signage informing drivers of the cost and travel time of the less congested, higher-priced lane. Drivers who are willing to pay for convenience can take the HOT lane, which not only enables them to get to their destination faster, but also reduces the congestion in the other lanes.

In London, Singapore and Stockholm, cordon pricing is used to reduce congestion in inner city zones. In some cases, the goal is to increase revenue streams. In others, it is a way to encourage the use of public transport on certain, high-traffic days. The ability to make decisions based on actual analytical road use, instead of only surveys, is the reason these programs succeed.

**Speeding the Parking Space Pursuit**

Every day, drivers waste time, fuel, increase congestion and pollute the air by the simple act of driving around, looking for on-street parking spaces. In major cities at peak times, 15 to 30 percent of traffic can be caused by people who have reached their destinations but are unable to find a place to park.

New technology, which combines cameras, sensors, and geo-tracking with analytics can “see” whether a particular spot is occupied or not, and transmit that information to a device within the car such as the GPS or driver’s mobile phone to actually guide the driver to the closest available space. That’s one way to reduce congestion.

Another is applying dynamic pricing options based on parking demand. Using demand management for on-street parking can have numerous benefits. Where prices are lowered, there is better utilization of the number of existing spaces. Where prices are raised, it becomes easier to find a space, for those individuals who are willing to pay the increased cost.

Unlike HOT lanes, however, the timetable of parking prices changes on a regular well known basis, not in real time, based on demand. Street parking could be more expensive during the work week to encourage the use of public transportation. Or, it could encourage drivers to park three blocks away, on a street with excess capacity for a lower price, and then guide them to that area.

Agencies could also set different pricing for residents and visitors, then change these for special events or as traffic dictates. In addition to using analytics to set pricing, agencies can also use these tools to see the impact of that pricing on the impacted neighborhoods, traffic flow, and other factors, which aids in future decision-making.

There is a simple approach to dynamic pricing that exists today, which scales to thousands of block faces, is easy to communicate and effective in tracking past demand. This approach is known as the “occupancy thermostat,” and works by raising prices when the average occupancy over the previous month was
significantly above target. By contrast, it lowers prices when the occupancy in the previous month was below target.

However, this approach has some limitations. First, occupancy may oscillate a lot. More significantly, it doesn’t factor in how road closures or holidays would impact travel and the resulting parking need. It also doesn’t help agencies identify appropriate occupancy targets, based on how much people value on-street parking as compared to public transport or off-street parking.

Although agencies can build models on how demand varies with price, this model has to mirror how people choose parking spaces, as well as taking into account the flexibility drivers have about where, when and for how long they stay in a specific location. With the large number of choices available, these computations are complex for larger cities and require algorithms that can be improved over time and that can be easily visualized and understood by decision makers.

With a full picture of the individuals using their parking services, agencies can create new ways to incent them to take public transportation, park in a different area or otherwise alter their behavior to reduce congestion and pollution.

**More Accurate Forecasting**

Predictive analysis has long been used for planning roadways based on projected population growth, and “what if” scenarios to anticipate the impact of temporarily closing a road, building a new station or changing a route. Agencies are also using predictive modeling to anticipate rider reaction to a fare increase to determine potential attrition, or identify what would happen if a specific route was cancelled or adjusted by 15 minutes. As a result, transit leadership can make more informed decisions with fewer surprises with the overall outcome of those decisions.

Today, predictive analytics can be used to enable transit operators and managers to make decisions rapidly for near real-time adjustments of vehicles or services. For example, are there more people waiting for a specific bus than the bus’ capacity will hold? Additional vehicles can quickly be added to handle the overflow. Is there a traffic accident along a specific route or roadway? Analytics enable dispatchers to gain the knowledge they need to reroute those vehicles as events occur to get riders to their destinations on time.

**The Final Analysis**

Today, the transportation industry is challenged to reduce congestion and pollution, improve safety and get people where they need to go faster. By working with a partner who can consolidate and analyze the volumes of data from multiple transportation modes, they can gain the actionable insight needed to meet these challenges, and provide a means of seamless, sustainable mobility to the people of the world.

Now, the question becomes, what is your data doing for you?

**Who We Are**

Xerox is a global leader in business processes and information technology services. For more than 40 years, we have translated that expertise into the transportation industry, working with clients in more than 35 countries to deliver reliable solutions that deliver results. In fact, we are the largest supplier of innovative mobility and transportation services to government worldwide. From fare collection to toll solutions, from back-office processing to infrastructure installation, we provide the system and services that help solve major transportation problems.

Just as important, we spend approximately $1 billion on research and development every year, with scientists dedicated to transportation projects in our different research centers throughout the world. Our work in analytics helps agencies transform their data into actionable insight that allows them to improve people’s lives by giving them more time in their days. As a business partner to the world’s most complex corporations and governments, we provide innovative solutions so our clients can focus on what matters most: their real business.
Innovation

Innovation only happens when it makes a difference to our customers. The Xerox Innovation Group ensures a balanced portfolio of research and technology projects that address the needs of today’s businesses as well as create options for the future. We bring our experience in the transportation market to help build the right solution for the project. As a technology integrator, we’re not restricted to one solution. In fact, with four percent of our revenue spent on R&D every year, we have the ability to meet your needs today and anticipate them for the future.

- $1.5 billion invested on R&D each year (Xerox/Fuji Xerox).
- 1,600 patents in 2010 (Xerox/Fuji Xerox).
- In the top 20 world leaders for patents.
- 100+ new products and 500 awards in the last three years.
- 55,000 global patents.

Throughout Xerox’s global research labs, data scientists are working on innovation projects to make multimodal transportation seamless and sustainable. Here are some examples of those projects.

Data Simulation to Optimize Public Transportation Networks

Scientists have created a user profiling engine that uses anonymous ticket validation sequences to infer the nature of a journey. The first ticket validation represents home or initiation point; the second validation could be the destination or could indicate that the rider changed transportation type—going from bus to bicycle, or train to bus. By analyzing the locations and times of ticket validations, and combining this with survey data, the engine presents a clearer picture of how people are using the transportation infrastructure and where they’re going—to work, to school, shopping or for a regular weekly appointment. This comprehensive picture, which takes advantage of existing fare data, enables agencies to better understand and respond to user needs.

To complement the user profiling engine, a ridership simulation engine predicts traveler decisions under different scenarios to gauge the effect of specific infrastructure changes. It uses probabilistic travel decisions based on data from the user profiling engine, demographics, weather, and the availability of other means of transport.

The objective is to create a mechanism for ongoing analysis of massive amounts of data, visualized in a city dashboard monitor. This insight enables transportation officials to make adjustments based on the changing needs of the people it serves.

Dynamic Pricing Engine for On-street Parking

In the labs, researchers have created a city management dashboard, used in conjunction with the existing ‘parking occupancy thermostat’ approach. This unique tool integrates information about public transportation and parking by combining data from parking sensors, parking enforcement officers and surveys, and factors in variables like weather, street closures, holidays and local business activities to provide more accurate simulation, prediction, visualizing, and pricing. Using new, “choice” models, recently invented for marketing, which capture the heterogeneity in people’s preferences, agencies can more accurately predict the value of a specific price schedule to drivers, and achieve better outcomes.

White Paper Sources:

Alan Allegretto, group president, Americas Tolling, DMV and Commercial Transportation, Xerox
Marco Bressan, chief innovation officer, Transportation, Xerox
Chris R. Dance, research fellow, Xerox Research Centre Europe
Geraldine Lievre, chief technology officer, International Transportation, Xerox
Mark Talbot, group president, Americas Local Government, Xerox