

# Developing a Decision Support System for Transit Prioritization in Kelowna

Cameron Taylor-Noonan and Rafael Villarreal

## **Abstract**

The Transit Analytics System is a bottom-up approach to assess the level of service offered by the existing transit network and to find opportunities for service expansion, optimization, or even reduction. By quantifying the market potential for transit, it is intended to help prioritize service in areas with the greatest opportunity for sustainable modal shift and reduction in carbon emissions. Building on a disaggregated land use database developed from BC Assessment Data, Canada Business Points, and surveys of major employers and institutions, the system combines information from census, household travel surveys, customer surveys, passenger counts, as well as future development proposals to assess the potential market for transit. Network analysis is performed in GIS to quantify the amount of activity (potential market) within walking distance of individual bus stops or along corridors to prioritize investments in transit or pedestrian infrastructure according to multiple criteria. The overall result of the Transit Analytics System is a decision support system, built on a comprehensive database which forms the basis of transit investment prioritization and the development of a future vision for sustainable transportation.

This method offers a number of advantages for municipal governments. It is designed with the resource constraints and data availability of medium-sized cities in mind. Much of the process is automated with Python scripts, allowing for it to be used by individuals without advanced training in GIS to rapidly assess multiple alternatives in near real-time.

## **Introduction**

Transit planning requires balancing multiple objectives. For instance, ensuring value for public money in terms of system efficiency or mode shift can conflict with the requirement for geographical equity. Or, the decision to incubate ridership by investing in higher frequency may run counter to the directive of matching service to existing demand. In the presence of these trade-offs, the Transit Analytics System is a tool to help make more transparent and informed decisions. It assists in the communication of trade-offs by integrating datasets, evaluating using multiple simple criteria, and displaying the results graphically. This paper will outline the methods and data sources used for the Transit Analytics System and briefly discuss two examples of how it is helping to support decision making for the City of Kelowna.

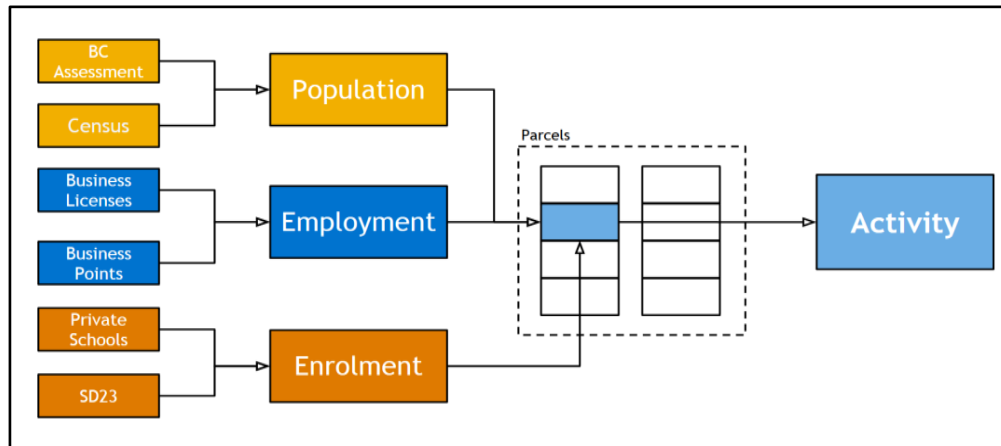
## **Rationale**

### *Principles*

Public transit cannot be planned solely around a single criterion like increasing ridership, providing equitable coverage, supporting future developments, or catering to the needs of students or seniors. Incorporating multiple dimensions gives a more complete picture of the potential for transit to be successful and serve the community. It also increases the complexity and resources required to make informed decisions. Given the limited resources of a medium-size city like Kelowna, this complexity calls for an analytics process which is replicable and robust. Partial automation reduces the turnaround time for responding to queries from stakeholders or testing alternatives. It also can reduce the level of knowledge of specialized software that is required to produce actionable results.

One of the overarching goals of the Transit Analytics system is to assess the level of service offered by the existing transit network and help determine priorities for expansion or opportunities for service optimization on the existing and future market potential for transit. Since the majority of transit trips begin and end on foot, the potential market for transit is largely defined by the number of origins and destinations within walking distance of bus stops (Guerra et al., 2012). Previous work has shown that the density of destinations- employment and enrolment- have a much stronger correlation with ridership than residential density in Kelowna. This is why population, employment, and enrolment are combined into a measure of activity as shown in Figure 1 below.

**Figure 1: Conceptual Map of Activity**



### *Challenges for Transit Analysis*

Quantifying activity at a pedestrian scale requires disaggregated data in both time and space. Census data often lacks sufficient spatial resolution, particularly in lower density areas where dissemination areas are much larger than pedestrian walksheds. Pedestrian networks themselves are difficult to model, as it is hard to account for shortcuts and safe crossing points. Data can be costly to obtain, but staff expertise and time availability is often a more pressing constraint. That is why one of the underlying principles when developing the Transit Analytics System was to automate the analysis wherever feasible.

### **Data & Methodology**

#### *Data Sources*

The primary source of land use data is the Central Okanagan Fine Scale Land Use Database, which provides parcel-level estimates of population, employment, and enrolment. Population is estimated with a combination of Census and BC Assessment data. Employment comes from Canada Business Points, a third-party marketing database, together with active business licenses issued by the City and floor space per employee factors from BC Assessment. Enrolment counts are provided by the major post-secondary institutions, School District #23, and a survey of private schools. Given the staff time and cost involved in network changes, transit planning also needs to consider future land use. The size and location of approved developments likely to occur within three to five years are obtained from land use planners at the City.

Information on travel patterns comes from three main sources. First, automated passenger counts (APC) are provided by BC Transit. These counts are supplemented by the Transit Utilization Survey conducted by the City, which provides insights into the trip making patterns of current transit riders. Finally, the Household Travel Survey is used for a broader view of travel behaviour across the region.

**Table 1: Summary of Data Sources**

<b>Component</b>	<b>Sources</b>
Population	BC Assessment; Census
Employment	Canada Business Points; Business Licenses; BC Assessment
Enrolment	UBCo; Okanagan College; SD 23; Survey of Private Schools
Near-Term Development	Development Permits
Transit Ridership	BC Transit APCs; Transit Utilization Survey
Travel Patterns	Household Travel Survey

*Methods*

Though the primary focus of this work was to quantify the activity surrounding bus routes, the methodology was based on intersections along the route rather than bus stops. This was done to facilitate more fair comparisons and avoid the need to assume stop locations on potential new routes. Drawing network buffers from every intersection along a route captures the theoretical upper limit of a route’s catchment area. Finding the optimal placement for bus stops, which maximizes the coverage within the catchment while maintaining desired speed and reliability, is left for the future. After the network buffers are drawn, as exemplified in Figure 2, activity values for the intersecting parcels are counted. The resulting totals can then be normalized by route length to capture the efficiency of a routing in terms of nearby activity per kilometre.

**Figure 2: Example of Network Buffering Method**



*Figure 2: Network buffering performed using the ‘Network Analyst’ tool in ArcGIS 10.1*

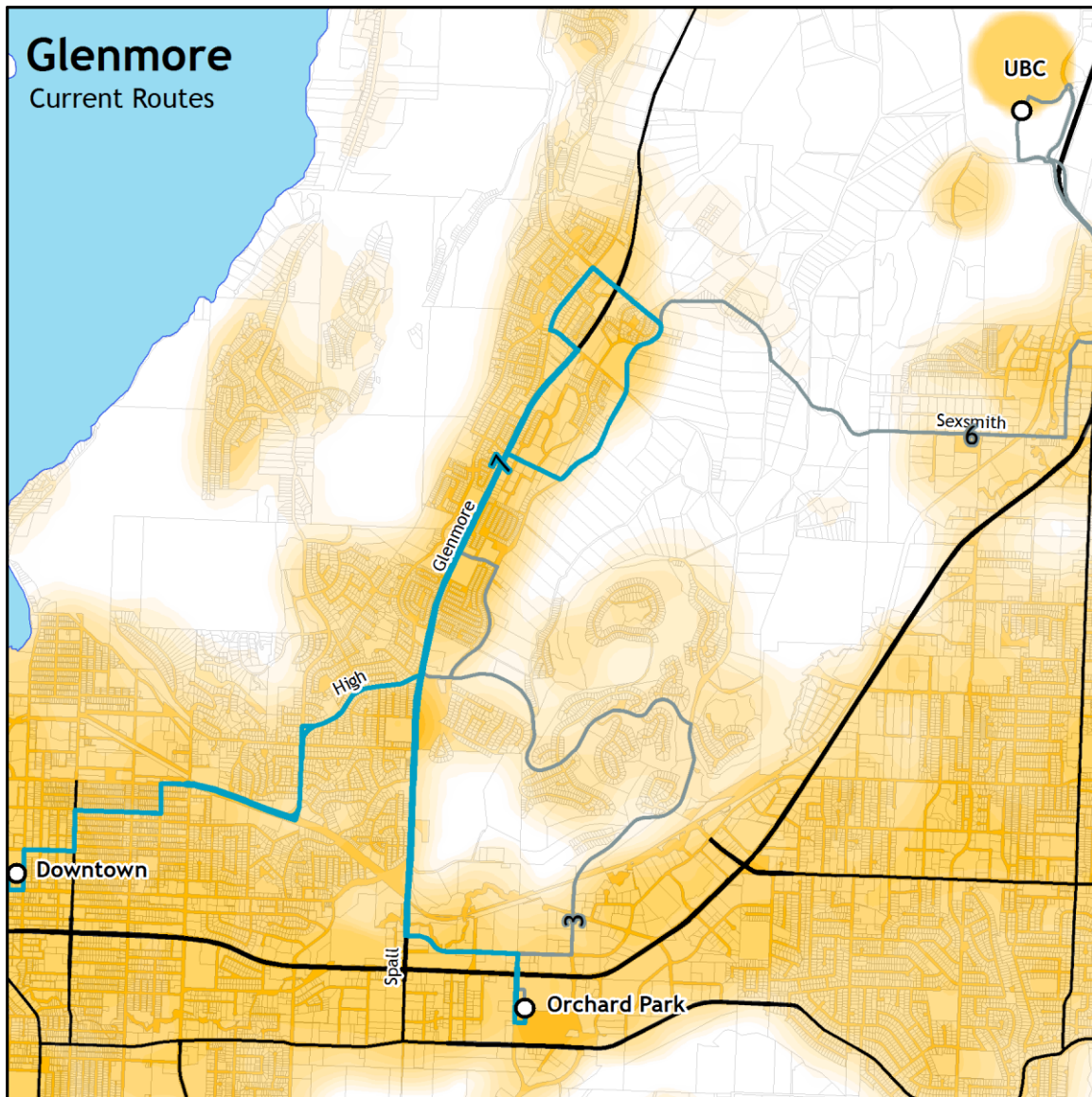
Besides market potential, one of the other tools available is the visualization of existing ridership profiles along routes. This is achieved using a Python script which divides routes into individual segments between stops and relates them to APC data. The next section will briefly discuss the application of these methods for two cases: an upcoming network restructuring following the extension of John Hindle Drive, and an evaluation of the performance of community shuttle routes in southwestern Kelowna.

## Results

### Case Study: John Hindle Drive

The forthcoming extension of John Hindle Drive creates a more direct route from Downtown to UBC Okanagan via Glenmore. As shown in Figure 3, the current 7 Glenmore routing runs from Downtown up Glenmore Drive, then loops back down to Orchard Park Mall. The current 6 Glenmore/UBCo runs from Downtown to UBCo via Sexsmith Drive. If one of the anchors of the 7 is changed to UBCo, the question becomes which ‘leg’ of the route to keep as part of the frequent network: the connection with Downtown or Orchard Park?

**Figure 3: Current Routes in Glenmore**

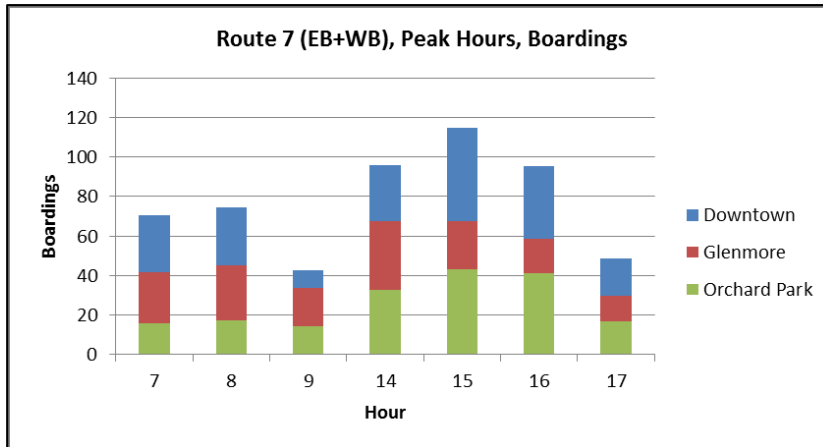


*Figure 3: Current routes in the Glenmore area overlaid on activity intensity per hectare. Darker colours indicate higher intensity.*





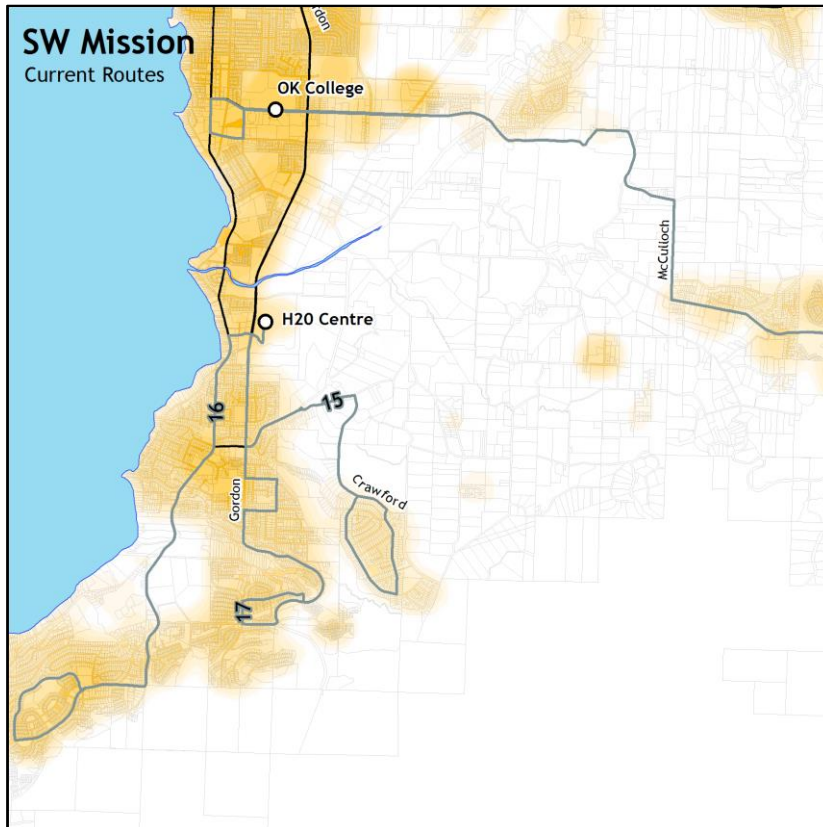
**Figure 5: Boardings per Leg in Peak Hours on Route 7 (Both Directions)**



*Case Study: Southwest Kelowna Shuttle Routes*

One of the key strategic directions for the City’s transit planning is to prioritize areas with high ridership potential. Given a fixed budget, this may entail reducing service in areas where service is less productive. There are currently four routes in the southern part of the City: the 12 McCulloch, 15 Crawford, 16 Kettle Valley, and 17 Southridge.

**Figure 6: Overview of South Kelowna Shuttle Routes**



*Figure 6: Existing shuttle routes in Southwest Kelowna overlaid on activity density per hectare.*

These routes fall in the bottom quartile of nearby activity per kilometre and boardings per revenue hour. As shown in Table 2 below, when boardings and nearby market potential are normalized and added together, the four southwestern routes receive the lowest ranking.

**Table 2: Results of Multicriteria Evaluation on Kelowna Routes**

Route	Nearby Activity (per km)	Boardings (per rev. hr)	MCA Score	Rank
8 University	2643	50	0.79	1
2 North End	4499	29	0.78	2
1 Lakeshore	2627	42	0.71	3
97 Okanagan	1677	47	0.66	4
10 North Rutland	2721	34	0.64	5
9 Shopper Shuttle	3520	23	0.62	6
11 Rutland	2396	30	0.57	7
5 Gordon	2978	22	0.55	8
6 Glenmore/UBCo	1599	36	0.54	9
3 Dilworth	1339	38	0.53	10
13 Quail Ridge	988	33	0.44	11
4 UBCo Express	1855	23	0.43	12
7 Glenmore	1568	23	0.40	13
14 Black Mountain	1241	22	0.35	14
16 Kettle Valley	695	19	0.26	15
12 McCulloch	1126	13	0.25	16
17 Southridge	800	15	0.24	17
15 Crawford	633	10	0.17	18

*Table 2: Results of MCA on Kelowna bus routes. Nearby activity and boardings per revenue hour are normalized and summed (even weighting) to determine the final rank.*

## Discussion

Above all, the Transit Analytics System is a tool to support transparent decision making and assist in communication. In the case of potential network changes in Glenmore, it helps visualize ridership by route segments and prioritize resource allocation. When evaluating the performance of routes in southwest Kelowna, the activity surface provides graphic reinforcement for the prioritization of the transit core.

While this project represents an important step towards a decision support system for transit in the Central Okanagan, there remains work to be done to improve the methods and expand the analysis into multiple dimensions. To begin with, the network analysis does not yet consider cycling connections to transit. This is a key area for improvement given the potential of cycling as a ‘last mile’ solution and its importance with the City’s transportation plans. Second, future versions of the Transit Analytics System should utilize more accurate representations of the pedestrian network. Rather than applying a standard walking distance, a more nuanced view of pedestrian accessibility could incorporate measures of safety and comfort through sidewalk widths, safe crossing points, topography, and the amount of traffic.



## **Conclusion**

Automated analysis cannot supplant discretionary judgement, and transit planning cannot be driven solely by the rigid application of criteria. The Transit Analytics System is a tool to help decision making. Its purpose is to reduce the time spent on data manipulation and synthesis, and allow more time for analysis and discussion. It provides a visual statement of principles, a clearer communication of trade-offs, and a more rapid assessment of alternatives.

## **References**

Guerra, E., Cervero, R., & Tischler, D. (2012). Half-Mile Circle: Does it Best Represent Transit Station Catchments? *Transportation Research Record*, 2276, 101-109. DOI: 10.3141/2276-12

## **Authors Information**

Cameron Taylor-Noonan  
M.A. Candidate  
School of Community and Regional Planning  
University of British Columbia  
433-6333 Memorial Rd  
Vancouver, BC V6T 1Z2  
[ctaylornoonan@gmail.com](mailto:ctaylornoonan@gmail.com)

Rafael Villarreal  
Regional Planning Manager  
Sustainable Transportation Partnership of the Central Okanagan  
206-346 Lawrence Ave  
Kelowna, BC  
[rvillarreal@kelowna.ca](mailto:rvillarreal@kelowna.ca)