RELAZIONE FINALE PROGRAMMA DI RICERCA STM

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Titolo del programma: Tiered Information Design to Encourage a Sustainable Commuting

Relazione Finale
The main objective of the research program is to design and test a tiered structured data flow for encouraging drivers to reduce single-occupancy vehicle (SOV) trips by sharing their daily commute to reduce costs, congestion and pollution.
During the visit, we have analyzed current MIT mobility patterns derived from MIT 2014 and 2016 commuting survey data, which include both commuting and demographic information, finding some interesting results:

- Even if from 2014 about 9% of car commuters have changed their commuting mode and about 3% of them started car-pooling, in 2016 20% of MIT commuters still use the car for their daily commuting, 20% of which commute within 10Km;
- 50% of the daily car commuters arrive at the MIT campus between 8 AM and 10 AM, 70% of which have work hours flexibility, meaning that there could be room for sharing;
- 80% of the car commuters leave within 6'-drive from closest transit stop.

Based on spatial and temporal constraints of the trips, we built a commuting map through the shareability networks, a paradigm introduced by our IIT research group to analyze taxi-sharing opportunities, we opportunely modified to model carpooling opportunities.
In order to evaluate sharing opportunities, we used two classical transportations approaches:

1. The first metric has the goal of maximizing the number of matched trips so to minimize the number of circulating vehicles. We call the algorithm associated to this metric *Maximum Cardinality* (M_c);
2. The second metric has the goal of maximizing the number of shared kilometers. The associated algorithm is called *Maximum Shared Distance* (Max_d).

Within the promising results, it is interesting to note that with only 4' of detour delay, and giving 5' of flexibility in the departure time, there is an average of 20 sharing opportunities per car commuter trip, becoming more than 40 when commuters have 15' of flexibility.

In 2017 MIT launched new commuting benefits to encourage sustainable travel and reduce parking demand. The program, called *AccessMIT*, includes: free subway/bus pass to all employees; shift to daily (more expensive) parking pricing in all MIT gated lots to disincentive car commuting; increased subsidies for subway/bus commuter rail and station parking; a dashboard developed my MIT to trace daily commuting and send specific messages; and gamification, to offer employees rewards and even more benefits. Car commuters are the next MIT target, and given the above reported results, our data analyses could actually help MIT to nudge daily car commuters towards a more sustainable commuting mode, such as public transit and carpooling, creating for the latter what we called *tiers of aggregation*.

The tiered information-nudging schema is based on a mixture of email- and dashboard- based messages that will target the MIT community in two different ways:

1) The whole MIT employees will receive emails to let them be aware of:

1. The average number of (potential) car poolers for all the commuters;
2. The average number of (potential) car poolers for a specific town;
3. The average number of (potential) car poolers for a specific zip code;
4. The average number of (potential) car poolers for specific census blocks.

2) A subset of specific car commuters (among those who in the survey agreed to be re-contacted), will receive ad-hoc personalized information, such as:

1. The number of their (potential) car poolers;
2. The number of commuters willing to pool and having matching trips with them;
3. The number of their (potential) poolers within the same census block;
4. How trip matching could change if increasing flexibility;
5. The closest transit stop if leaving in a high transit-accessible area.

Each message will also contain information such as the amount of untraveled km, emission reduction, saved money, etc., given by potential mode shifts.

We also wanted to understand whether carpooling could be used as a tool to *actively* promote social integration. In order to do so, we designed a novel methodology and a set of algorithmic tools to *actively* promote social integration through carpooling. In particular, we introduced two novel social-based metrics to evaluate sharing opportunities:

1. The first metric is rooted on the observation that carpooling, by locating two travelers into a physically constrained and private environment like the car, can become an active means for starting new social relationships or strengthening the existing ones, if any: a form of social *mingling*. To this purpose, we defined a metric aiming at maximizing the time travelers spend together on their way to the destination (*mingling time*). We call the associated algorithm *Maximum Mingling Time* (M_t);
2. The second social metric aims at favoring shared trips across different social categories of travelers and, thus, *social mixing*. In particular, we took into consideration two specific traveler features to form distinct social categories: *age* and *educational level*, since these features are routinely used in social sciences to define social categories. We call the associated algorithm *Maximum Social Mixing* (M_x).

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By analyzing the shareability networks generated from MIT survey data with the above mentioned algorithms, it could be observed that there is no substantial difference in the percentage of sharable trips (Fig. 1), while the results in terms of saved distance and mingling time are quite different if the goal switches from environmental (Fig. 2) to social (Fig. 3), showing that a trade-off between environmental and social benefits of carpooling is likely to arise and could be be addressed when promoting carpooling.

As a first, tangible result of this visit, we are submitting a manuscript to the Journal Transportation Research Part B entitled "*Home-work Carpooling for Social Mixing*", where we analyze carpooling from this new perspective, investigating the question of whether it can be used also as a tool to favor social integration, and to what extent social benefits should be traded off with transportation efficiency.

Firma del Fruitore

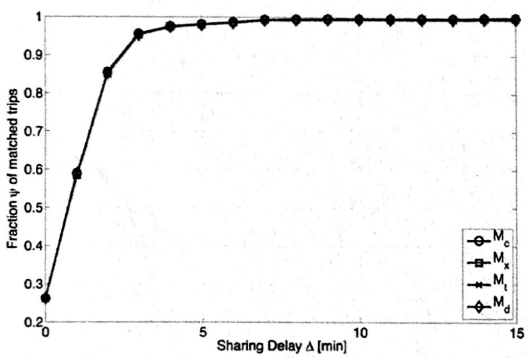

Figure 3: Fraction of matched trips.

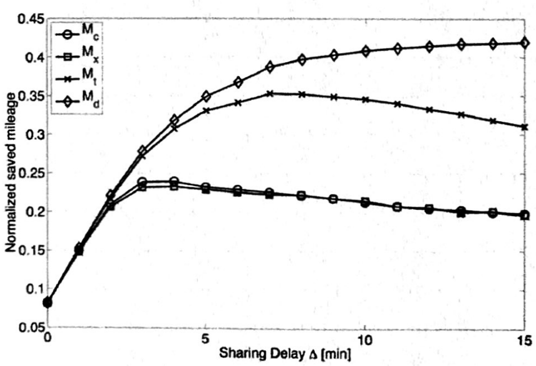

Figure 1: Saved distance.

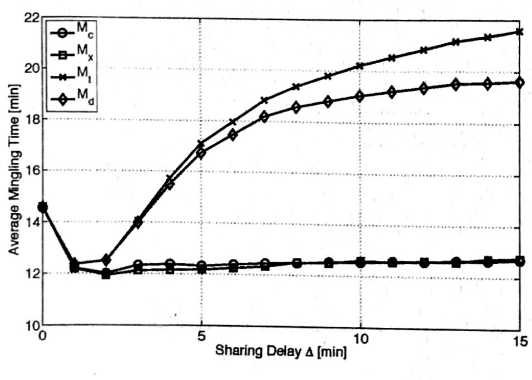

Figure 2: Average mingling time.