# Build it. But where? The Use of Geographic Information Systems in Identifying Optimal Locations for New Cycling Infrastructure

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## ABSTRACT

Concern over climate change, traffic congestion, and the health consequences of sedentary lifestyles has resulted in a surge of interest in cycling as an efficient form for urban transportation. The link between the presence of cycling facilities and increasing the numbers of cyclists has been well-documented; however no methodology for locating new facilities has been developed to date. In the absence of such a methodology, new facilities are often built with a view towards recreational cycling or keeping them "out of the way". However, in order to best serve the needs of current cyclists and attract future ones, methodologies need to be developed to objectively determine how to optimally locate these facilities.

This paper uses Montréal, Canada as a case study; this city contains over 400kms of recreational and utilitarian cycling facilities and its transportation plan calls for a doubling of its network. This paper describes a method of using several data sources in a geographic information systems (GIS) environment to identify optimal locations of new facilities. The methodology demonstrated here involves modeling : 1) current cyclists' trips based on the Origin-Destination (O-D) survey; 2) short car trips based on the O-D survey; 3) suggested routes for new facilities from a recent survey of Montréal cyclists; and 4) records of bicycle crashes obtained from police and ambulance records. Findings from all these sources are then superimposed on 300 x300 meter grid cells covering the entire island of Montréal. Optimal locations for new routes, minor linkages and upgrades are identified by analyzing the results of the grid cells in conjunction with existing facilities. Additional recommendations can be derived from the methods used to help in identifying areas to invest in bicycle parking spaces or public bicycle stations.

## INTRODUCTION

As problems with urban congestion and concern over air quality increase, so too has interest grown in encouraging utilitarian cycling for short distance trips. Many North American cities have commenced initiatives to implement new on-street and off-street cycling facilities, yet much progress must be made to complete networks that provide safe, efficient access to multiple destinations.

In Montreal, the case study city examined in this paper, the recent transportation plan calls for a doubling of the existing cycling infrastructure. The location of these new routes will determine how successful these efforts are in attracting new cyclists and improving safety for current cyclists. However, despite the growth in bicycle facility and travel behavior research, there has been little attention given to developing sound methodological tools for locating new facilities. This may be due to problems of data availability across regions that prevents standardizing the process of building new cycling infrastructure. However, faced with these shortcomings, this paper proposes a methodology for locating new cycling facilities that embodies flexibility in the data types employed. This paper argues for a model of facility location based on a grid cell model in a geographic information system (GIS). This method offers the flexibility to accommodate various readily available datasets and identifies corridors where cycling facilities would provide the maximum benefit to existing and potential cyclists.

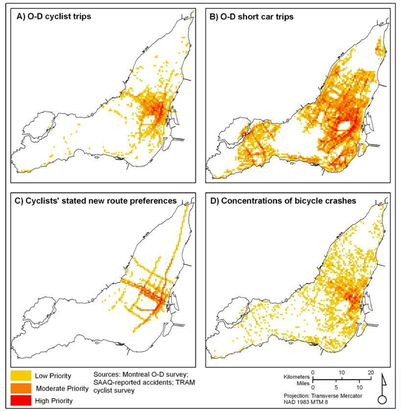


FIGURE 1. Visualizing four data types individually

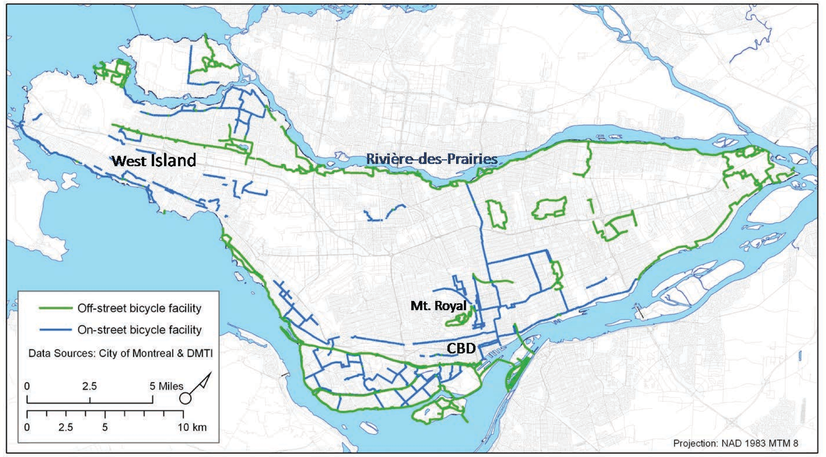


FIGURE 2. Montreal Island, with on- and off-street bicycle facilities

## METHODOLOGY

The rationale for this paper is to identify the best areas for investing in the cycling infrastructure in the Montreal region to help in increasing the number of cyclists and improving the safety conditions for existing cyclists. Accordingly several measures can be used in identifying the high priority areas in a region where new infrastructure will benefit existing and potential users. The first measure used in prioritizing areas to build new cycling infrastructure or upgrade the existing infrastructure is through an analysis of the travel behavior of the existing cyclists in the region. Identifying areas with high cycling activities can be achieved through an analysis of origin-destination surveys (O-D). The shortest estimated travel path between origins and destinations can be modeled to identify parts of the region where high numbers of cycling trips occur. However, this method addresses existing demand only, limiting benefits to areas with presently high levels of cycling, while leaving the areas with lower levels un-served with new cycling facilities.

Identifying areas where cycling can replace existing short distance car trips is the second measure we chose to use. This measure is directed towards potential cyclists. The first step is to identify how far cyclists are willing travel to reach destinations using the OD survey. Second is to identify short motorized trips that fall under a certain distance threshold. The areas with high number of short motorized trips may indicate where new cycling infrastructure can attract new cyclists.

Cyclists' opinions, expressed in surveys, may also be usefully employed in locating new facilities. An online survey - involving over 3000 respondents - was conducted by our research team in the summer of 2009. This tool reveals current demand for new facilities, but benefits from the "on the ground" experience of cyclists.

## ANALYSIS & RECOMMENDATIONS

Safety is one of the most important decisions affecting cyclists travel behavior and the perception of unsafe cycling conditions deters some people from commuting by bicycle. An indication of safety levels can be found in accident data, which are generally available through archived police reports. This data can be geocoded in GIS and plotted, allowing the identification of priority areas where interventions would likely improve safety. It should be noted that this method for identifying areas of intervention does not account for exposure, which is not available in many cases. Figure 1 shows each of the four data sources after being intersected with the 300-meters grid cells and normalized by the number of observation of each data source. Figure 2 shows the results when the above four data sources are combined into one variable and normalized. The areas identified could be considered as priority zones, where future investments in cycling infrastructure are likely to benefit the greatest number of cyclists and potential cyclists.


FIGURE 3. Four data sources combined

A simple visual analysis of the combined methodology reveals that cycling facilties could be increased in central areas, even where nearby facilities exist. Also, select routes from residential suburbs could help to increase cycling in peripheral areas. Obviously, the selection of new routes must take into account current cycling facilities with an aim to providing maximum connectivity and accessibility to important activity generators. As seen in figure 4, there are several indicators that reveal optimal locations of new bicycle facilities or upgrades to existing facilities.

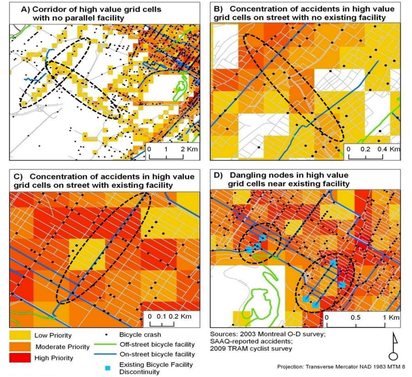


FIGURE 4. Indicators of opportunities for intervention

Four different types of indicators are identified: dangling nodes (indicating discontinuities); concentrations of crashes (indicating safety concerns); corridors with high grid cell values (indicating high demand); and isolated high value grid cells (indicating isolated demand). These scenarios are summarized in the table below.

This methodology outlines how GIS can be used to locate new bicycle facilities. Continued research in this field of infrastructure planning will allow transportation planners and engineers to better plan the placement of future facilities.

| Indicator | Location | Action recommended | Figure |
|---|---|---|---|
| Dangling node of existing facility | High value grid cell | Connect to nearby facility through high value square | 3d |
| | Low value grid cell | Take no action | - |
| Concentration of crashes | In high value grid cell with no cycling facility | Build new facility | 3b |
| | On a street with cycling facility | Field study of existing conditions and possibly upgrade existing facility | 3c |
| Corridor of high value grid cells | Not containing existing cycling facility | Build new facility | 3a |
| | Containing existing cycling facility | Upgrade existing facility and/or build parallel facility | - |
| Isolated high value grid cell | Anywhere | Improve cycling conditions; new facility not necessarily required | - |

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