HOW DO PEDESTRIAN CHOOSE THEIR ROUTES?

PREDICT THE PEDESTRIAN ROUTE CHOICE PATTERN AROUND RED LINE CENTRAL STATION IN THE EVENING PEAK HOUR

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Subject: Advance Spatial Analysis

Key Reference:
Ewing, Reid, and Susan Handy. "Measuring the unmeasurable: Urban design qualities related to walkability." Journal of Urban design 14.1 (2009): 65-84.
Golledge, Reginald G. "Path selection and route preference in human navigation: A progress report." International Conference on Spatial Information Theory. Springer Berlin Heidelberg, 1995.
Hess, Paul, et al. "Site design and pedestrian travel." Transportation Research Record: Journal of the Transportation Research Board 1674 (1999): 9-19.
Speck, Jeff. Walkable city: How downtown can save America, one step at a time. Macmillan, 2013.

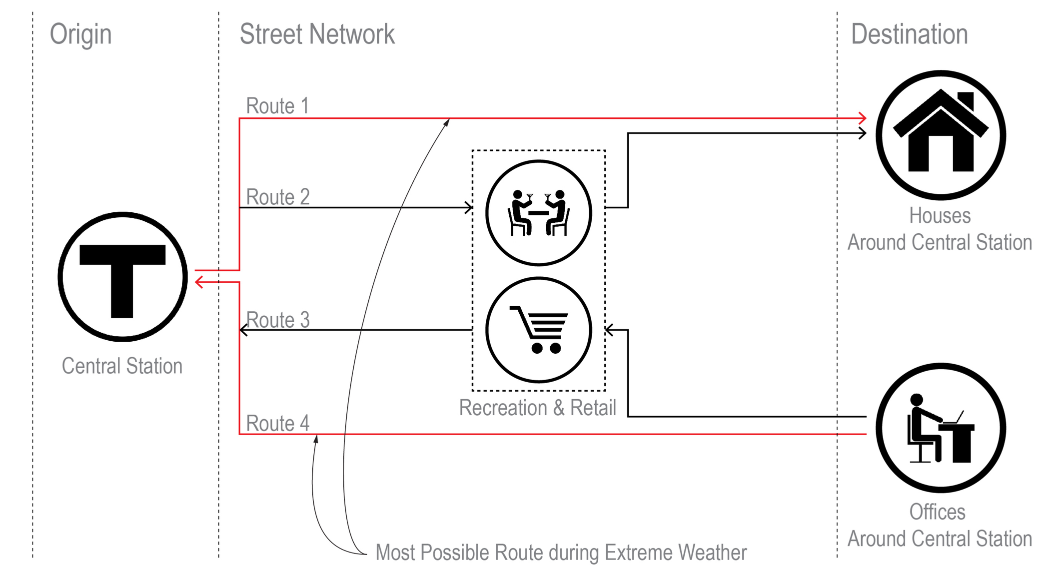
INTRODUCTION & HYPOTHESIS

Influenced by various factors such as safety and comfort of the streets, pedestrian route choice is closely related with the vitality of street network in a city. Especially around the subway station during a certain time period of a day, the pedestrians tend to choose some specific routes rather than randomly walk around. In order to find out how pedestrians choose routes around a subway station during the evening peak hour, we look into the areas within one kilometer walking distance from the MBTA Central Station in Cambridge as a case study. By route choice modeling and field survey, we come up with a best fit prediction model to simulate the pedestrian flows around the Central Station during the evening peak hour.

In our case study, there might be four possible directions of pedestrian flows around the Central Station during the evening peak hour, with different pairs of origin and destination. Firstly, those employees working around the Central Station often take the subway to go back home during the evening peak hour. Secondly, local Cambridge residents around central station who work remotely or possibly walk from the Central Station home in the evening peak hours.

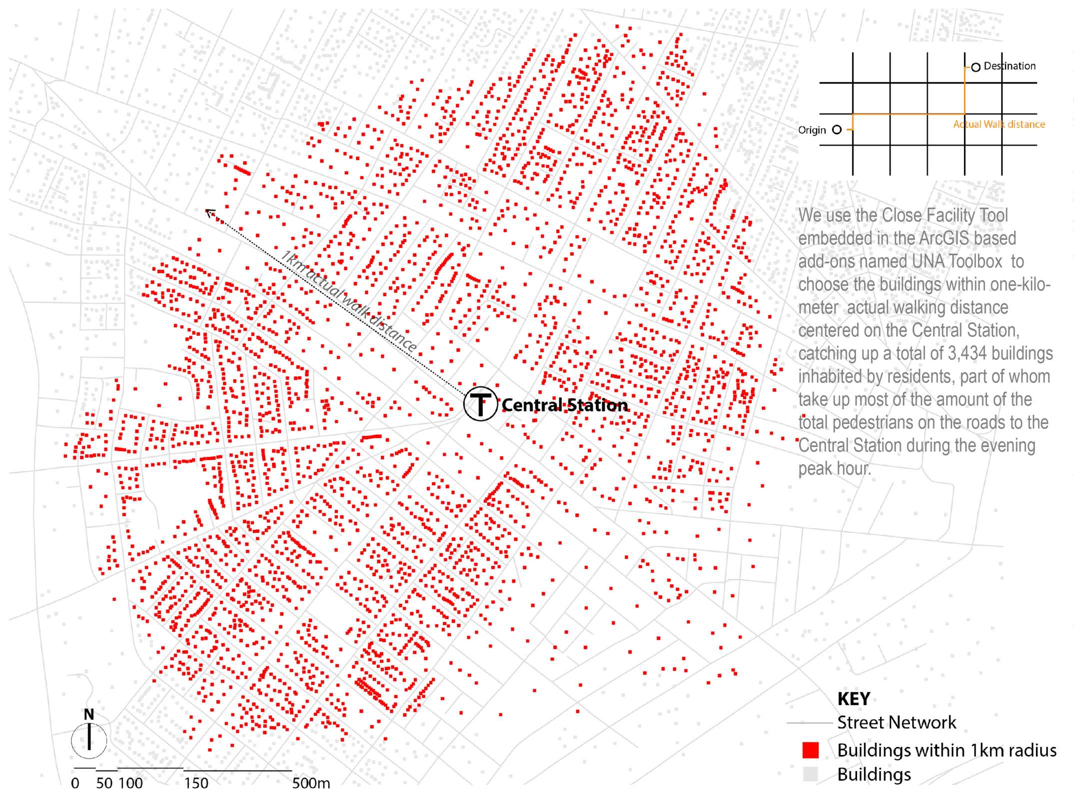
In these two possible kinds of travelling routes, pedestrians might also wonder around for shopping, entertainment or some other activities on their way home. However, under some extreme circumstances, especially when the weather is cold and rainy for example, which was exactly the case of the day when we carried out our survey, we might presume that during the evening peak hour, pedestrians on the roads around the Central Station, possibly directly walk from their workplace to the Central Station, or from the station to home without any intentional detours on the way.

However, between those two possible kinds of travelling routes, we also presume that pedestrians on the roads around the Central Station during the evening peak hour, are mainly those local Cambridge residents who work remotely or possibly in other cities of Boston, and after work should take the subway home. Therefore, it is those local Cambridge residents who take the subway to work that our prediction model focuses on.

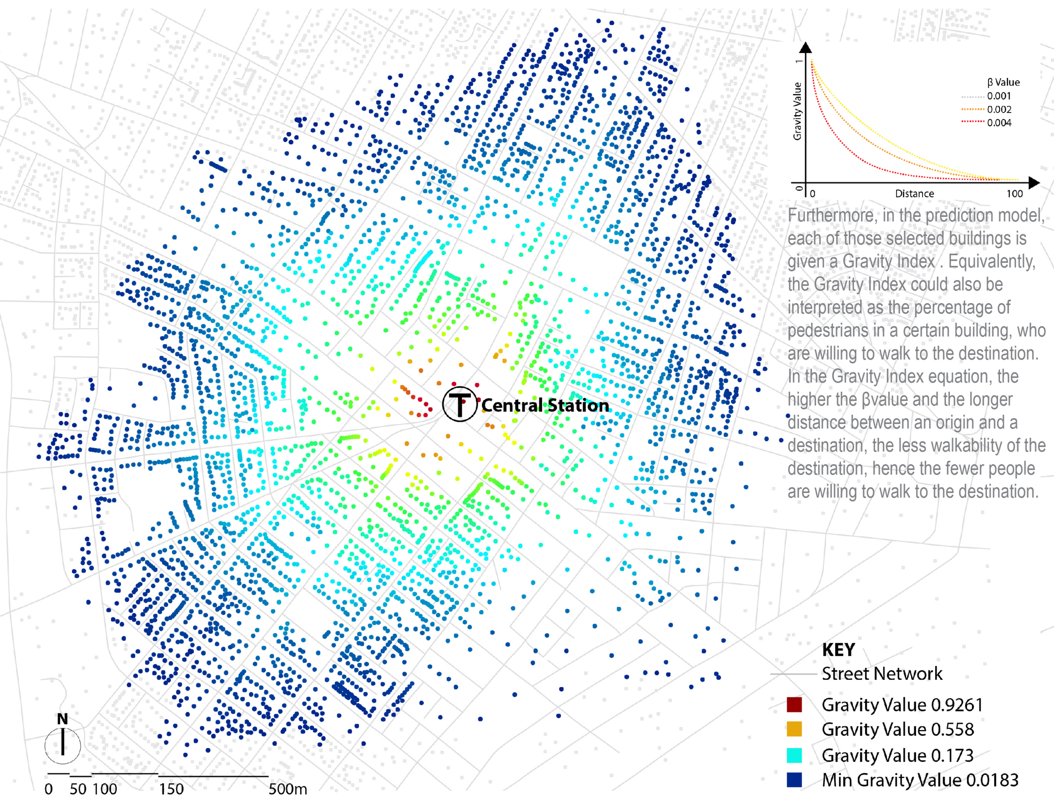


PREDICTION MODEL

Our prediction model is used to predict the pedestrian flows on each street segment, considering mainly three parameters: 1) The types of pedestrian (employee or resident); 2) pedestrians' sensitivity to travelling distance ; 3) and the directness of the routes that pedestrians travel.



We use the Close Facility Tool embedded in the ArcGIS based add-ons named UNA Toolbox to choose the buildings within one-kilometer actual walking distance centered on the Central Station, catching up a total of 3,434 buildings inhabited by residents, part of whom take up most of the amount of the total pedestrians on the roads to the Central Station during the evening peak hour.



Furthermore, in the prediction model, each of those selected buildings is given a Gravity Index . Equivalently, the Gravity Index could also be interpreted as the percentage of pedestrians in a certain building, who are willing to walk to the destination. In the Gravity Index equation, the higher the βvalue and the longer distance between an origin and a destination, the less walkability of the destination, hence the fewer people are willing to walk to the destination.

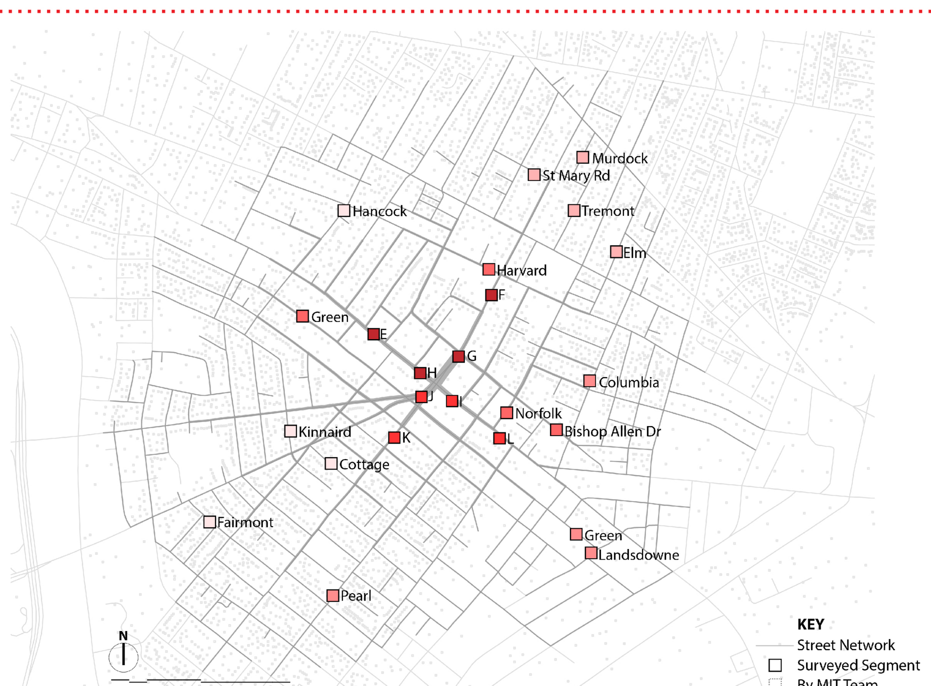
Based on the Gravity Value of each building and general percentage of population in Cambridge who usually take subway travelling back and forth between workplace and home , each building is weighted by

Weight=R*53%*19%*β

R: Residents in each building;
53%: There are 53% of the Cambridge residents who work;
19%: Among the Cambridge residents who work, there are 19% of them take the subway back and forth between workplace and home;
β: In this case we use 0.004 as discussed previously.

FIELD SURVEY

Using Betweenness Tool , we predict the pedestrian flows on all the street segments within one-kilometer distance from the Central Station, with a detour ratio of 1.1, given each building weighted by "R*53%*19%*β" respectively. Then we rank the street segments by the pedestrian numbers predicted in descending order; and pick out 8 street segments from top 5% of the busiest street segments, 4 street segments from top 5% to 20% less busy streets, and 4 from 20% to 45%, 4 from 45% to 60% and 4 from 60% to 75%. Finally we get a total of 24 street segments to count the actual number of pedestrian from 6:30 pm to 8:00pm on February 15th. Then we multiply the pedestrian flows of each selected street segment by its corresponding ratio to achieve an hourly pedestrian flows of the segments.



Rank	Predicted Top 1%-5% Busiest Street				Predicted Top 5%-10% Busiest Street				Predicted Top 10%-20% Busiest Street			
Street Name	Mass Ave E	Prospect F	Prospect G	Mass Ave H	Mass Ave I	River St J	Magazine St K	Mass Ave L	Bishop St	Norfolk St	Harvard St	Green St N
6-7pm	269	129	215	311	523	279	32	286				14
7-8pm									52	43	23	

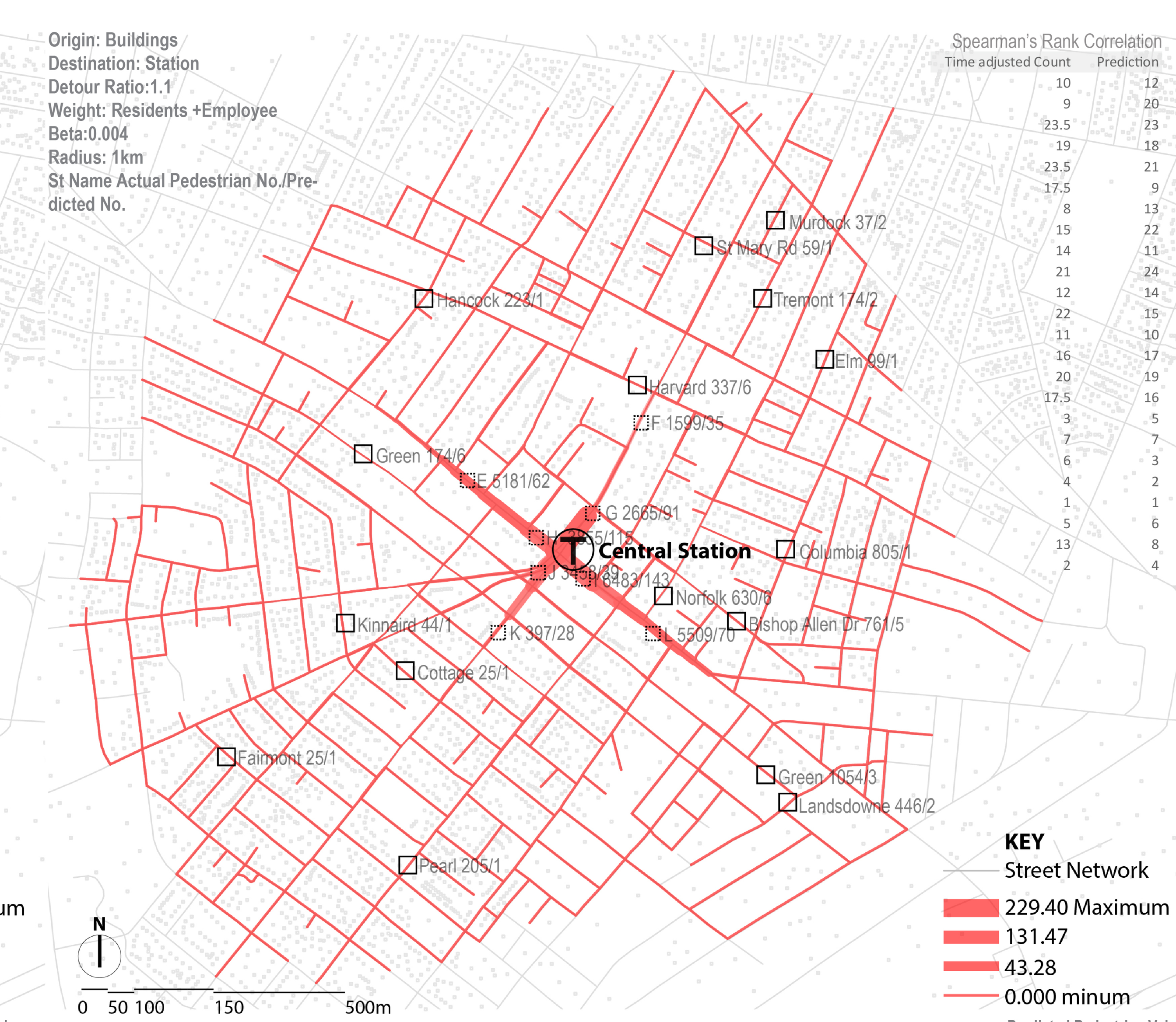
Rank	Predicted Top 25%-45% Busiest Street				Predicted Top 45%-60% Busiest Street				Predicted Top 60%-75% Busiest Street			
Street Name	Columbia St	Green St	Landsdowne St	Pearl St	Murdock St	St Mary Rd	Tremont St	Elm St	Cottage St	Fairmont St	Hancock St	Kinnaird St
6-7pm		85	36		3		14	8	2	2	18	
7-8pm	55			14		4						3

PREDICTION MODEL TEST & SCENARIOS

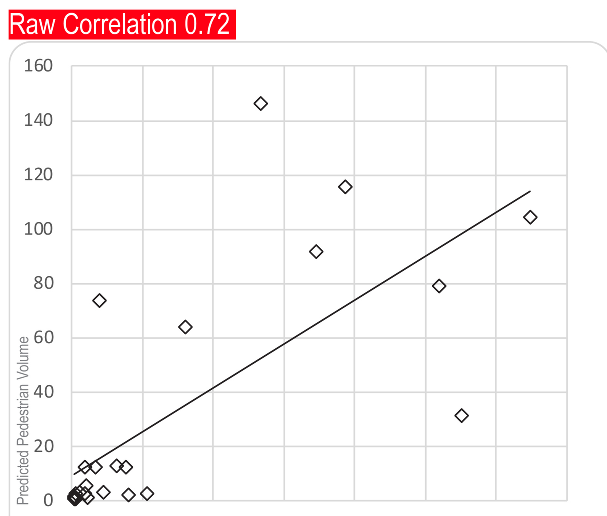
RESIDENTS < STATION The first scenario assumes the local residents, who live within one - kilometer walking distance from the Central Station but work remotely, will take the subway. When the β value is 0.002, and detour ratio is 1.1, the actual and predicted pedestrian flows on the selected 24 street segments, have a Raw Correlation of 0.72 and Spearman's Rank Correlation of 0.78.

EMPLOYEES > STATION The second scenario only considers that the employees who work within one - kilometer walking distance from the Central Station but live remotely. It turns out that, if the β Value is 0.004, and the detour ratio is 1.0, the actual and predicted pedestrian flows on the selected 24 street segments, have a Raw Correlation of 0.90, along with Spearman's Rank Correlation of 0.86.

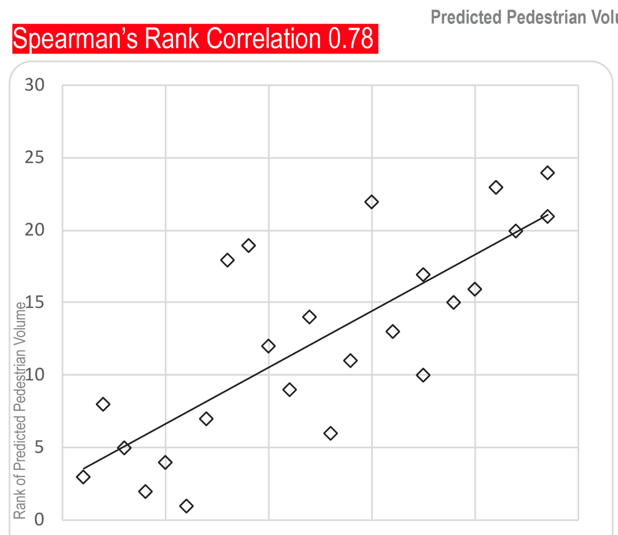
RESIDENTS < STATION & EMPLOYEES > STATION In the third scenario, we presume that above two types of commuters constitute the major amount of the pedestrians on roads around the Central Station within one - kilometer walking distance. It turns out that in this scenario when the β is 0.004, and the detour ratio is 1.1, the actual and predicted pedestrian flows on the selected 24 streets segments, have a Raw Correlation of 0.89 and Spearman's Rank Correlation of 0.83.



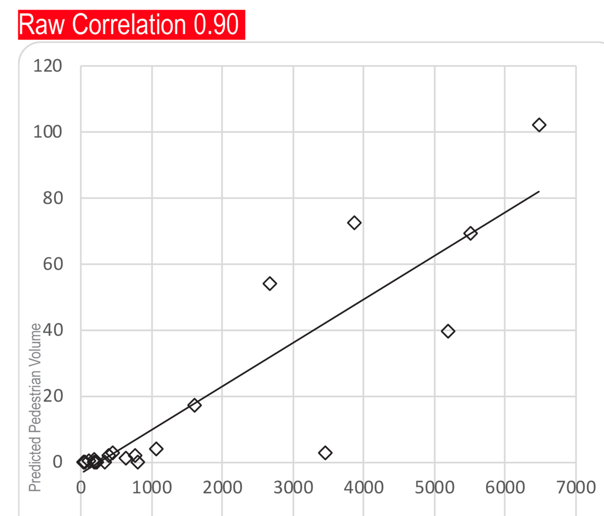
Raw Correlation 0.72



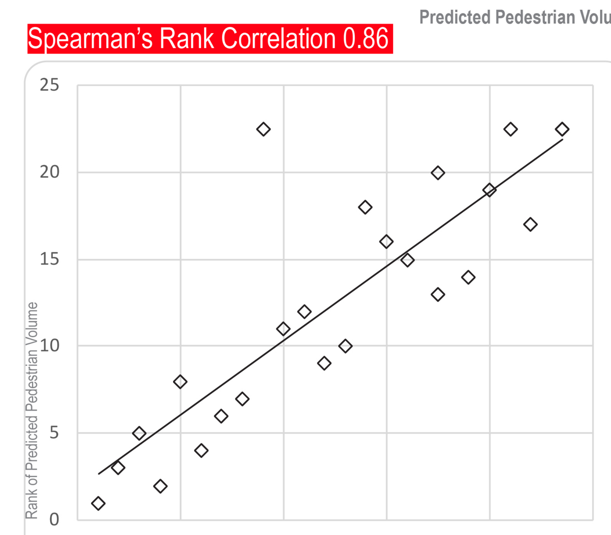
Spearman's Rank Correlation 0.78



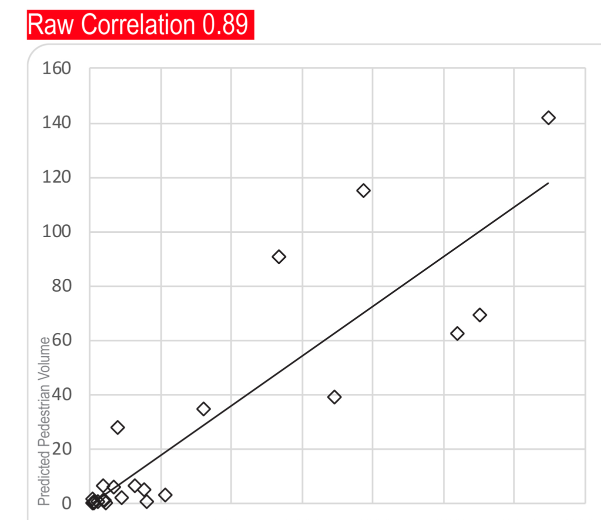
Raw Correlation 0.90



Spearman's Rank Correlation 0.86



Raw Correlation 0.89



Spearman's Rank Correlation 0.83