A Team Final Report: Analysis of the Cycling trends in London

Course:	CO4 LSE Employer Project
Assignment:	Final Report
Prepared by:	A-Team
Prepared for:	Thoughtworks
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INTRODUCTION

CONTEXT OF THE REPORT

Transport for London (TFL), as guided by the London Mayor's Transport Strategy 2018 (MTS) has the central aim for 80% of all trips in London to be made on foot, by cycle or using public transport.

Cycling is expected to contribute towards TFL's goals and benefit society in general, in many ways. From lifting and shifting road traffic and reducing network bottlenecks to improving the health of everyday commuters. Cycling as a mode of transport has tremendous potential that requires thorough analysis to allocate sufficient and effective investment and ensure its long-term adoption.

MAIN THEMES OF HYPOTHESIS ADDRESSED IN THIS REPORT

The scope of our analysis focused on three main categories:

- Infrastructure: How does infrastructure affect uptake in cycling?
- Safety: How safe is cycling in London and is safety affecting uptake in cycling?
- Economic: How do socioeconomic factors contribute to cycling uptake?

PROJECT DEVELOPMENT PROCESS

CLEANING PROCESS

- The workstation was prepared by importing the necessary libraries and four data files (Central London.csv, Inner London.csv, Outer London.csv, Biking sites.xlsx) in a new Python3 file.
- Files were converted to DataFrames and sense-checked.

REPLACED

- Central London: 1.6% (11,834 entries) of rows with missing values in Weather column were replaced with 'Unknown'; 0.008% (64 entries) of rows with missing values in each, 'Number of private cycles' and 'Number of cycle hire bikes', column were replaced with medians (7 and 1 respectively) due to the data being highly skewed (skewness of just over 5.1); as a result 'Total cycles' column were recalculated;
- Inner London: 0.9% (4,674 entries) of rows with missing values in Weather column were replaced with 'Unknown'; 0.001% (6 entries) of rows with missing values in each, 'Start hour' and 'Start minute', column were replaced with 14

and 15 respectively (as the closest to the means - 14 and 23); as a result the corresponding missing values in Time and Period columns were replaced with ‘1415 – 1430’ and ‘Inter-peak (10:00-16:00)’ respectively;

- Outer London: 0.3% (968 entries) of rows with missing values in Weather column were replaced with ‘Unknown’;
- Biking sites: two missing values in ‘Functional cycling area’ column was replaced with 'Outer' in line with the assigned boroughs;
- Left as NaT: missing dates (1.3% of all entries in Central London, 0.5% in Inner London and 0.3% in Outer London); no pattern was identified to fill the missing dates.
- Duplicates: 2.9% (15,069 entries) of rows in Inner London DataFrame were removed.
- Outliers: none were identified.

IDENTIFIED AND CORRECTED ERRORS

- Central London: 648 dates (0.09% of all dates) from ‘Survey date’ column was assigned to the wrong year in ‘Survey wave (calendar quarter)’ column and 25,698 dates (3.4% of all dates) from ‘Survey date’ column were assigned to the wrong quarter in ‘Survey wave (calendar quarter)’ column;
- Inner London: 384 dates (0.08% of all dates) from the ‘Survey date’ column were assigned to the wrong year in the ‘Survey wave (year)’ column.
- New Weather classifications with 30 weather types was introduced to fix repeating and incorrectly spelt categories:
  - Central London: 283 categories were reduced to 30;
  - Inner London: 165 categories were reduced to 25;
  - Outer London: 124 categories were reduced to 23

R DATA CLEANING

- Two functions from the CycleInfraLnd package used to obtain either lines (get_cid_lines()) or points (get_cid_points()) from the Cycling Infrastructure Database;
- For each type of infrastructure a separate dataframe is created;
- Data observed and quick-checked for sanity;
- The size of the dataframe and datatypes checked;
- Missing values:

Missing data investigated and corrected manually where possible, using pictures and geographical points included in the TfL dataset. Missing boroughs corrected by combining a map of London boroughs boundaries with geo points of infrastructure. The main challenge was to assign a cycle lane to a specific borough in case when it goes through 2 boroughs or located on the border. The decision was made to manually match the lanes longer than 500 metres and not divided between boroughs and subset the rest from the dataframe. Out of 354 lanes, 69 were manually matched and 285 (about 1.14%) removed.

- Descriptive statistics for numerical columns used to see obvious outliers:

  One extreme value ("6482-04-01" in cycle_lane dataframe) was removed as it was not possible to define the correct survey date.

- Unique values checked to avoid duplicates and misspellings.

- The results are presented in the (**Error! Reference source not found.**).

ANALYTICAL APPROACH

INSIGHTS OR OBSERVATIONS RELATED TO GENERAL CYCLING TRENDS

- Upward cycling trend in Central, **Error! Reference source not found.** London between 2015-2019 followed by the drop related to COVID pandemic. Consistently low number of cycle trips in Outer London versus Central and Inner London whilst the population in Outer London is 1.5 times larger than in Inner London (Appendix: Graph 1 and 3).

- Higher cycling uptake during the Inter-Peak hours in Inner and Outer London and high number of cycling trips during the Evening hours in Inner London were observed in 2021 versus 2017-2019, suggesting that Londoners started to cycle for leisure more often (Appendix: Graph 2).

- Under 10% of commuters in Inner London and under 5% in Outer London choose bicycles as the method of travel to work, which makes it the 5th most popular method overall (Appendix: Graph 4).

- 74% of all cars in London in 2021 were owned by residents of Outer London (Appendix: Graph 5) They also live further away from their place of work than residents of Inner London. Nevertheless, the high percentage of Outer London population lives less than 10 kilometres away from places of work which makes it a cyclable distance.

INSIGHTS OR OBSERVATIONS RELATED TO EARNINGS

- Considered the effects earnings had on cycling numbers in all Central, Outer and Inner London. The rationale for this analysis was the presumption that boroughs with higher earnings would see higher cycling rates.

- Initially, determined the effect wages had on total and private cycling numbers in central London.

- Imported external data from ONS regards earnings per borough. https://data.london.gov.uk/dataset/earnings-place-residence-borough

- Compared percentage change in earnings to changes in total and private cycles between 2014 and 2019 (Appendix: Table 2)

- Note that City of London was excluded due to missing values regards earnings. Found little relationship between rising wages and rising cycling numbers.

- From here we then analysed boroughs which had the highest full-time weekly earnings compared to the cycling numbers in inner and outer London. The rationale was to determine if boroughs with the highest earnings also had the highest cycling number both total and then in subcategories (private, hire, male, female). (Appendix: Table 3 and 4)

- Again, found little evidence to suggest a strong correlation between boroughs with higher earnings and higher cycling numbers. Following this analysis, we decided to end any further investigation into earnings and cycling rates and focus our efforts on other hypotheses.

INSIGHTS OR OBSERVATIONS RELATED TO CYCLING SAFETY

- Safety is paramount as cyclists are road users. More cycling accidents will discourage the number of people cycling. Analysis of cycling safety in boroughs was conducted in groups for Inner London and Outer London (Appendix: Graph 6 and 7).

- There are relatively minimal changes over the years in terms of accidents. Most boroughs in London have accident counts of below 1000 over the 3 years. Lambeth, Wandsworth Camden, and Hackney have the highest number of accidents as compared to other boroughs. This is likely since the boroughs are densely populated with a high volume of commuters. High traffic levels would create a challenge for cyclists to navigate, contributing to the higher number of cycling accidents. Low numbers of accidents such as most of the boroughs in Outer London were likely due to the low population density in those areas.

- Based on the scatter plots of the number of accidents against the number of cycles for each borough over the 3 years, there is a plausible positive relationship that the number of accidents increases as the number of cycles increases in both Inner and Outer London (Appendix: Graph 8 and 9).

- More could be done to reduce the number of accidents as we move forward to increase the cycling uptake in the future. Using natural language processing, data was tokenized and extracted to a word cloud to show the common words that were used in each accident report (Appendix: Graph 10).

- Junction seems to be the word that was commonly used in most of the accident reports. Thus, it is viable to investigate junctions to enhance safety and reduce accident counts. Specifically, the sufficiency of infrastructures at junctions.

INSIGHTS OR OBSERVATIONS RELATED TO INFRASTRUCTURE

- We look separately at fully and partially segregated cycle lanes by borough, as the safest for cyclists. Additionally, cycle lanes in the parks and along the waterways were filtered as traffic-free zones that might be more suitable for inexperienced cyclists.

- Junctions were found to be the areas of high risk. ASLs, special signal lights for cyclists (giving them priority at the junctions) and special crossings were analysed as the most important.

- Traffic calming measures (speed humps) were included as they can slow down the traffic and make the streets safer for all (Appendix: Table 5 and 6).

- Findings have shown inequality in infrastructure development not only between Inner and Outer London, but also between boroughs. In general, Outer London has less infrastructure available (considering greater area and bigger population). Fully segregated lanes present only 3.2% in London on average, and it is even less for Outer London (2.83%). It is better for partially segregated lanes (about 10% in Outer vs 6% in Inner London). However, together it is only 11.88% of total length and it is not enough for a city like London.

- Junction safety infrastructure is predominantly located in Inner London: ASLs are mostly located in central boroughs (Lambeth, Southwark, Camden), while in Outer London their number is 50% less. Special signal lights are predominantly found in Inner London. There are lots of boroughs in Outer London where this type of traffic light does not exist at all. In Inner London Kensington & Chelsea has a lower number of infrastructure available than any other borough in this area.

- Traffic calming measures are the most frequent type of infrastructure, which might be connected to their lower cost, compared to cycle lanes or special types of crossings. It might be a cheaper solution to make roads safer for cyclists.

- Mini holland program boroughs (Waltham Forest, Enfield, and Kensington upon Thames) have more developed infrastructure (Appendix: Table 7 and 8)

Insights or observations related to Mini Hollands

- Following the infrastructure analysis, we decided to investigate the three boroughs that were part of the mini holland initiative: Waltham Forest, Kingston upon Thames, and Enfield. These boroughs received significant infrastructure investment and so could see the effects on infrastructure.

- Found that for Waltham Forest and Kingston upon Thames, there was a significant rise in cycling numbers between 2015 and 2021 (Appendix: Graph 11)

- We then took a deeper look at Waltham Forest, as it experiences a continual growth in cycling numbers even during the Covid-19 years.

- We found that over the same period, there was a significant rise in both male and female cycling as shown in the appendix (Appendix: Graph 12).

- Female cycling numbers are particularly important as safety is a primary barrier for this group, as per a TFL report. This backs up our hypothesis that improving cycling infrastructure would increase cycling numbers overall and amongst minority groups https://content.tfl.gov.uk/cycling-potential-in-londons-diverse-communities-2021.pdf

- Our analysis of mini hollands and the performance of Enfield led us to consider other factors which might cause lower cycling numbers (Appendix: Graph 11).

- Enfield received very similar infrastructure investment to the other two boroughs, so why does it perform so poorly?

- One factor we considered is the population split of boroughs and whether there is a difference in cycling numbers amongst different ethnic groups.

Insights or observations related to Ethnic & Minority Groups

- Data on the ethnic population of boroughs taken from ONS https://data.london.gov.uk/dataset/ethnic-groups-borough

- Split Data to look at white, black and Asian populations compared to the number of cyclists in outer London. Focused on outer London due to the lack of infrastructure compared to inner as highlighted earlier.

- Found signs that boroughs with higher black populations did tend to have lower cycling rates. In some instances, like Enfield and Barking & Dagenham, they also had lower full-time weekly earnings compared to boroughs with lower ethnic populations (Appendix: Table 9).

- Also, considered female cycling as a minority group due to the disparity compared to male cycling numbers. Analysed female cycling numbers for each outer London borough.

- We can see that Richmond has the highest count of female cyclists for an outer London borough, though it has a considerably lower total population (Appendix: Table 10)

- We know from our earlier infrastructure analysis; Richmond has a high percentage of park and waterside cycle lanes (Appendix: Graph 13). This backs up our insight that investing in infrastructure and having segregated cycle lanes will increase cycling numbers both overall and amongst females.

TECHNICAL OVERVIEW OF THE CODE

CHOICE OF ANALYSIS TECHNIQUES

We were not able to produce any prediction models based on the data. All analysis was conducted using descriptive analytics. We analysed patterns and trends in data and utilised external open data sources (ONS) and reports (TfL) to back up our recommendations. To avoid bias in parameter estimation and reduce the risk of invalid conclusions we prepared and cleaned the data following the procedure described in the project development section.

VISUALISING DATA

- Seaborn, Matplotlib, Plotly libraries in Python
    - Customized plots, lines, titles, ticks and axes labels, size of the chart, grid, style, colours, and legend format to make them consistent and accessible (Appendix: Picture 1).

- Mapview and sf packages in R to work with map data.

- To define London boroughs borders, Office of National Statistics (ONS) data was used.

CHOICE OF ANALYSIS TOOLS

- GitHub repository: https://github.com/SanaFed/CO3_LSE-Employer-Project.git

- Python was used due to the large sizes of the original data sets and libraries for data analysis, data manipulation (Pandas, Matplotlib and NumPy) and visualisation of trends and patterns (seaborn, plotly, matplotlib).

- Infrastructure data is accessible from the open data portal and there is the R package that allows importing it into R as spatial data ((https://github.com/PublicHealthDataGeek/CycleInfraLnd). That was the main

rationale behind using R. After the data on each type of infrastructure is obtained, .csv files were generated for analysis together with the rest of datasets used in the research. Tidyverse and dplyr packages used for data manipulations and mapview and sf to work with maps and spatial data.

- Microsoft Excel was used for the second resource data sets to clean and convert extracted data to CSV files and upload it to Python for the analysis.

RECOMMENDATIONS TO THE BUSINESS, INCLUDING AREAS FOR FURTHER ANALYSIS

PATTERNS, TRENDS AND INSIGHTS HEADLINE

- Cycling in London is the 5th most popular mode of transport, though cycling counters seem to tick more for leisure purposes. Outer London residents seem to own more cars and drive to work, even though their place of work can be considered cycling distance.

- Infrastructure is not developed equally in Inner and Outer London's boroughs. Small percentage of segregated cycle lanes make cycling less attractive. Improving infrastructure can increase safety and lead to an increase in cycling participation.

- Mini Hollands can be a successful scheme and cycling safety can improve female cycling.

- Access and owning a bike seem to be a barrier for ethnic groups. Government scheme can be used to eliminate this barrier.

FINAL RECOMMENDATIONS

- Our final recommendations are presented in the table below. They have been split into Short/Medium/Long priorities depending on their impact and complexity.

Area of Concern	Recommendation Headline	Impact	Complexity	Priority
Infrastructure: Ease of access	1. Expand cycle network in outer London 2. Connect major work and travel hubs 3. Connect cycle network to safe and secure parking spaces	High	High	**Long**
Infrastructure: Safety	1. Improve Junction safety for cyclists 2. Develop segregated cycling lanes 3. Increase traffic calming measures	High	Medium	**Medium**
Ethnic and Minority Groups	1. Offer government subsidies targeting low income and minority groups	Medium	Low / Medium	**Medium**
General Cycling Popularization	1. Make cycling training widely accessible across all age groups – e.g. Schools 2. Utilize targeted social media campaigns to promote safe cycling – e.g. Enfield	Medium	Low	**Short**

AREAS IDENTIFIED FOR FURTHER ANALYSIS.

- Further research needs to be conducted into hire cycles and how TFL and MTS can capitalise on the increasing rates in hire cycle numbers. This further analysis could look at customer reviews of hire cycles, safety of the bikes, technological advances, and potential locations for further investment in hire cycles.

- Impact of cycle infrastructure on number of accidents and cyclist safety. As an area of further research, studying more about the experience of such bike-friendly countries as Denmark and Netherlands might be interesting.

- Further research on public transport use and walking statistics.

APPENDIX

HYPOTHESIS LIST

- What impact does improving infrastructure & safety have on cycling rates?
- How does improving cycling infrastructure improve female cycling numbers?
- Is there adequate infrastructure across all of London?
- Is there comparable infrastructure in inner and outer London?
- Are the travelling behaviours different in inner and outer London?
- Do boroughs with higher earnings have higher rates of cycling?
- As earnings increase, do cycling rates? Is this the case for men and / or women?
- Do boroughs with higher populations of minority groups have lower rates of cycling?
- How do socioeconomic factors contribute to cycling uptake?
    - Is cycling uptake higher in areas of London where the average income is higher?
    - Is cycling higher where the Education level is higher?
- How does cycling uptake change amongst different demographics?
    - How can cycling uptake be improved amongst young black, Asian and mixed-ethnicity men and women?
    - This can include age, class, gender & race.
- Has cycling uptake been higher since the introduction of PAYG bikes?
    - Where are PAYG cycling hubs situated? Are these based in areas of higher average income?
- How do technological advances affect the uptake of cycling?
- Has the introduction of electric bikes increased cycling uptake?
- How does the weather affect cycling uptake?
    - Does an increase in temperature mean an increase in cycling?
    - What do seasonal changes affect cycling uptake?

- Could availability / price of PAYG change during high seasons?

- How has WFH affected cycling uptake?

  o How can government initiatives (Cycle to Work) help increase cycling uptake?

- How has tourism affected cycling uptake?

  - Has there been a knock-on effect from Brexit on tourism / immigration to London and thus cycling uptake?

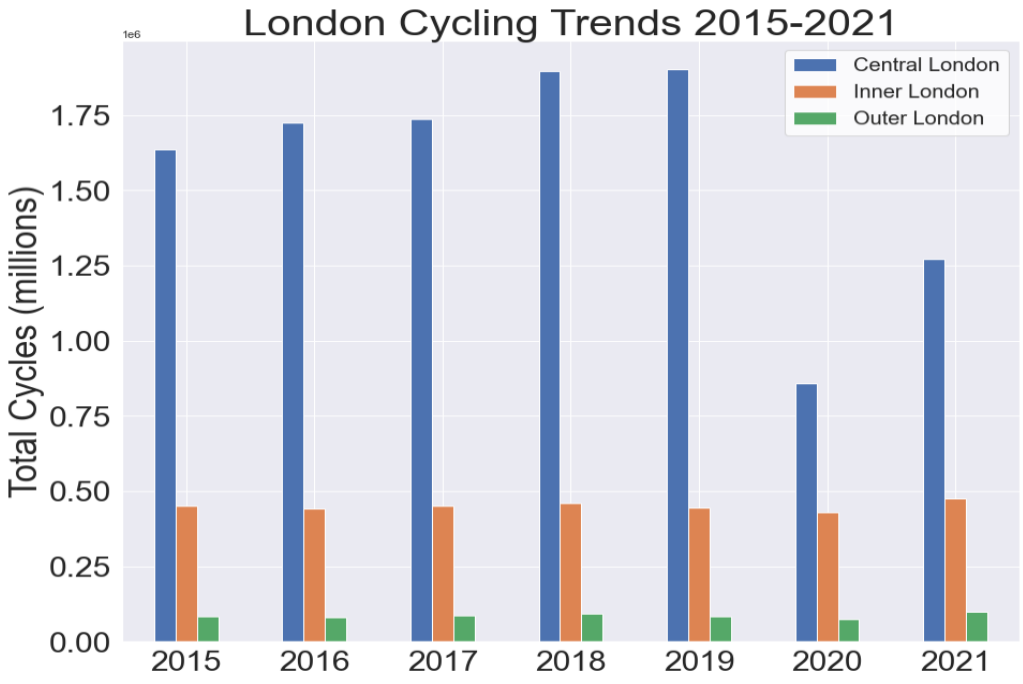
TABLES & FIGURES

TABLE 1:

Infrastructure Summary

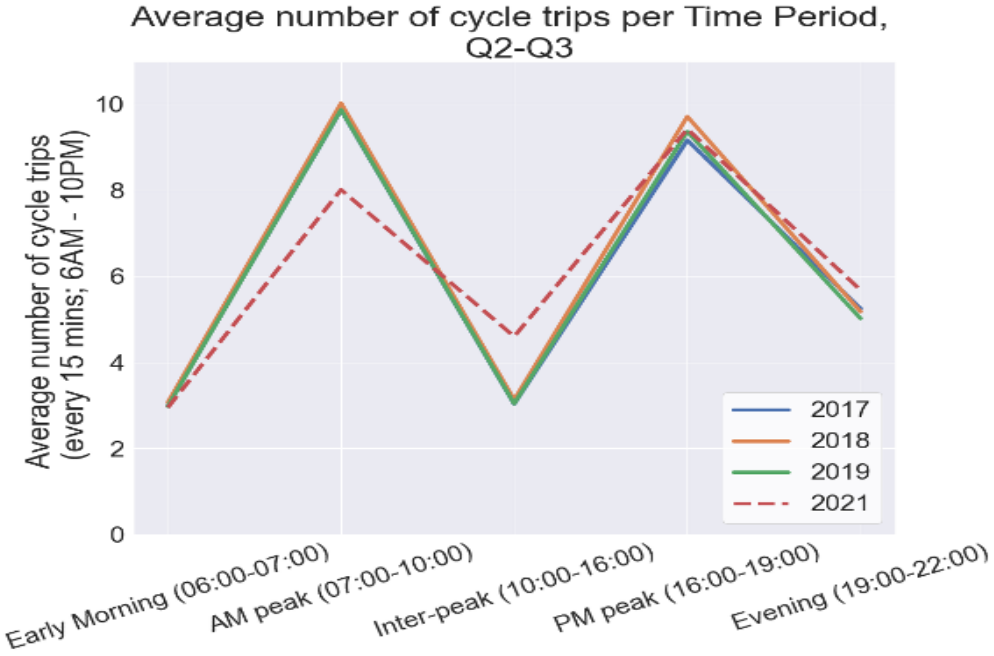
Line features:	Point features:
Cycle lanes and tracks: 24,690 lanes with total length 2,860 km	Cycle parking: 23,758 sites and total capacity of 145,942 accessible.
Advanced Stop Lines (ASLs): 3,775 sites with total length 17,32 km	Traffic calming: 58,565 records. Usually speed humps (vertical) or horizontal (road narrowing).
Restricted routes: 1,378 sites. Cyclists may use if dismount only.	Signals: 443 sites. Allows cyclists move before the traffic on junctions.
Crossings for cyclists: 1,687 sites. Signal controlled crossings for cyclists.	Restricted points: 180 sites. Stairs or lifts along the cycle path.
	Signs: 118,834 sites. Any signs or road marking including route information for cyclists.

GRAPH 1:

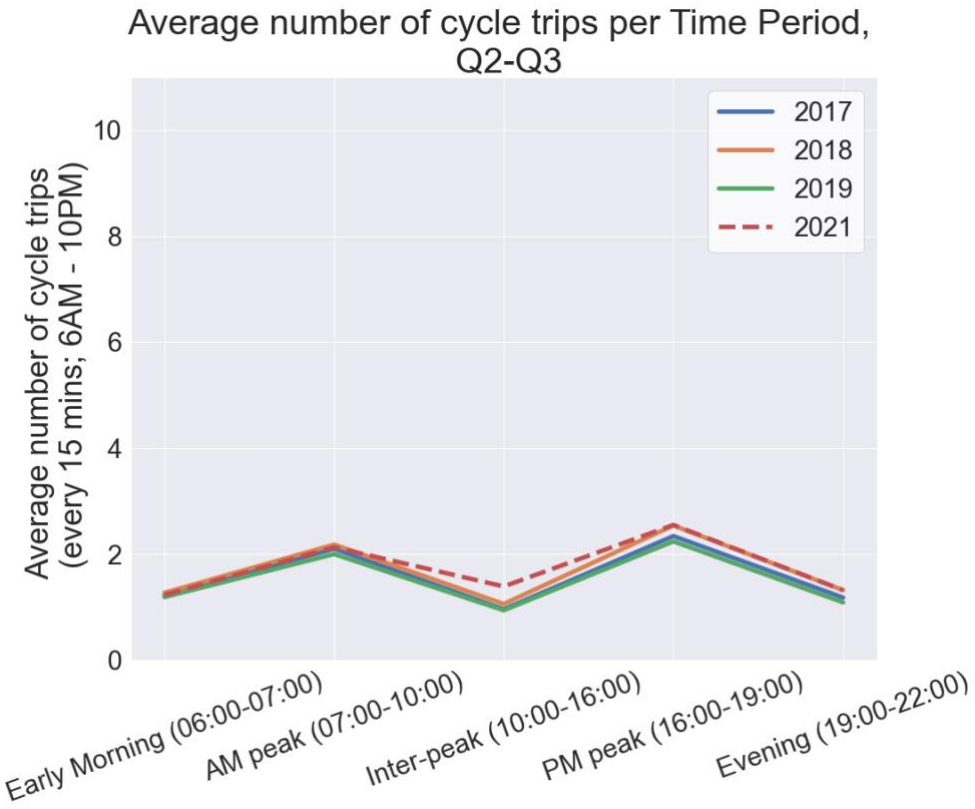


GRAPH 2:

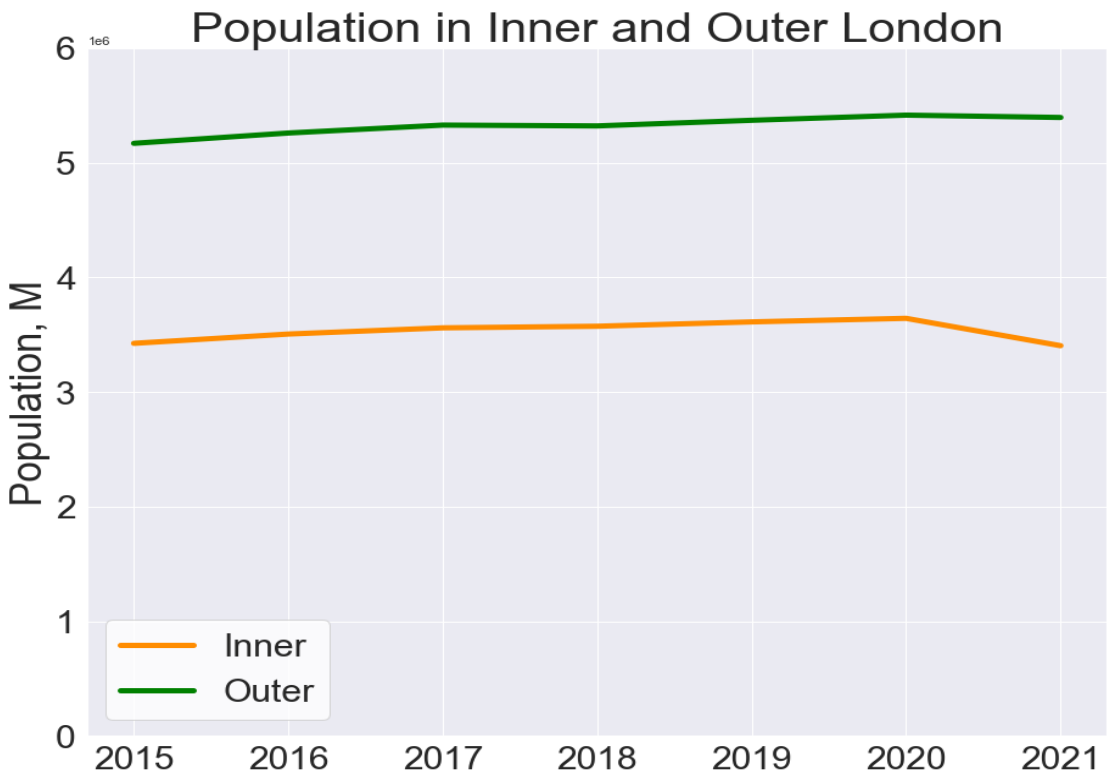
INNER LONDON:



OUTER LONDON:



GRAPH 3:


Population in Inner and Outer London
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Population, M
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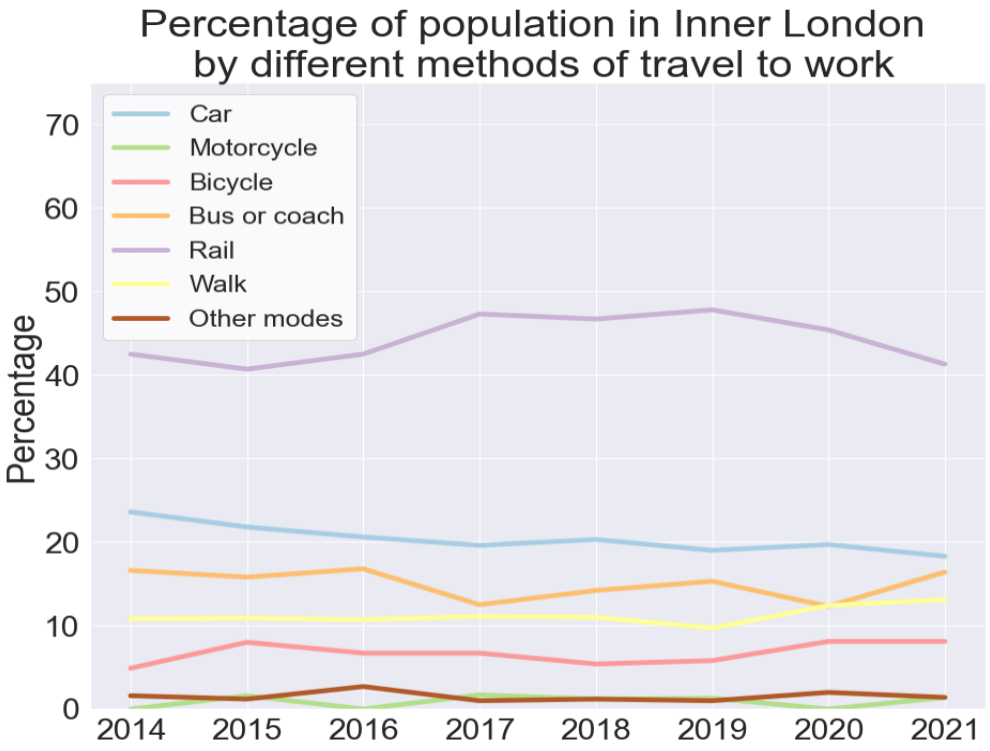
1
2
3
4
5
6
2015
2016
2017
2018
2019
2020
2021
Inner
Outer

GRAPH 4:


Percentage of population in Inner London
by different methods of travel to work
Car
Motorcycle
Bicycle
Bus or coach
Rail
Walk
Other modes
Percentage
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20
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2014
2015
2016
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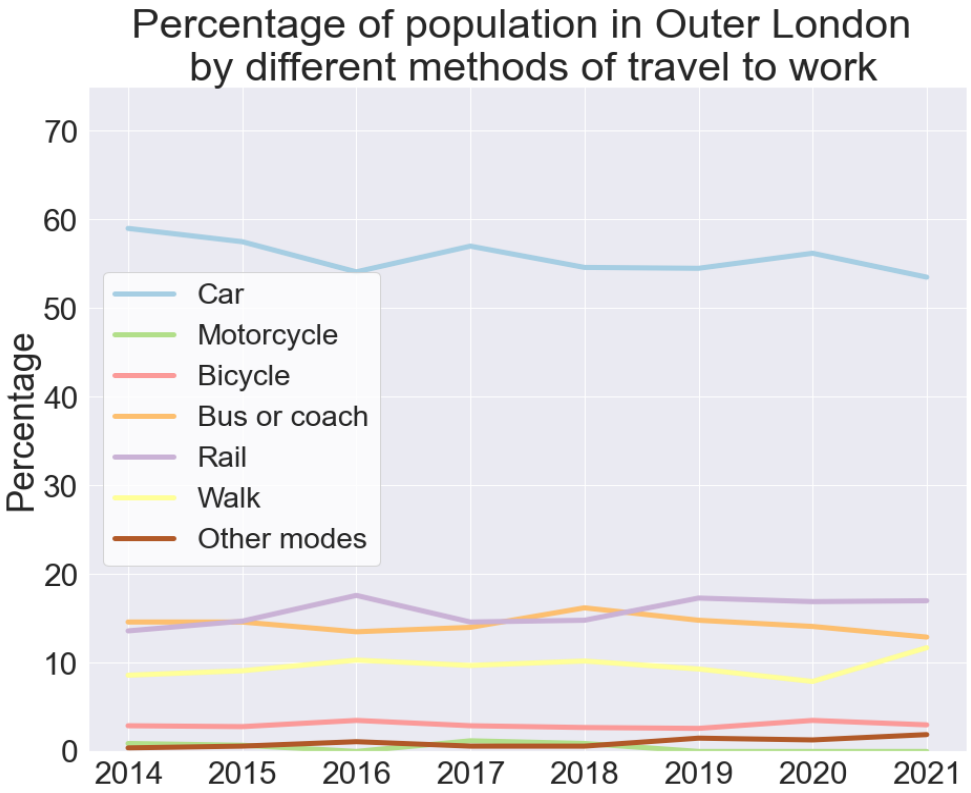
2020
2021


Percentage of population in Outer London
by different methods of travel to work
Car
Motorcycle
Bicycle
Bus or coach
Rail
Walk
Other modes
Percentage
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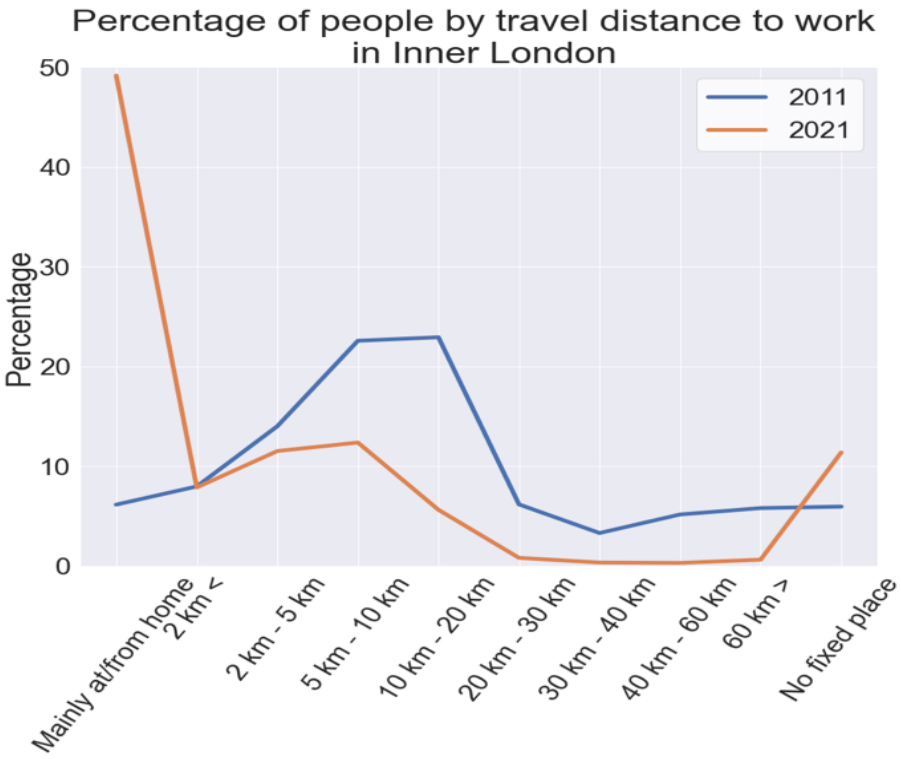
GRAPH 5:


Percentage of people by travel distance to work in Inner London
Percentage
50
40
30
20
10
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2011
2021
Mainly at/from home
2 km <
2 km - 5 km
5 km - 10 km
10 km - 20 km
20 km - 30 km
30 km - 40 km
40 km - 60 km
60 km >
No fixed place

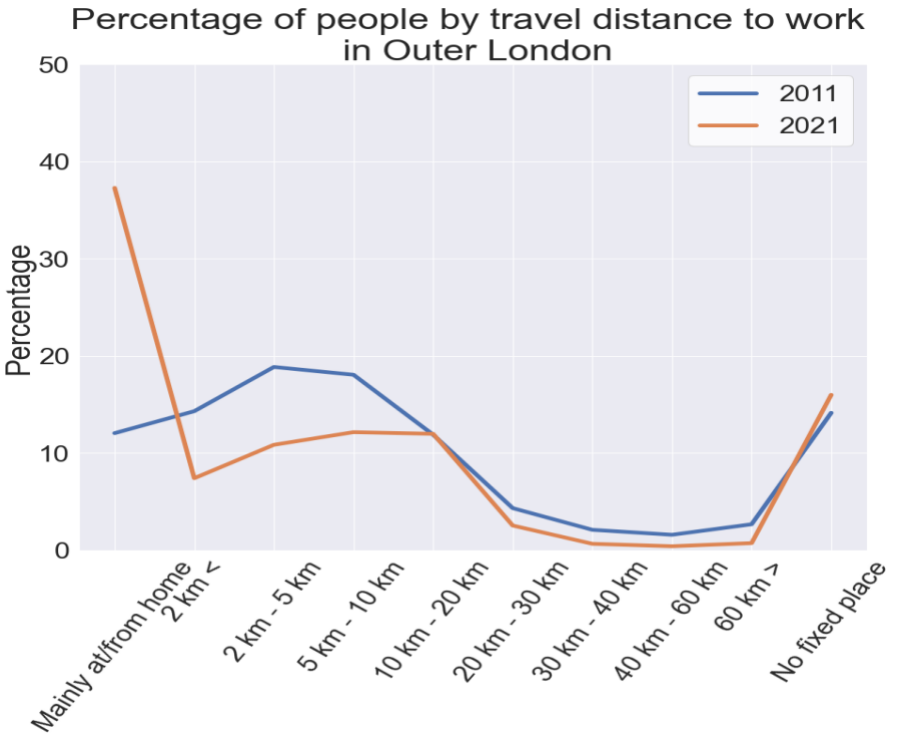

Percentage of people by travel distance to work in Outer London
Percentage
50
40
30
20
10
0
2011
2021
Mainly at/from home
2 km <
2 km - 5 km
5 km - 10 km
10 km - 20 km
20 km - 30 km
30 km - 40 km
40 km - 60 km
60 km >
No fixed place

TABLE 2:

	Borough	% Change in private cycles	% Change in hire cycles	% Change Total Cycles	14_19%
0	Camden	0.10	0.08	0.10	0.08
1	Hackney	1.13	0.44	1.04	0.12
2	Islington	0.10	0.08	0.10	0.14
3	Lambeth	-0.06	0.20	-0.04	0.16
4	Southwark	0.38	0.48	0.39	0.19

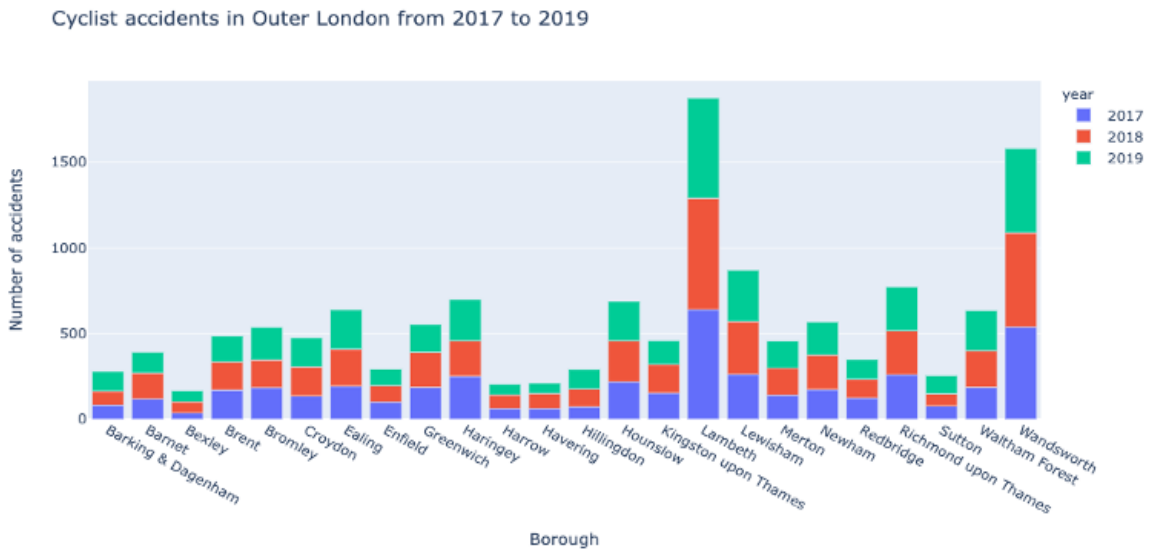
TABLE 3:

	Year	Borough	Number of private cycles	Number of cycle hire bikes	Total cycles	2019 Pay (£)
10	2019	Kensington & Chelsea	40273	5642	45915	901.3
15	2019	Richmond upon Thames	1922	47	1969	820.3
20	2019	Westminster	31450	5134	36584	812.8
19	2019	Wandsworth	44008	2596	46604	811.8
9	2019	Islington	54823	1217	56040	801.0
2	2019	Camden	23486	698	24184	795.4
6	2019	Hammersmith & Fulham	39770	2567	42337	795.3
1	2019	Bromley	249	2	251	785.3
17	2019	Tower Hamlets	42639	3418	46057	780.4
11	2019	Lambeth	32884	960	33844	714.4
13	2019	Merton	5443	8	5451	710.4
5	2019	Hackney	52357	1092	53449	709.2
16	2019	Southwark	32726	364	33090	709.1
18	2019	Waltham Forest	2926	2	2928	680.3
4	2019	Greenwich	106	0	106	679.6
7	2019	Haringey	4326	24	4350	670.8
8	2019	Hounslow	256	6	262	658.8
12	2019	Lewisham	8506	18	8524	654.1
14	2019	Newham	931	41	972	622.8
3	2019	Ealing	2227	5	2232	622.4
0	2019	Brent	1035	14	1049	609.6

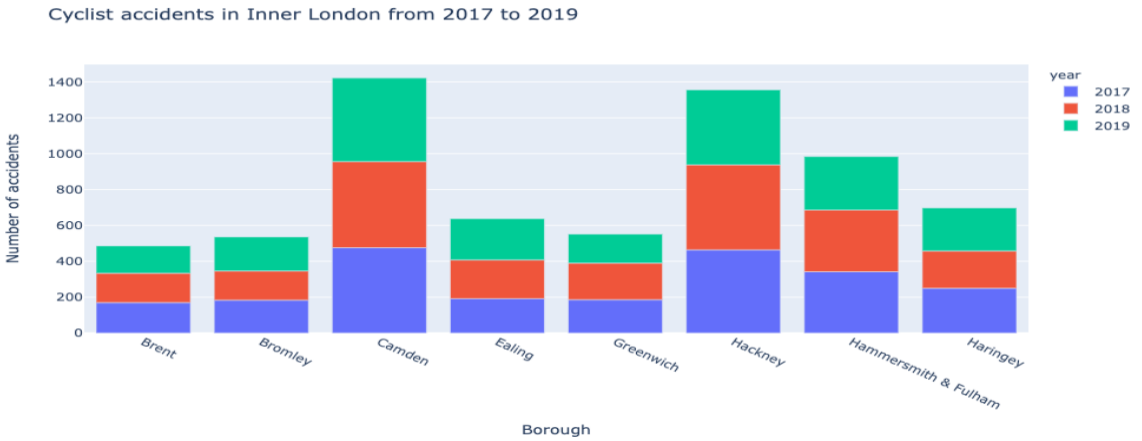
TABLE 4:

	Survey wave (year)	Borough	Number of male cycles	Number of female cycles	Total cycles	2019 Pay (£)
20	2019	Richmond upon Thames	8158	2510	10730	820.3
23	2019	Wandsworth	46	21	67	811.8
4	2019	Bromley	2402	213	2650	785.3
14	2019	Kingston upon Thames	4730	1060	5882	742.8
15	2019	Lambeth	152	33	185	714.4
17	2019	Merton	3723	495	4294	710.4
10	2019	Harrow	661	125	797	693.5
19	2019	Redbridge	1225	193	1426	683.9
22	2019	Waltham Forest	3468	949	4421	680.3
8	2019	Greenwich	2698	363	3072	679.6
1	2019	Barnet	2369	336	2773	677.5
5	2019	Croydon	2508	202	2718	671.4
2	2019	Bexley	954	92	1056	671.0
9	2019	Haringey	3283	417	3743	670.8
21	2019	Sutton	2065	291	2417	668.6
13	2019	Hounslow	5210	1165	6433	658.8
16	2019	Lewisham	4204	572	4796	654.1
11	2019	Havering	1189	147	1344	650.4
7	2019	Enfield	1342	212	1561	638.9
18	2019	Newham	5121	956	6144	622.8
6	2019	Ealing	5757	1637	7455	622.4
12	2019	Hillingdon	3012	444	3489	621.7
3	2019	Brent	3112	393	3553	609.6
0	2019	Barking & Dagenham	939	142	1111	589.8

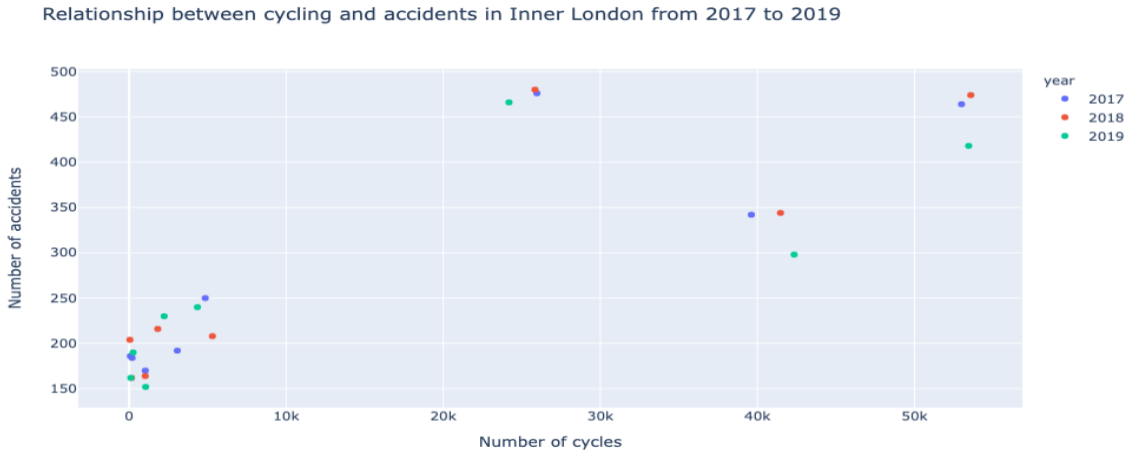
GRAPH 6:



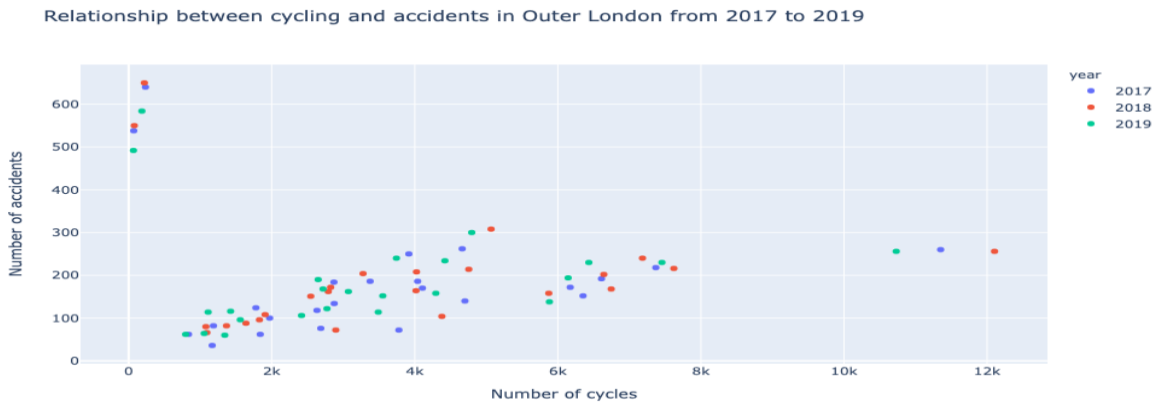
GRAPH 7:



GRAPH 8:



GRAPH 9:



GRAPH 10:

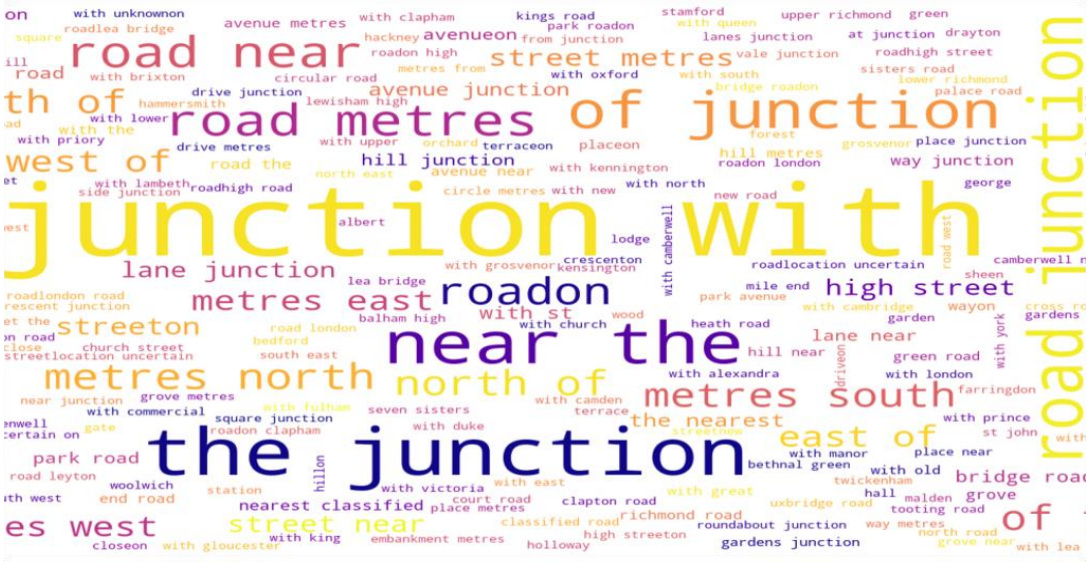

junction with
road junction
road near
road metres
of junction
the junction
near the
metres north
north of
metres south
metres east
lane junction
roadon
high street
street metres
avenue junction
west of
hill junction
the nearest
east of
park road
bridge road
nearest classified
street near
es west
of
with unknownon
avenue metres
with clapham
kings road
park roadon
hackney
avenueon
from junction
roadon high
metres from
with oxford
with south
stamford
upper richmond
green
lanes junction
at junction drayton
vale junction
roadhigh street
sisters road
lower richmond
palace road
bridge roadon
road
with brixton
circular road
drive junction
lewisham high
hammersmith
with lower
with the
with priory
drive metres
with upper
orchard
terraceon
placeon
forest
grosvenor
place junction
hill metres
roadon london
way junction
george
road the
roadhigh road
north east
avenue near
with kennington
with north
new road
circle metres
with new
side junction
with lambeth
albert
lodge
with camberwell
crescenton
with grosvenor
kensington
roadlocation uncertain
camberwell
sheen
road west
lea bridge
mile end
park avenue
with cambridge
wayon
garden
gardens
roadlondon road
rescent junction
balham high
with st
wood
with church
heath road
road london
bedford
south east
streetlocation uncertain
church street
lane near
hill near
green road
with york
driveon
with alexandra
with london
farringdon
near junction
grove metres
with fulham
seven sisters
with camden
terrace
with commercial
square junction
roadon clapham
with duke
with prince
st john
gate
park road
road leyton
with manor
place near
bethnal green
with old
twickenham
woolwich
station
with victoria
with east
with great
hall
malden
grove
uxbridge road
tooting road
end road
court road
clapton road
richmond road
roundabout junction
way metres
north road
closeon
with gloucester
with king
embankment metres
holloway
high streeton
gardens junction
grove near
with lea

TABLE 5:

Summary Statistics:		Parking Capacity	Signal Lights for Cyclists	Cycle Crossings	Traffic Calming	Advanced Stop Line (m)	Cycle Line Length (km)
Mean		4,423	19	53	1,978	524.93	86.65
Standard Deviation		2,910	25	24	1,107	376.27	31.8
Min		1,180	1	17	190	27.15	20.81
Max		12,322	96	118	4,264	1595.79	139.94
IQR		3,510	27	31	1,927	372.55	45.64
Camden	Inner	9,023	36	42	1,929	1,202.66	45.88
City of London	Inner	3,046	58	24	190	609.49	20.81
Hackney	Inner	12,322	22	56	3,295	877.71	88.49
Hammersmith and Fulham	Inner	6,826	3	57	1,408	379.82	66.46
Haringey	Inner	3,229		34	2,266	377.35	88.25
Islington	Inner	7,046	16	35	2,574	764.58	41.87
Kensington and Chelsea	Inner	5,902	5	17	379	367.32	26.60
Lambeth	Inner	8,590	44	48	3,571	1,595.79	92.61
Lewisham	Inner	3,465	1	37	3,779	609.16	81.18
Newham	Inner	4,402	-	118	3,637	626.41	138.10
Southwark	Inner	9,951	44	98	4,264	1,341.79	89.56
Tower Hamlets	Inner	6,535	57	48	2,480	525.50	99.50
Wandsworth	Inner	4,879	17	62	2,377	1,072.70	94.21
Westminster	Inner	10,703	96	73	765	1,019.46	55.14
Barking and Dagenham	Outer	1,827	-	53	1,792	352.85	105.24
Barnet	Outer	2,499	-	18	383	27.90	70.55
Bexley	Outer	1,180	-	19	1,035	27.15	83.28
Brent	Outer	2,910	1	30	3,008	423.91	67.02
Bromley	Outer	2,231	2	24	856	227.75	111.46
Croydon	Outer	2,958	2	66	2,261	511.83	114.66
Ealing	Outer	3,944	1	48	3,182	676.68	135.08
Enfield	Outer	2,093	5	86	1,630	168.26	116.31
Greenwich	Outer	3,387	-	68	3,049	556.08	121.96
Harrow	Outer	1,855	6	36	1,359	191.95	65.82
Havering	Outer	1,991		51	1,064	192.32	96.57
Hillingdon	Outer	2,392	4	91	939	253.86	99.69
Hounslow	Outer	3,869	-	79	1,420	426.66	139.94
Kingston upon Thames	Outer	3,067	4	68	1,469	286.79	50.44
Merton	Outer	3,008	2	66	1,375	412.41	58.45
Redbridge	Outer	1,281	1	31	1,462	208.57	114.52
Richmond upon Thames	Outer	4,132	-	57	1,081	353.82	135.45
Sutton	Outer	1,540	-	54	1,542	124.01	59.69
Waltham Forest	Outer	3,859	11	64	3,467	530.20	84.81
TOTAL:		145,942	438	1,758	65,288	17,323	2,860
Total Inner London:	Inner	95,919	399	749	32,914	11,370	1,029
Total Outer London:	Outer	50,023	39	1,009	32,374	5,953	1,831

TABLE 6:

Borough	Length (km)	Fully Segregated (km)	%	Part Segregated (km)	%	Parks Lanes Length (km)	%
Camden	45.88	2.98	6.49	3.71	8.09	8.85	19.28
City of London	20.81	2.65	12.72	0.28	1.33	-	-
Hackney	88.49	0.96	1.09	2.61	2.95	50.04	56.55
Hammersmith & Fulham	66.46	0.46	0.69	3.16	4.75	29.13	43.84
Haringey	88.25	0.93	1.06	5.44	6.17	55.86	63.30
Islington	41.87	2.88	6.87	0.88	2.10	9.59	22.91
Kensington & Chelsea	26.60	0.18	0.69	1.13	4.23	11.96	44.97
Lambeth	92.61	2.95	3.18	2.03	2.19	41.73	45.06
Lewisham	81.18	0.54	0.66	3.85	4.75	47.49	58.50
Newham	138.10	3.45	2.50	14.94	10.82	77.74	56.30
Southwark	89.56	3.54	3.95	6.41	7.15	38.50	42.99
Tower Hamlets	99.50	10.26	10.31	5.83	5.86	64.81	65.14
Wandsworth	94.21	2.35	2.50	9.67	10.26	47.31	50.21
Westminster	55.14	5.79	10.50	2.84	5.15	19.83	35.97
Barking & Dagenham	105.24	1.91	1.82	12.05	11.45	35.21	33.46
Barnet	70.55	1.81	2.56	1.85	2.63	46.23	65.52
Bexley	83.28	2.49	2.99	8.12	9.75	50.81	61.02
Brent	67.02	0.02	0.03	8.26	12.32	44.13	65.85
Bromley	111.46	1.10	0.99	7.33	6.57	72.30	64.87
Croydon	114.66	0.39	0.34	1.39	1.21	45.20	39.42
Ealing	135.08	2.94	2.17	9.38	6.95	63.11	46.72
Enfield	116.31	4.29	3.68	25.96	22.32	66.18	56.90
Greenwich	121.96	4.23	3.47	17.47	14.32	63.52	52.08
Harrow	65.82	1.33	2.03	5.83	8.86	21.13	32.10
Havering	96.57	1.40	1.45	5.21	5.39	46.94	48.61
Hillingdon	99.69	4.79	4.81	19.57	19.63	32.16	32.25
Hounslow	139.94	10.35	7.39	12.63	9.02	61.54	43.98
Kingston upon Thames	50.44	4.38	8.69	4.10	8.13	9.82	19.47
Merton	58.45	2.03	3.47	4.67	7.99	25.70	43.97
Redbridge	114.52	0.54	0.47	8.73	7.62	81.51	71.18
Richmond upon Thames	135.45	1.56	1.15	3.49	2.58	88.64	65.44
Sutton	59.69	3.31	5.55	9.85	16.51	39.74	66.57
Waltham Forest	84.81	2.89	3.40	19.52	23.02	14.65	17.28
TOTAL:	2,860	92	3.21%	248.19	8.68%	1,411.38	49.36%
Total Inner London:	1,028.65	39.91	3.88%	62.78	6.10%	502.86	48.89%
Total Outer London:	1,830.94	51.75	2.83%	185.41	10.13%	908.52	49.62%

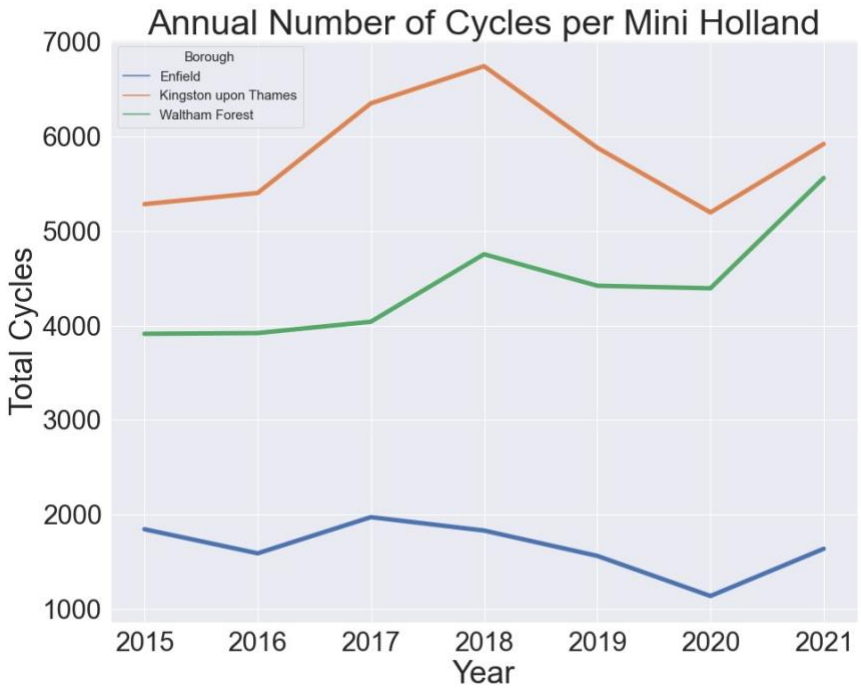
TABLE 7:

Mini Holland Boroughs	Parking Capacity	Signal Lights for Cyclists	Cycle Crossings	Traffic Calming	Advanced Stop Line	Cycle Line Length (km)
Enfield	2,093	5	86	1,630	168.26	116.31
Kingston upon Thames	3,067	4	68	1,469	286.79	50.44
Waltham Forest	3,859	11	64	3,467	530.20	84.81

TABLE 8:

	Length (km)	Fully Segregated	%	Part Segregated	%	Parks Lanes	%
Enfield	116.31	4.29	3.68	25.96	22.32	66.18	56.90
Kingston upon Thames	50.44	4.38	8.69	4.10	8.13	9.82	19.47
Waltham Forest	84.81	2.89	3.40	19.52	23.02	14.65	17.28

GRAPH 11:



GRAPH 12:

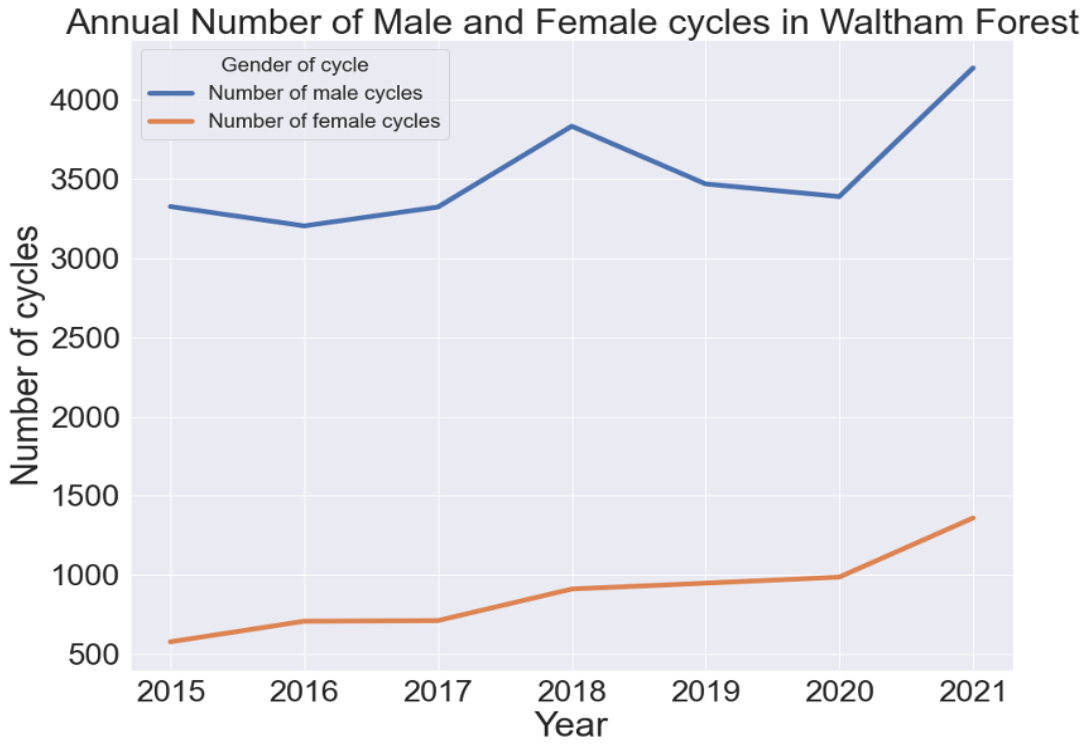


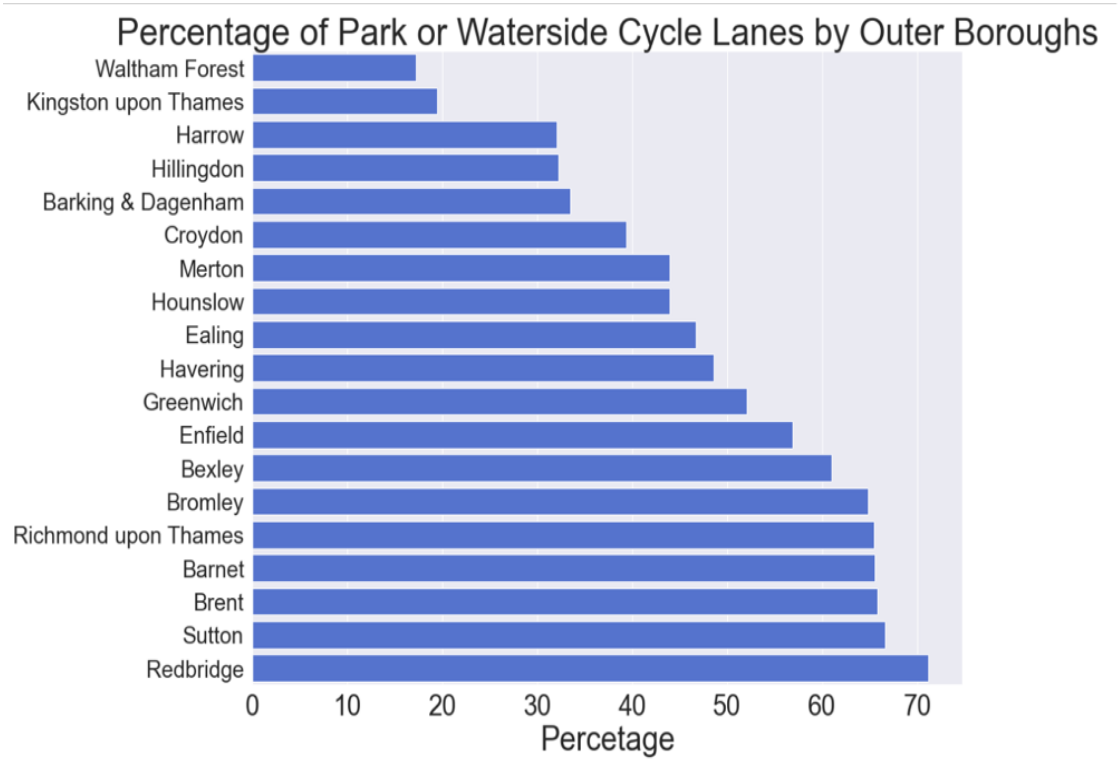
TABLE 9:

	Borough	2019 Black	2019 Total cycles	2019 Pay (£)
5	Croydon	75000	2718	671.4
16	Lewisham	71000	4796	654.1
18	Newham	65000	6144	622.8
15	Lambeth	62000	185	714.4
7	Enfield	61000	1561	638.9
0	Barking & Dagenham	59000	1111	589.8
3	Brent	53000	3553	609.6
8	Greenwich	53000	3072	679.6
6	Ealing	40000	7455	622.4
9	Haringey	39000	3743	670.8
22	Waltham Forest	36000	4421	680.3
12	Hillingdon	27000	3489	621.7
17	Merton	25000	4294	710.4
1	Barnet	24000	2773	677.5
4	Bromley	24000	2650	785.3
13	Hounslow	23000	6433	658.8
11	Havering	23000	1344	650.4
23	Wandsworth	21000	67	811.8
2	Bexley	20000	1056	671.0
19	Redbridge	16000	1426	683.9
14	Kingston upon Thames	8000	5882	742.8
10	Harrow	8000	797	693.5
21	Sutton	7000	2417	668.6
20	Richmond upon Thames	3000	10730	820.3

TABLE 10:

	Borough	2019 Female cycles	2019 Total cycles	2019 Total
20	Richmond upon Thames	2510	10730	198000
6	Ealing	1637	7455	343000
13	Hounslow	1165	6433	273000
14	Kingston upon Thames	1060	5882	179000
18	Newham	956	6144	358000
22	Waltham Forest	949	4421	280000
16	Lewisham	572	4796	309000
17	Merton	495	4294	209000
12	Hillingdon	444	3489	309000
9	Haringey	417	3743	279000
3	Brent	393	3553	330000
8	Greenwich	363	3072	289000
1	Barnet	336	2773	396000
21	Sutton	291	2417	206000
4	Bromley	213	2650	335000
7	Enfield	212	1561	340000
5	Croydon	202	2718	389000
19	Redbridge	193	1426	311000
11	Havering	147	1344	261000
0	Barking & Dagenham	142	1111	219000
10	Harrow	125	797	250000
2	Bexley	92	1056	251000
15	Lambeth	33	185	326000
23	Wandsworth	21	67	324000

GRAPH 13:



PICTURE 1:

```
# Plot graph showing the trends over time
nc_mini_holland = sns.lineplot(x='Survey wave (year)', y='Total cycles',
                        hue='Borough', lw=5, data=mini_hollands_group, ci=None)

nc_mini_holland.legend(title='Borough', loc='upper left', title_fontsize=15, fontsize=15)
nc_mini_holland.set_xlabel('Year')
nc_mini_holland.set_ylabel('Total Cycles')
nc_mini_holland.set_title("Annual Number of Cycles per Mini Holland")
nc_mini_holland.title.set_fontsize(40)
nc_mini_holland.xaxis.label.set_fontsize(35)
nc_mini_holland.yaxis.label.set_fontsize(35)
nc_mini_holland.tick_params(axis='both', which='major', labelsize=30)

plt.savefig('nc_mini_holland.png')
```