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D.C. Food Truck MRV Swapping: Project Proposal and Plan

I. Background

Beginning in December 2013, the District of Columbia Department of Consumer and Regulatory Affairs (DCRA) implemented the Mobile Roadway Vending (MRV) lottery system. The lottery is the mechanism by which the DCRA assigns highly-demanded vending locations to food trucks. The vending locations are assigned on a monthly basis, it costs $25 for a vendor to enter the lottery, and $150 to use the space on the day assigned. The eight current MRV locations are:

- Farragut Square (17 spaces)
- Franklin Square (12 spaces)
- George Washington University (3 spaces)
- L'Enfant Plaza (19 spaces)
- Metro Center (11 spaces)
- Navy Yard (8 spaces)
- Union Station (15 spaces)
- Virginia Avenue (10 spaces)

The lottery is designed such that the maximum difference between the number of spots any two vendors are assigned in a given week is one. That is to say, for example, if the minimum number of spots a vendor is assigned in a given week is two, then the most spot assignments any other vendor could have in that week is three. However, although vendors are asked to submit their preferences for MRV locations, the locations are assigned randomly and without regard to these preferences. This project seeks to remedy this by providing the vendors a spot-swapping platform. Spot assignments cannot be sold, but they can be traded on a "one spot for one spot" basis. Each trade must be approved manually by the DCRA.

II. Objective

Providing a mechanism that takes into account vendors' preferences for MRV locations would benefit both major the food truck vendors and the DCRA. It would be of obvious benefit to the food truck vendors, allowing them to be in the locations that they believe are best for their business thereby leading to higher profits. It would also benefit the DCRA because the more satisfied a vendor is with their assignment, the less likely

they are to be absent from their spot. From the point of view of the DCRA, each no-show costs the DCRA $150 in forgone revenue per spot per day. The current approval process for trading spots is rather rudimentary. This project will provide a mechanism for the DCRA to approve all compliant trades en masse. Though outside the scope of this project, it is worth mentioning that if we assume vendors respond to consumer demand and incorporate it into their preferences for spot assignments, a more efficient allocation of MRV locations would also improve the satisfaction of food truck patrons.

The goal of this project is to provide a platform that would enable MRV assignment trading among vendors subsequent to the initial lottery allocation. The platform will be based on an algorithm that would only permit one-for-one trades, in compliance with DCRA rules. Given vendors' preferences and their initial assignments, the objective is to achieve a Pareto-optimal allocation of MRV location assignments.

III. Strategy and Approach

A. Phase I: Algorithm Development

We plan to approach this problem by breaking it down into two components. The first component involves formulating and implementing an algorithm that will achieve a stable or near-stable matching between vendors and MRV locations.

The main strategy behind the algorithm is to optimize vendors' assignments through linear programming (LP) methods. Given the results of the lottery and the preferences of the vendors, an LP approach should be able to produce significantly improved pairings if not the optimal allocation. It is important to note that this approach does not require actual trading among the vendors, only that they submit their preferences so the algorithm can determine where improvements can be made.

The LP will work by assigning a score to each location alternative the vendor considers superior. The list of alternatives will be an ordinal set so the vendor's can differentiate between the desirability of the spots they consider superior. For example, if on a particular day of the month, the vendor would prefer two alternatives to the lottery assignment he received, and he deems one of the alternatives clearly superior to other (though both are considered better than the assignment he currently has), the algorithm will allow him to rank the alternatives by assigning a positive "score" to these preferences. If the spot he currently has is indeed his third choice of all the locations on that day, then that spot will be given a "score" of zero. All other spots will be given a score of $-M$, that is, a score sufficiently negative that the LP will not consider it as a possible alternative. The objective of the LP will be to maximize scores subject to the constraints of the problem. Such constraints include not exceeding the maximum number of spots at a given MRV location (see the above list) and not allowing any truck to have a different total number of assignments than what they were initially given for that month, which enforces the one-for-one trading rule.

The algorithm will be tested on a scaled down data set. If the algorithm produces valid results, we will begin testing and evaluation on a real data set provided by our sponsor.

B. Phase II: Interface Design

The second phase of the strategy involves the interface. We plan to develop a mechanism by which vendors can submit their preferences and have these preferences inputted into the algorithm. We envision using a survey style approach where vendors submit their superior alternatives in ranked order and the results are returned to the algorithm in a machine-readable format.

Final validation of the model and interface will include a full dry run of the entire secondary trading process. The initial conditions will be the initial assignments from the previous month's lottery. The following items will be included in the test procedure:

- The ability of food trucks indicate the locations that they hold and are trading
- The ability of food trucks to indicate what locations they are willing to trade for
- The ability of that algorithm to accept these inputs
- The ability of the algorithm to reassign locations based on what the food trucks prefer
- The ability of the algorithm to output a new schedule

IV. Challenges

The challenges in this project are not insignificant. Designing the way in which the interface communicates with algorithm presents a technical challenge. Other challenges will be less technical. The motivation of food truck vendors to participate remains an open question. The success of the project can be adversely affected by the lack of vendors willing to submit their preferences and having too small a pool to allow for improvement in the MRV allocation.

V. Project Schedule

1. Sign and submit NDA's. (September 25) (Dave)
2. Get data from sponsor (Present to Monday, September 29) (Evan)
3. Agree on Algorithms (Present to Thursday, October 2) (Vince & Evan)
    - Team meets with Dr. Hoffman for assistance.
4. Build Initial Prototypes (Present to Thursday, October 2) (Vince & Evan)
    - Prototype will use dummy data.
5. Begin writing documentation (keep high level) (Present to Thursday, October 9) (Vince)
6. Solicit Information from Food Trucks (Present to Thursday, October 2) (Dave) 2 pm
    - Anonymous inputs
    - Are you part of the FTA and do you participate in the DCRA MRV lottery?
    - Do you currently trade spots and what is the mechanism?
    - Do you ever not use the assigned spot and if so how frequently?
    - What do you consider to be the ideal trading platform within the rules of the DCRA (1-1 trades, no money involved, only trade within month, etc.)

- Do you know how the DCRA allocates the MRV assignments?
- Do you think your preferences are being taken into account?
- How satisfied are you with the current system 1-10?
- What does the ideal schedule for you look like?
- How similar is your schedule from month to month, to what extent does your preferences for specific MRVs change?
- If a system took into account preferences to a greater degree than the current system, would you participate in the DCRA lottery?
- Provide a high-level description of what we are doing, and then ask if they would participate in the "Big Trade." If they would not participate, what modifications can be made so that they would participate?

7. Contact GW Professor H.G. Abeledo (Thursday, October 9 to Thursday October 16) (Evan)
    - Need valid LP problem formulation before contacting Prof. Abeledo

Test and Evaluation Phase

8. Modify and expand algorithm for whole system/ entire data set (Thursday, October 9 to Thursday, October 16) (Vince & Evan)
9. Internally review algorithm (group + Dr. Hoffman) (Thursday, October 16 to Thursday, October 23)
10. Integrate algorithm with interfaces (Thursday, October 16 to Thursday, October 30) (Dave)
11. Show program to sponsor and gain feedback (Thursday, October 23 to Thursday, October 30) (Vince)
12. Incorporate comments from sponsor (Thursday, October 30 to Thursday, November 6) (Dave)
13. Update System Documentation (Thursday, October 30 to Thursday, November 6) (Evan)
    - Requirements Document
    - Algorithm Commentary
    - System User Guide
14. Finalize integration of interfaces with program (Thursday, October 30 to Thursday, November 6) (Dave)
15. Show "Final Product" to sponsor (Thursday, November 6 to Thursday, November 13) (Team)
16. Refine "Final Product" from sponsor comments (Thursday, November 13 to Thursday, November 20) (Dave)
17. Finalize documentation (Thursday, November 13 to Thursday, November 20) (Vince)