GIS NETWORK ANALYSIS REPORT

A GIS Network Analysis Involving Various Kebab Shops Across London

GROUP 16

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Contents

1. Introduction

1.1 Necessity for the report

The Kebab industry has made a significant presence in the UK's economy and culture, which can be seen through the rapid growth of awards like the British Kebab Awards (1). Whether it's for a quick snack, a late-night munch or a meal of delicacy, a kebab is the ideal choice due to the variety available and the cost effectiveness. There is a strong demand for kebabs in Britain as seen through figures which show that 1.3 million kebabs sold daily across Britain (2). Therefore, a route to the best kebab shops around London, being the capital of Britain, is very much necessary. In order to do this, kebab shops were assessed based on quality of food, price effectiveness, location and service. Of these, the ones located in Zone 1 were then chosen. The most convenient route was then mapped, linking all the kebab shops together. This route will be useful to any kebab lover, locals and tourists, as it provides a quick and easy route to some of the best kebab shops in London.

1.2 Objective of the Report

There are 4 main objectives of this report:

1. To find the best route possible in visiting the highest-rated and award-winning kebab stores in proximity to UCL
2. To find kebab shops within a 2.4 km radius around UCL for pedestrians (since a majority of students do not own a car, or do not have time to travel quite far between lectures)
3. To find the most popular kebab shops based on census data and determine their respective service areas.
4. To determine the closest Kebab shops to UCL, with a maximum of 15 minutes walking distance.

2. Criteria for Analysis

The routes to the kebab shops were determined after considering different criteria. The criteria which the project was based off are as follows:

- Accessibility via London Underground: Since public transportation is one of the most common methods of commute by Londoners, the use of the London Underground, combined with walking, was taken into consideration as a method of transport between stops.
- Accessibility via car: In another instance, visiting multiple kebab stops can be considered recreational. In this case, the route determined can be used for a road trip, in which driving would be the preferred method of transport.
- Proximity to UCL: The kebab locations considered for this analysis are the ones located within an arbitrary 2.4km radius of UCL. This is to simplify the problem and limit the number of kebab shops such that a road trip is realistically possible.
- Population Density: It is assumed that kebab shops located in densely populated areas would be more popular, therefore likely to be busier. By using census data, this will help determine which shops are located in the more densely populated areas, and which shops are within a certain distance from them. In the event of all popular shops being busy at a given time, other shops would be highlighted and can be considered alternative choices.

3. Datasets

3.1. Various Datasets used

File	Format	Source
OS MasterMap® Integrated Transport NetworkTM (ITN) Layer	GML2	Edina Maps
OS MasterMap Topography Layer	File Geodatabase	Edina Maps
Points of interest	Comma Separated Value	Edina Maps
TFL London Tube Map	Shapefile	ArcGIS Online
Population Data	Shapefile	Edina Maps
Google Maps Locations	KML	Google Maps

Table 1: List of Datasets Used and Corresponding Source

3.2. Conversion of data for application in ArcGIS

3.2.1. OS MasterMap® Integrated Transport NetworkTM (ITN) Layer

The layers obtained from the ITN datasets cannot straightforwardly be imported into the data frame as it is in the GML2 format. In this case, the appropriate feature classes from the ITN folder, namely the *Road Links* feature classes, were exported using the **Feature Class to Feature Class** tool, and were then used included in the creation of the *Transportation* feature dataset.

3.2.2. Points of Interest (POI)

The data for POI was obtained from Edina Digimap in the form of a *.csv file. A Qualifier data filter was applied to the excel sheet to filter it for the Kebab shops in London and the file updated accordingly. The filtered data was then saved in *.csv file format and was then imported to ArcGIS.

This data was used to locate certain kebab shops in Zone 1 London. More data for highly rated kebabs was obtained using the British Kebab Awards, the Evening Standard and the Londonist. This data together with the POI file was used to locate the best kebab shops in London and those closest to UCL. The coordinate system of collected data was then converted from WGS 1984 to British National Grid.

3.3.3 London Underground Data

The TfL Underground data was obtained from ArcGIS Online. The file used was uploaded by a user named 'Mon Zacharias,' (5) which implies that the data may not be completely accurate as it is not officially from ESRI. The coordinate system was then converted to the British National Grid System from WGS 1984. The data obtained, however, does not provide any information on the exact

location of the entrances and exits of London Underground stations. This information is important as it is necessary to establish connectivity between the tube stations and the streets. Because of this, tube entrances and adjoining paths to the stations were assumed.

Moreover, the information regarding the duration of transit was calculated using the average speed of each tube line (6) and dividing it by the respective distance between the required stations. This information was then added to the attributes table of the underground lines.

4. Methodology

4.1 Tools used

Tool	Necessity in Project
Project	Convert data from WGS 1984 to British National Grid
Buffer	Highlight all elements in a 2.4 km radius around UCL
Clip	Clips features to show only elements within the buffer
Feature to Point	Converts *.csv data to a point shapefile
KML to Layer	Converts data downloaded in *.kml to shapefile
Select Layer by Attribute	Creates layer based on selected attribute from table (extracts all kebab shops from the Points of Interest table)
Feature Class to Feature Class	Converts shapefiles to Feature Classes to be used in a Feature Dataset
Summary Statistics	Summarises data based on specified attribute
Split Line at Point	Used to split the London Underground tube lines between stations

Table 2: Tools Required to Carry Out Project

4.2. Network Analysis

Network Analysis was the main tool used in this project, as it determined the best routes and facilities against multiple variables. The expected outputs are as follows:

1. Route Analysis to determine fastest route for visiting specified kebab shops
2. Route Analysis to determine the best route from a multimodal network dataset
3. Service Area Analysis to determine estimated walking time from kebab shops in densely populated areas.
4. Closest Facility Analysis to determine kebab shops 15 minutes' walking distance from UCL.

4.2.1 Preliminary: Obtaining Topographic Data

1. Download Datasets from Edina Digimap: OS-Topography, ITN Networks, Census Data, and Points of Interest.

4.2.2 Sourcing Kebab Shop Data

1. Source the list of 2017 winners from the British Kebab Awards (1). From this list, select the ones located in London. These locations were first plotted in Google Maps for visualisation. Upon observation, it was seen that locations were quite scattered among zones 1-6, as seen in Figure 1. These points were exported as a *.kml file.

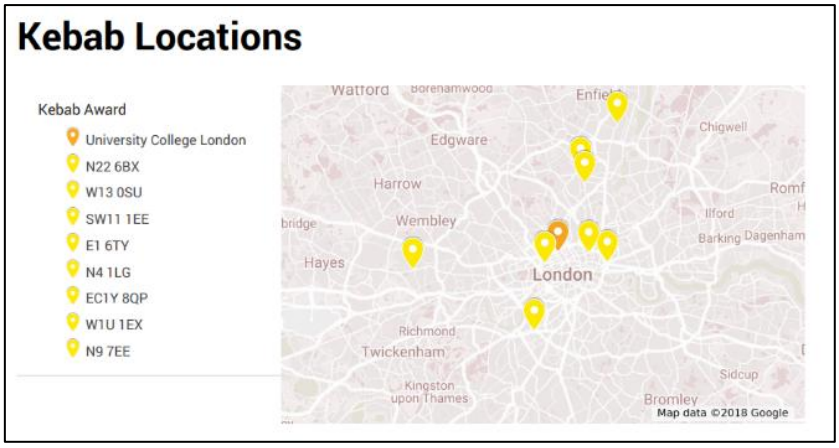

Figure 1: Test Map Showing Initial Points for Analysis from the British Kebab Awards

2. Find articles for highly-rated kebab shops in London. The lists referenced were from Londonist (3) and Evening Standard (4). Again, these points were plotted in Google Maps, but the locations still looked quite scattered. It didn't seem possible to do a road trip to all these kebab shops starting from UCL. Again exported the file as *.kml.
3. Download a Points of Interest (POI) file from EDINA as a *.csv file. This included all points of interest for the area specified, which would give shops not necessarily popular or award-winning, but would be in close proximity to UCL.
4. Open the POI dataset in Excel and use **Text to Column** tool to sort the data into columns, including *ITN Easting, ITN Northing*, and *Qualifier Type*.
5. Filter the points of interest to find names which contain the term 'kebab.' From these, set their Qualifier Type to *Kebab.*
6. In ArcMap, **Create Feature Class** from **POI.csv** 'from XY Table,' where the X and Y values are *ITN Easting* and *ITN_Northing* respectively.
7. Using the **Select Layer by Attribute** tool, Select all points in the POI file which fit the following equation: $Qualifier\_Type = "Kebab"$
8. Export the selected attributes as a new shapefile named *Kebabs2* and add to layout.

4.2.3 Processing London Underground Dataset

The data for the London Underground Tube network was found on ArcGIS Online (6). It was not officially created by ESRI, which questions its credibility. The tube lines layer is not fully compatible for doing a network analysis, meaning some conversions and transformations needed to be done to ensure an efficient network analysis.

4.2.4 Creating the TfL feature class

1. Import the *TfL_Lines* shapefile from the map downloaded from ArcGIS Online.
2. Import the station points layer, *Tube_Stations.*
3. Edit the points layer, and move the points so that they rest on the tube lines, by enabling **'Snapping to Edge'** in the Snapping toolbar.
4. For tube stations with more than one tube line, or lines which do not intersect, e.g. King's Cross, add new points on each line under the station points layer.
5. In the *TfL_Lines* layer, use the **"Split Line at Point"** tool to split tube lines in between stations. E.g. Northern Line would be split so that separate lines exist between stations such as Euston, King's Cross, Angel, and so on.
    a) [OPTIONAL] For clarity, edit the names in the **'LINE**' column in the *TfL_Lines* attribute table to specify line segments. E.g. Russell Square to Covent Garden, Covent Garden to Holborn, etc., as shown in Fig. 2.

TfL_Lines

OBJECTID_1 *	Shape *	OBJECTID	LINE	Transit_Tim	Shape_Length	Meters
26	Polyline	10	Russell Square to Holborn	17.349445	10669.908971	10669.908971
27	Polyline	10	Holborn to Covent Garden	1.0391	639.046492	639.046492
28	Polyline	10	Covent Garden to Leicester Square	0.506933	311.763859	311.763859

Figure 2: Edited Attribute Table

b) Add attribute field '*TransitTim*' to calculate the approximate time between stations. Values for the average speed of the tube lines were found online (6). The formula used was as follows:

TransitTim = **[SHAPE-Length]** / average velocity of corresponding tube line

6. Create a new point shapefile, *Tube_Entrances*, to link the tube stations to the street. This connects the tube station to the street in the form of an entrance. These points are not geographically accurate and are just assumptions.
7. Create a new polyline shapefile, *Transfer_Street_Stations*, to link the tube entrances to the stations.
8. Create a new polyline shapefile, *Transfer_Station*, to link multiple tube lines within the same station, e.g. King's Cross.
9. Create new file geodatabase, **kebab_tings.gdb** in the 'Kebab Tings' folder
10. From the mastermap-ITN folder, export the *.gml file '*RoadLine*' into **kebab_tings.gdb,** rename to *Roads.*
11. Convert *TfL_Lines*, *Stations*, *Tube_Entrances*, *Transfer_Street_Stations* and *Transfer_Station* from shapefiles to feature class, using the "Feature Class to Feature Class" tool. Export to **kebab_tings.gdb.**
12. Create new feature dataset under **kebab_tings.gdb,** named *Transportation.*
13. Import multiple feature classes. Select *RoadLine*, along with *TfL_Lines, Stations, Tube_Entrances, Transfer_Street_Stations* and *Transfer_Station*.

4.2.5 Creating Multimodal Network Dataset

1. Import all relevant map datasets to ArcMap.
2. Ensure the **'Network Analyst'** extension is turned on.
3. Under the *Transportation* feature dataset, create a new network dataset that will accommodate drivers, as well as pedestrians who have access to the London Underground. Name this **'LondonMultimodal_MD.'**
4. The dataset should include all the feature classes: *TFL_Lines, Roads, Transfer_Stations, Transfer_Street_Station, Tube_Entrances*, and *Tube_Stations*.
5. Set the number of group columns to 2.
    a) *TFL_Lines, Transfer_Stations, Transfer_Street_Stations*, and *Tube_Stations* should be set in group 1;
    b) *Roads* should be in group 2;
    c) *Tube_Entrances* in both groups 1 and 2. This differentiates between the tube network and the streets and ensures that people can't just travel in between street and tube network.
    d) *Tube_Entrances* are the connecting points between the 2 networks, therefore Connectivity Policy should be set to Override. This is shown in Fig. 3.

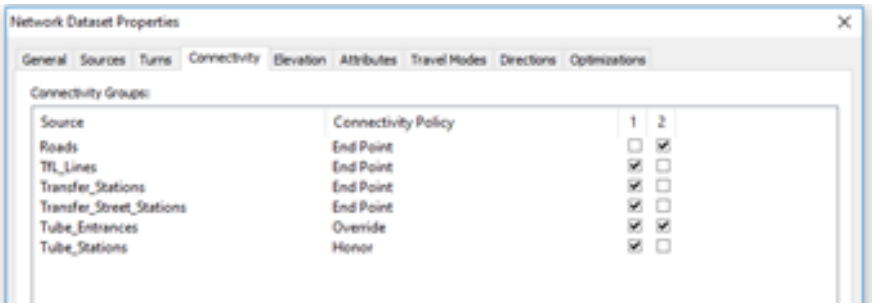

Figure 3: Edited Connectivity for Multimodal Network

6. There is no elevation set for this dataset, thus this is set to 'No' when asked to use elevation data.
7. Since the network is analysed via pedestrian and drive time, 2 time-cost attributes must be set: *PedestrianTime* and *DriveTime*. Both attributes are in minutes.
8. Add a restriction attribute for Driving a Vehicle, since vehicles cannot drive on one way roads.
9. Setting up a Meters evaluator to determine the length of each edge.
    a) For *Transfer_Stations* and *Transfer_Street_Station*, value is **SHAPE_Length**.

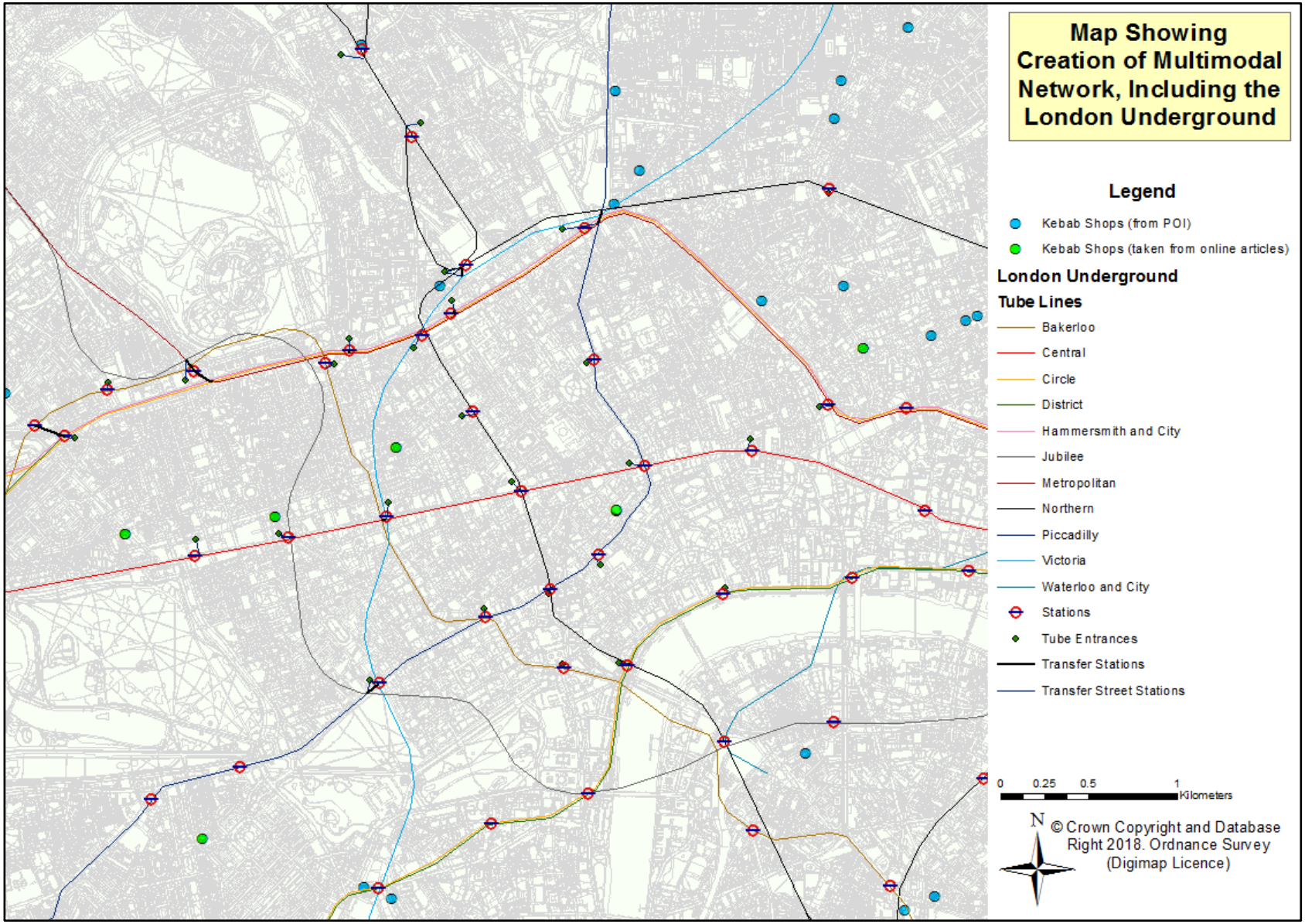

Figure 4: Map Highlighting the Multimodal Network Created for Pedestrian and Driving Routes

4.2.6 Finding Best Route by Car

1. From the **LondonMultimodal_ND** dataset, the route can be determined through Network Analyst.
2. A route analysis layer is created by selecting **New Route** in Network Analyst.
3. From the toolbar, click on **Stops,** and then click the **Create Network Location** tool.
4. In no particular order, select the shape representing UCL, along with all the kebab points located within the buffer.
5. Click the **Analysis Layer Properties** button to edit the properties of the proposed route.
6. Set Impedance to **Drive Time**. Ensure that all restrictions are checked.
7. Check the **'Reorder Stops to Find Optimal Route'** box, as well as **Preserve first stop.**
8. Click the **Solve** button to generate the route.
9. Click the **Directions** button to for a detailed breakdown of the route, the estimated distance and time of each element, and the total distance and time required for the route.

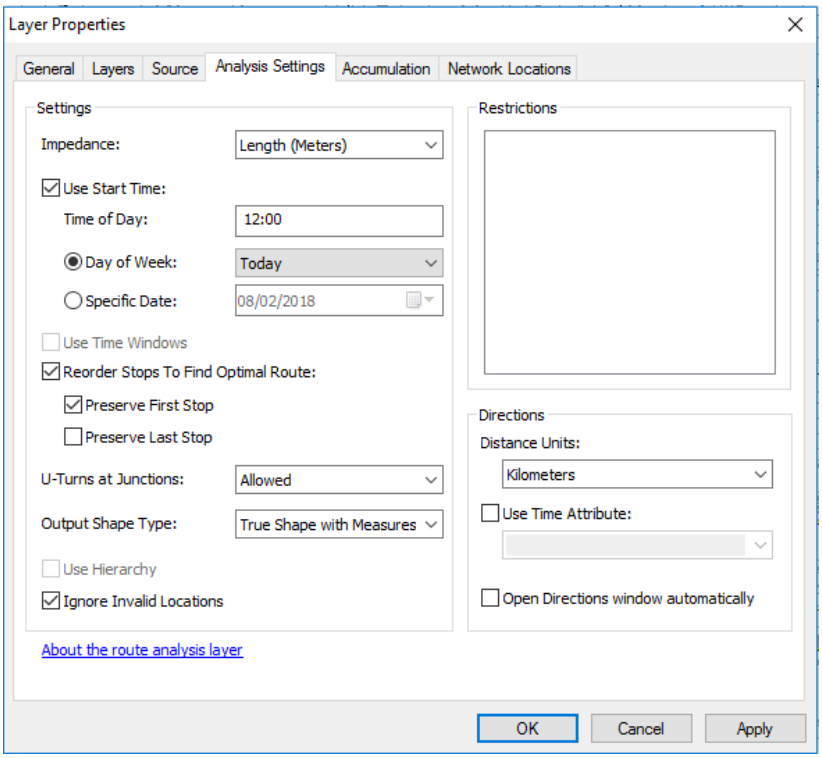

Figure 5: Factors Involved in Creating Driving Route

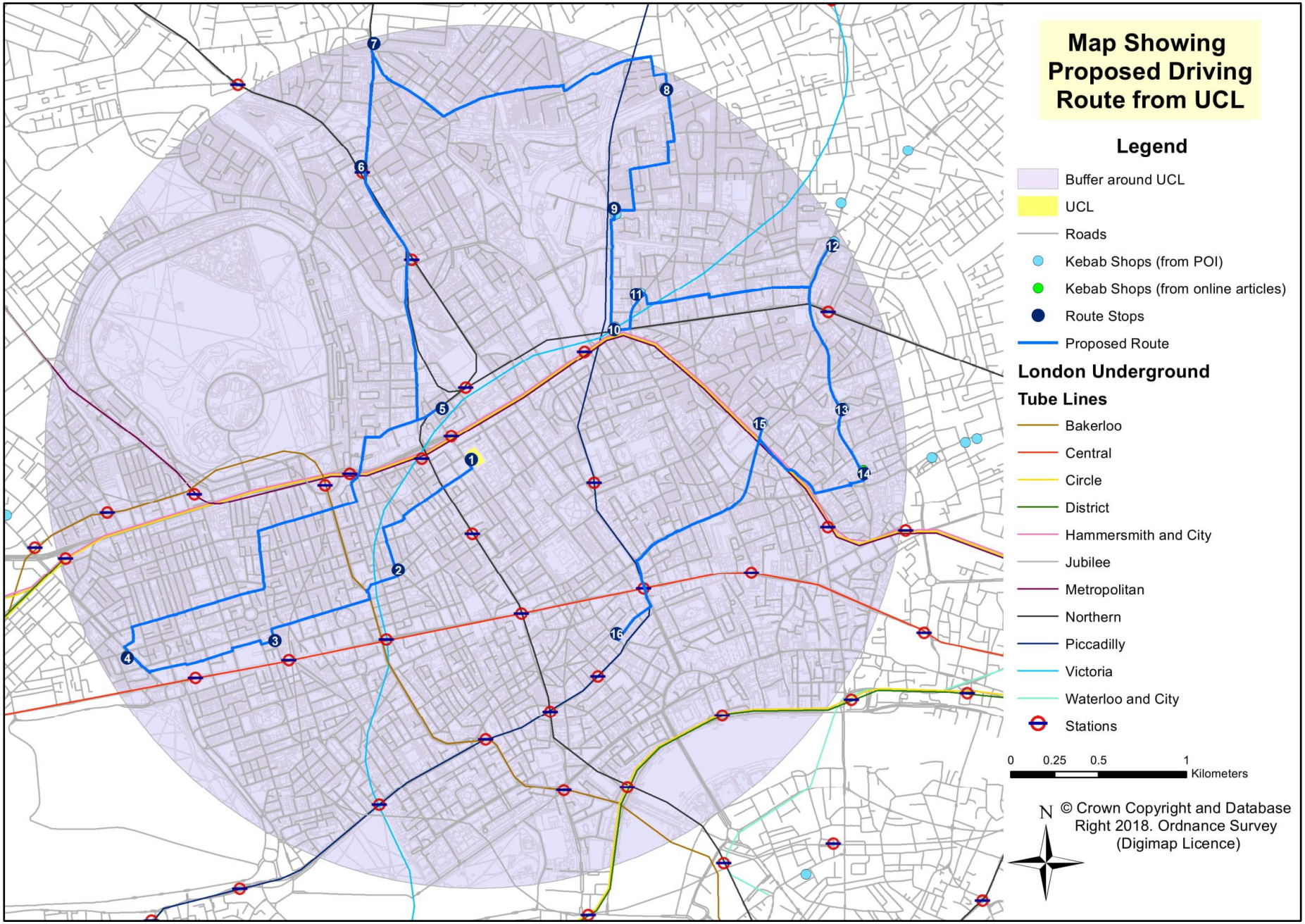

Figure 6: Map Highlighting Proposed Route via Car

4.2.7 Finding Best Route for Pedestrians

1. Like the driving route, select **New Route** in Network Analyst, click on **Stops** and then **Create Network Location.**
2. Select all kebab points within the buffer as well and the shape representing UCL.
3. Click **Analysis Layer Properties** to set impedance to **Pedestrian Time.** Since there are no restrictions on walking, uncheck these boxes.
4. Check the **'Reorder Stops to Find Optimal Route'** box, as well as **Preserve first stop.**
5. Click the **Solve** button to generate the route.
6. Unfortunately, two of the stops located at the top of the buffer were unable to be included in the pedestrian route. This can be attributed to an error when using the **Split Line at Point** to split the Northern Line shapefile, as the Northern Line consists of a loop between Camden Town Station and Morington Crescent Station, as seen in figure 7.

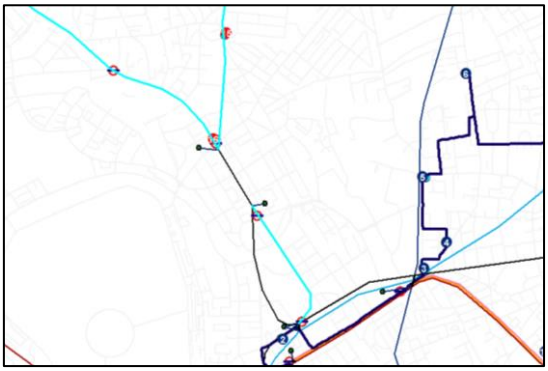

Figure 7: Map Highlighting an Error by Splitting Tube Lines, due to the Complexity of the Northern Line

7. Additionally, geographical data is not available for the tube routes as directions could not be set up when building the Network Dataset. This can be caused by the fact that tube lines had to be split manually, thus affecting the original properties of the shapefiles.

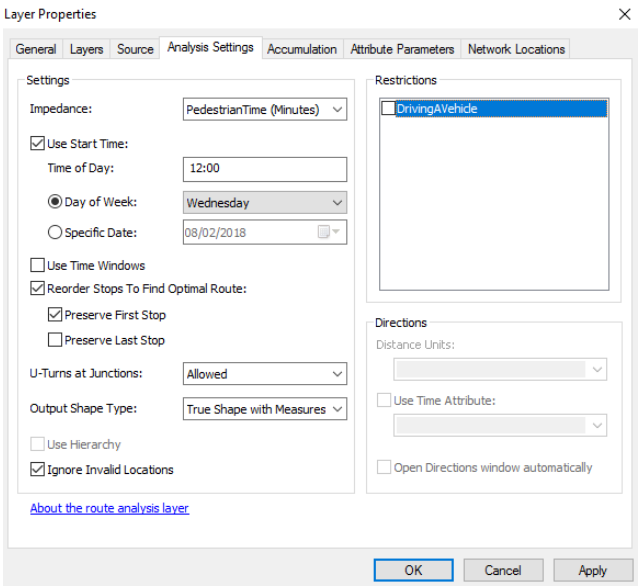

Figure 8: Factors Involved in Creating Pedestrian Route

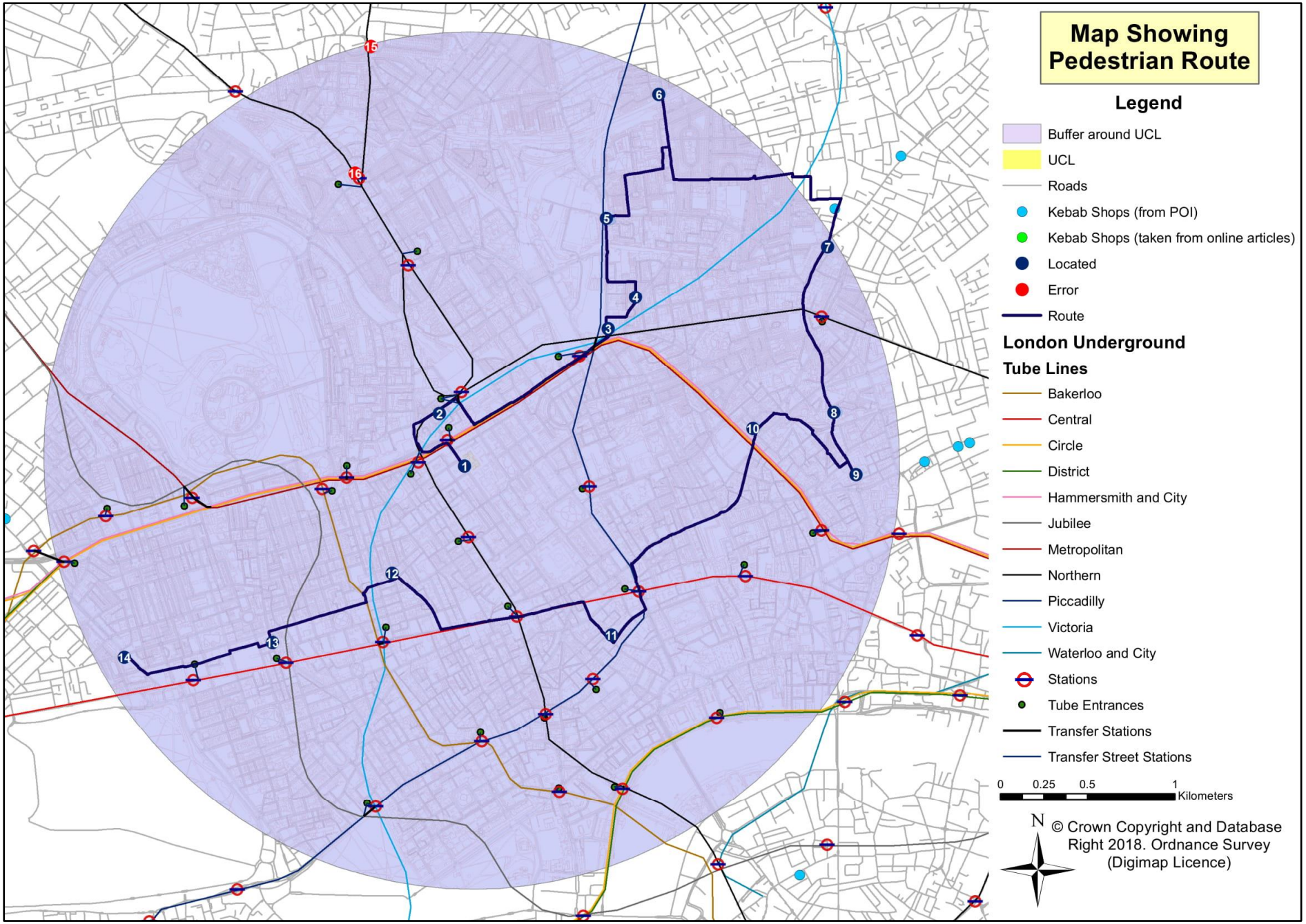

Figure 9: Proposed Route for Pedestrians, using the Multimodal Network

4.2.8 Determining Service Area for Potentially Popular Kebab Shops

Kebab shops are usually very small and can't accommodate many people. Therefore the census data for London is integrated into the map to determine how many people might visit the kebab shops which are closest to them. Then, a service area analysis is conducted to determine their proximity to other kebab shops.

1. **Integrating Census data:**

1) Load the census data available from EDINA Maps, available as polygons. These area converted into points, which is the form needed to do a closest facility analysis.
2) Load the census points into **Incidents**, setting **OBJECTID** as both name field and sort field.
3) Running the analysis gives a map with all the facilities, incidents, and network route to the incidents.
4) Join the route with census points, which identifies the number of people going to their respective kebab shops
5) Export the Routes as a new layer *Closest_Facility_Join*
6) Create

2. **Find service area for the popular kebabs:**

1) Use the **New Service Area** tool from Network Analyst
2) Under the **Facilities** tab, Load Locations:
3) Set up parameters for the analysis:
4) Under the Analysis Settings tab, set **Impedance** to **Length (Meters)**, this simplifies the analysis.
5) Set the **Default Breaks** text box as **250, 500**, and **750**. This represents the duration of walking for 5, 10, and 15 minutes, assuming a walking speed of 3km/h.
6) Set the Polygon Generation as **Merge by Break Value**
7) Run the network analyst

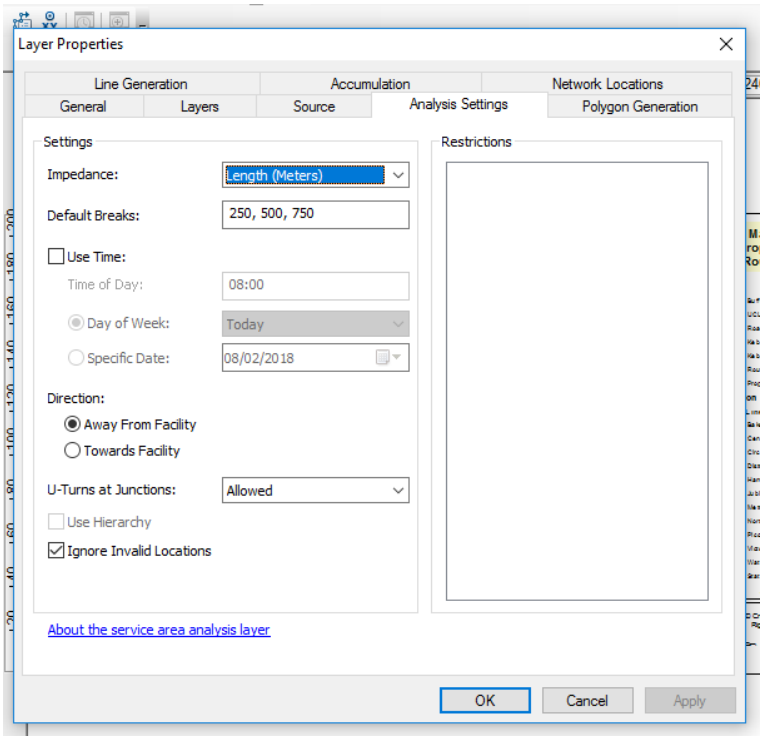

Figure 10: Dialog Box Showing Factors Considered for Closest Kebab Shops

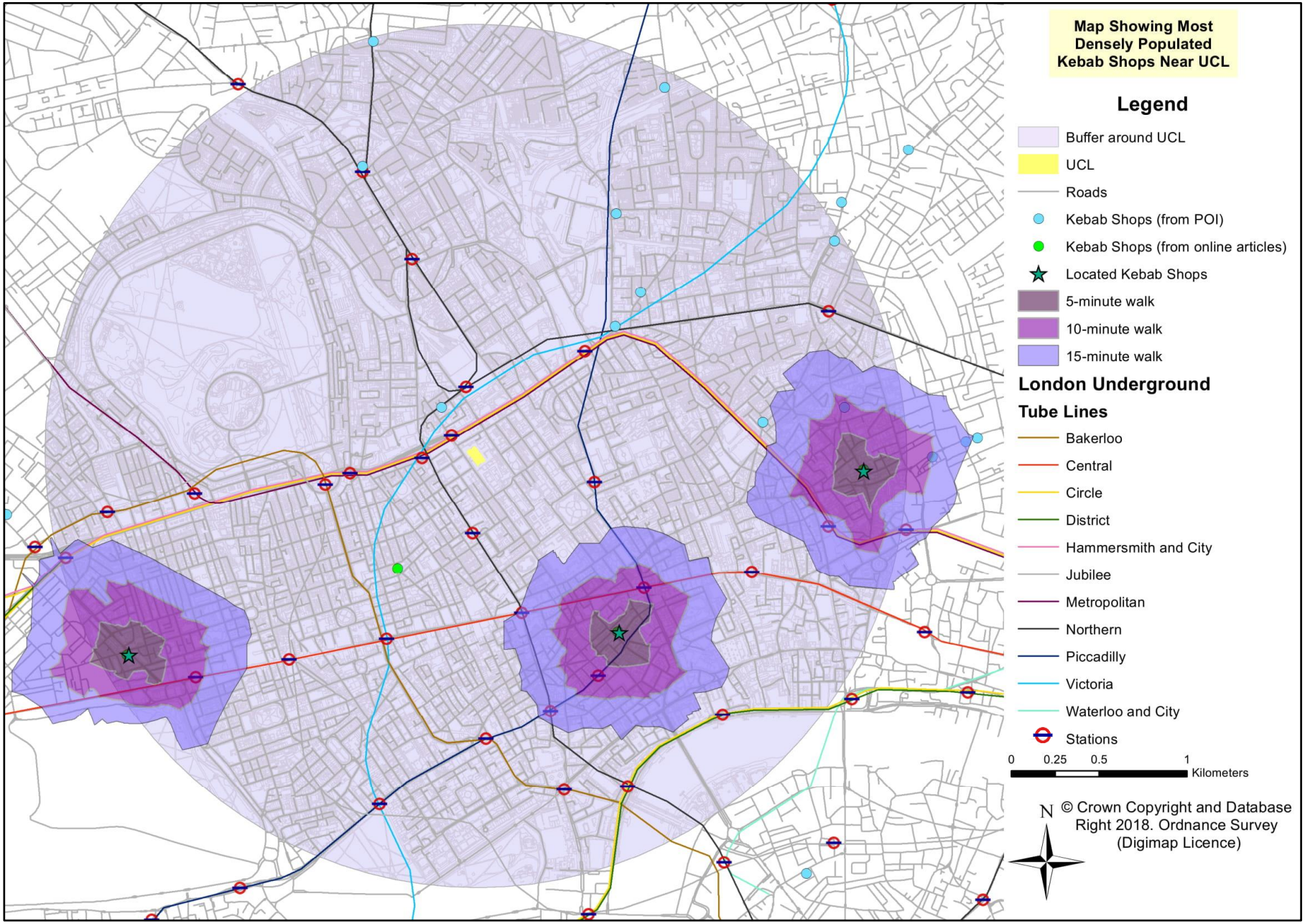

Figure 11: Map Highlighting the Most Densely Populated Kebab Shops within the Buffer

4.2.9 Finding the Closest Kebab Shops to UCL

Kebabs are a popular, cheap, 'on-the-go' meal. UCL students usually have a 1 - 2 hour break between classes, which makes kebabs the perfect lunch as it is both cheap and easily accessible. It is clear that there is an abundance of kebab shops near UCL, but not all may be accessible by students during their lunch breaks. By using the **Closest Facility** option via Network Analysis, the closest kebab shops to UCL can be found. For the closest facility, the shops located a maximum of 20 minutes away by walking will be determined.

1. Use the **New Closest Facility** tool from Network Analyst
2. Under the Facilities tab, load the locations of the kebab stops in proximity of UCL.
3. Add the location of UCL under the Incidents tab
4. Set up parameters for the analysis:
    a) Set **Impedance** to *PedestrianTime* (Minutes), this allows the analysis to be based on time
    b) Increase the **Facilities to Find** to **15**, which encompasses all the kebab stops near UCL.
    c) Type **20** in the **Default Cutoff Value**, this will find the kebab shops within 20-minute travel time from UCL.
    d) Check **Incidents to Facilities**
5. Run the network analysis.

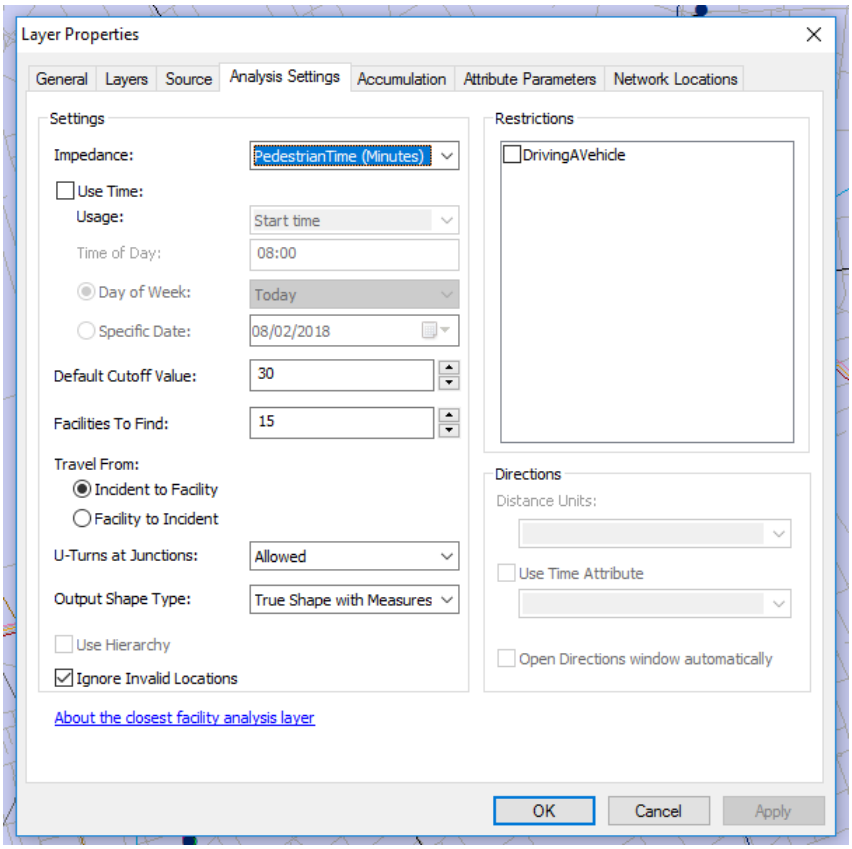

Figure 12: Dialog Box Showing Factors Considered for Closest Kebab Shops

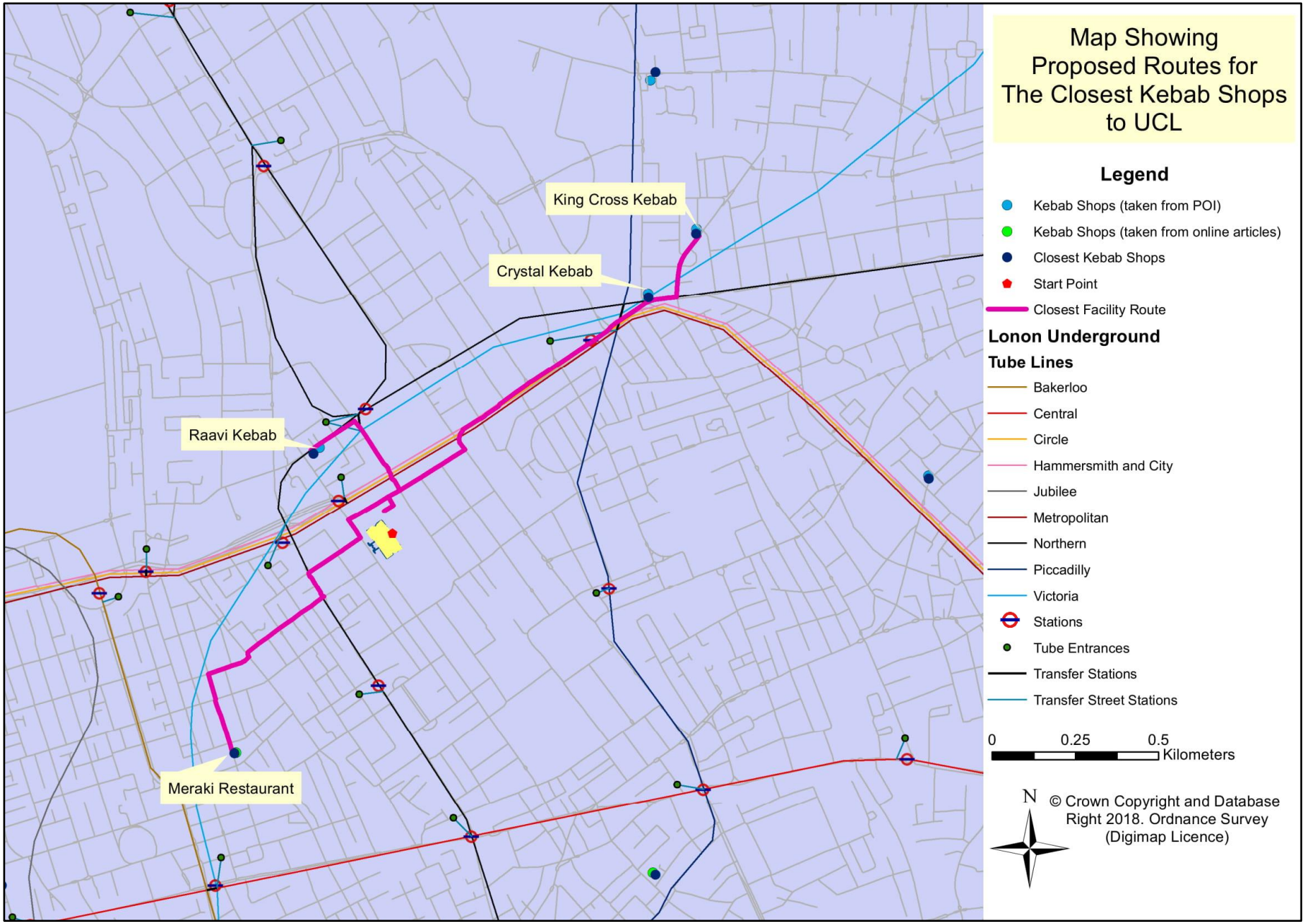

Figure 13: Map Showing Routes to the Closest Kebab Shops to UCL, with w Maximum of 15-Minute Walking Time

5. Analysis of Results

After analysing the data collected, the final map included 16 kebab shops within a 2.4 km radius around UCL. The quickest method of visiting each of the 16 locations was by following the car route, with the journey taking approximately 53 minutes to travel an estimated 17.6 km. This involves driving time only, assuming there is no traffic and a constant driving speed of 20 km / hr. In addition, the 4 nearest kebab shops to UCL were identified and the quickest walking route to each of them was highlighted. This would enable students studying at UCL to visit these shops during their lunch breaks, for example.

5.1 Constraints

The underground tube route timings may be slightly inaccurate since the time taken to walk within a tube station, the time taken to switch between lines, and the length of time for which the tube stops at a given station before departure were assumed to be constant values. In addition to this, an average speed for each tube line was applied to estimate the duration of the journey. In practice, however, the tubes will not maintain an average speed and also may operate quicker during different times of the day. Tube delays were also not accounted for, along with the duration of trains decelerating at each stop. In reality, these durations should be considered, especially since tube stations within Central London are located much closer to one another as opposed to those out of Zone 1.

5.2 Further Considerations

The only form of public transport considered was the London Underground. The use of busses can be considered to form an alternative route to the kebab shops. As there is the newly implemented Hopper Fare (7), this would prove to be significantly cheaper than travelling via Underground. Bus data, however was inaccessible online due to file formats which were difficult to manipulate for use in ArcMap, as well as copyright restrictions.

The use of bikes should also be considered, as it is a relatively fast and cheap form of transport. Students might prefer hiring bikes from Santander Cycles rather than taking the tube. Therefore cycle docking station locations also need to be considered.

For a more in depth analysis, live transit data is available on the TfL website in the form of API Open Data, including current traffic conditions and London underground timetables. This would be useful in incorporating the waiting time of each train, which makes the travel time more accurate.

6. Group Contribution Marks

NAME	CONTRIBUTION %	SIGNATURES
Farzaana Ali	100%	
Karina Augustine	100%	
Humaid Cader	100%	

7. References

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