WHAT ARE THE EFFECTS OF A 'SHARED SPACE' SCHEME ON DIFFERENT USERS?

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1. INTRODUCTION

There is for a strong interest among street design professionals to consider a shared space approach when re-designing streets with high conflicting pedestrian and vehicle flows. The design principles are outlined in both of the UK's Manual for Streets documents (DfT, 2007 and CIHT, 2010). Despite much being written on this subject, there is no agreement on the meaning of the term 'shared space', nor is there much evidence on whether such schemes are broadly beneficial to users and under which circumstances. For example, some academics have questioned the effectiveness of parts of the Ashford scheme (Moody, 2012), and concerns have been raised on the impacts on vulnerable users, such as the visually impaired (Childs and Tyler, 2010).

This study aimed to resolve some of the knowledge gaps acknowledged by a shared space appraisal carried out by the MVA Consultancy (Reid, 2009) and their subsequent more detailed quantitative (Shore, 2010) and qualitative (Dickens, 2010) operational assessments. These studies identified gaps in assessing pedestrian behaviour with respect to movement and risk evaluation, such as the use courtesy crossings and the relationship between pedestrians and the drivers who give way to them. There have also been relatively few studies that have managed to capture video from both before and after a scheme, in particular like-for-like data that can be directly compared and analysed.

This paper reports on an MSc dissertation[1] (Horrell, 2014) which looked in detail at the effects of introducing various forms of shared space treatment in Bexleyheath along part of the central shopping street and its approaches. The analysis drew on a recordings from a large number of video cameras, plus business interviews and a range of existing data sources.

2. SITE LOCATION - BROADWAY, BEXLEYHEATH

The study area is illustrated in figure 1. Construction work took place between January and June 2013. The study area can be broken down into 3 distinct areas: a junction (Trinity Place), a link (Broadway) and a square (Christ Church). A number of features have been introduced to help the scheme achieve its aims, including introducing a 20mph zone, constructing gateway features, and by breaking up the carriageway of Broadway into visibly different sections to reduce the psychological length of the street. These are illustrated in the before and after photos in figures 2 to 7.

Figure 1: General layout design of Bexleyheath Broadway scheme (OS Mastermap Topography Layer, 2013 edited from Linfield, 2012)

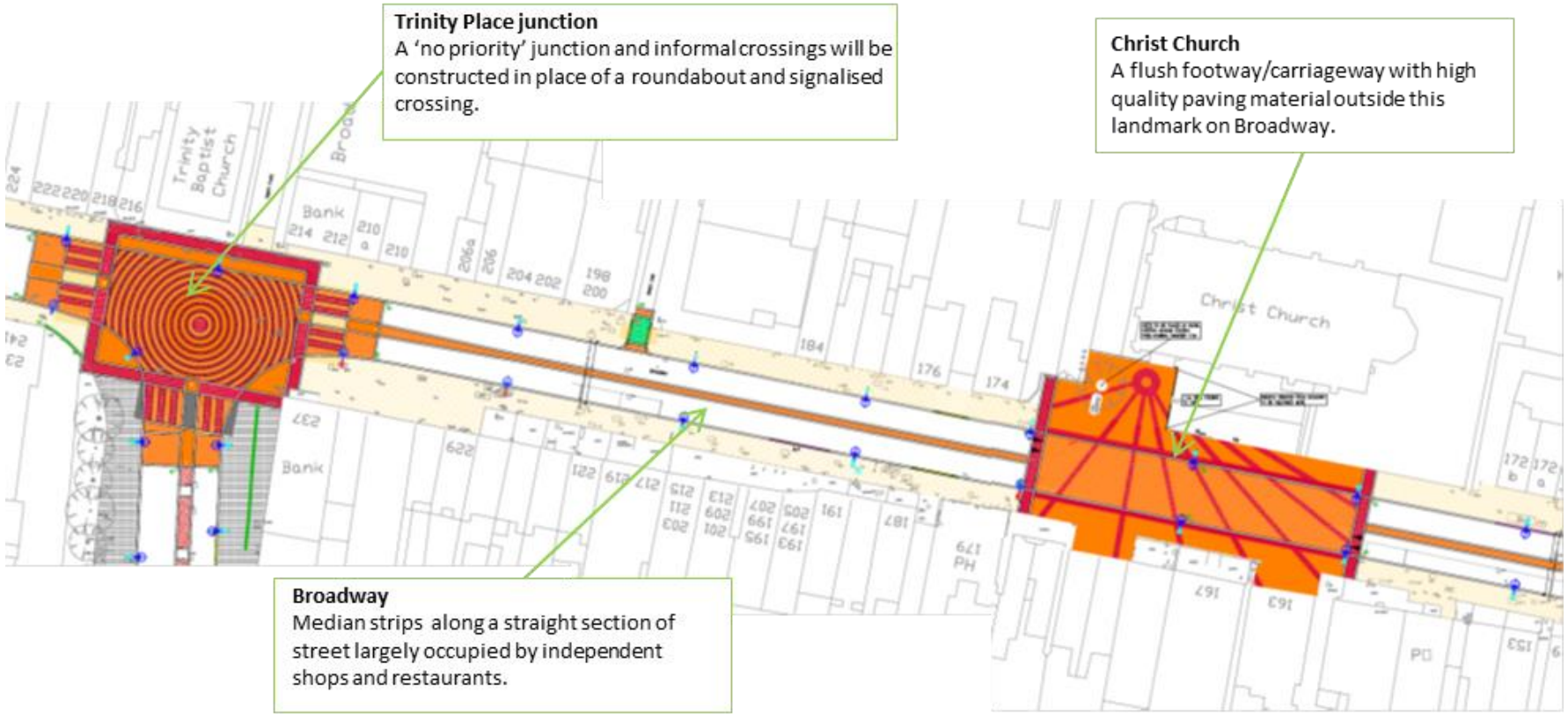


Figure 2: Trinity Place junction, Bexleyheath, prior to construction, November 2012

Figure 3: Trinity Place junction, Bexleyheath, following construction, November 2013

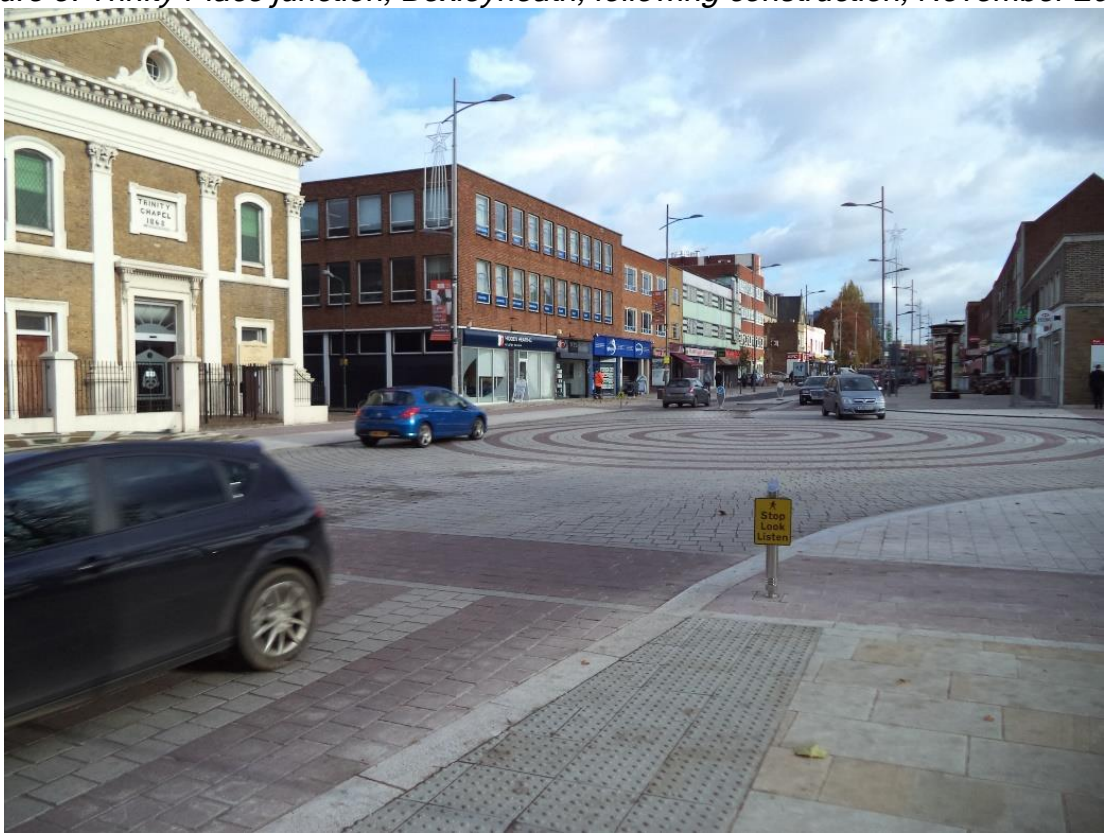


Figure 4: Bexleyheath Broadway prior to construction, November 2012

Figure 5: Bexleyheath Broadway following construction, June 2013

Figure 6: Bexleyheath Broadway outside Christ Church prior to carriageway construction, November 2012

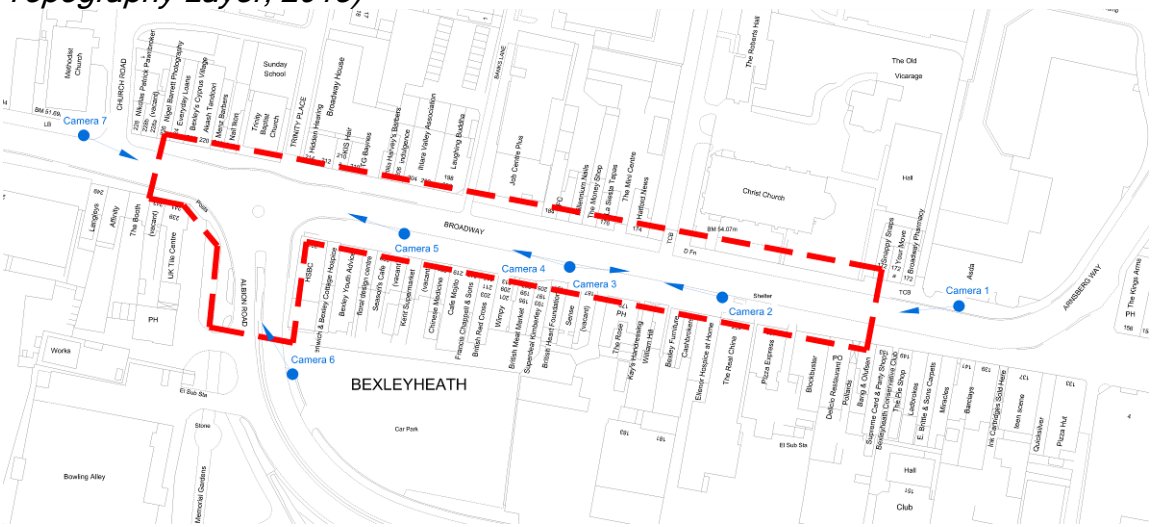
Figure 7: Bexleyheath Broadway outside Christ Church following construction, June 2013

3. METHODOLOGY

Twenty-two hypotheses were developed for empirical testing, with the results of ten of the most noteworthy outlined in this paper. H1 to H3 examine changes in pedestrian behaviour, H4 to H6 focus on vehicle responses, H7 deals with business perceptions, and H8 to H10 examine some differences in short and long term user responses.

Before and after video footage was collected for a 250m stretch of Broadway in addition to the junction of Broadway and Albion Road. The area in question and the location of the cameras is shown in figure 8.

Figure 8: Location of cameras for December surveys (OS Mastermap Topography Layer, 2013)



Two 24-hour surveys were carried out on Tuesday 18th and Saturday 22nd December 2012, which provided 'before' footage prior to the main construction phases that began in early January 2013. These 24-hour surveys were repeated on Tuesday 17th and Saturday 21st December 2013 after all temporary traffic management had been removed.

Bexley Borough Council also carried out 24 hour video surveys of the Broadway and Albion Place junction on Friday 21st and Saturday 22nd June 2013. This enabled analysis of both the short-term impacts of the new layout (approximately 3 weeks after opening) and the longer-term impacts six months later.

In order to assess the local businesses opinions of the scheme and associated consultation, a questionnaire was completed with businesses both before and after the scheme. In most cases, the questionnaire was completed face-to-face with a business representative, as this typically enables the highest rate of return to be achieved, compared to conducting the survey by letter drop or telephone survey.

4. KEY FINDINGS

4.1 Pedestrians

Hypothesis 1: Pedestrian delay at the kerbside will be lower, as drivers will give way to pedestrians more often and the median strip will be used as a waiting area for pedestrians.

Table 1 shows the changes in mean kerbside waiting time for different levels of vehicle intensity, before and after the scheme. The vehicle intensities are classified as follows:

- Low intensity: less than 300 vehicles travelling along Broadway per hour.
- Medium intensity: 300 to 800 vehicles travelling along Broadway per hour.
- High intensity: More than 800 vehicles travelling along Broadway per hour.

In most cases there appears to have been a reduction in the time a pedestrian waits at the kerbside before being able to cross the road. However, on Broadway this change is only statistically significant during periods of high vehicle flow, at which point it is highly significant, although waiting times also show some reductions at medium levels of vehicle intensity,

On the Albion Road arm of the Trinity Place junction, the removal of a signalised crossing means that pedestrians now have to observe the traffic and cross on their own initiative. However, it was observed that 53% and 34% of drivers gave way to pedestrians on the new 'informal' crossings during the weekday and weekend surveys, respectively. This has led to the results shown in the bottom half of table 1, which indicate that there is a highly statistically significant reduction in crossing time during medium and high vehicle flow periods. Pedestrians no longer have to wait for the 'green man' to show on the controlled crossing, and this has reduced the vehicle dominance of the junction – so that hypothesis 1 is accepted.

Tables 2 and 3 consider differences between mean pedestrian waiting times to cross on the three different streetscape areas of Broadway following completion of the scheme. For the weekday sample in table 2, the data shows lower waiting times on the informal crossing on the eastern arm of the Trinity Place junction and on the kerbed up-stand area adjacent to the median strip, compared to that of Christ Church's flush surface. These differences are statistically significant. There is also a statistically significant lower waiting time on the informal crossing compared to that adjacent to the median strip.

This pattern is generally replicated in the weekend survey, as shown in table 3. However, here there is no statistical significance between pedestrian waiting times to cross the carriageway adjacent to the median strip and those on the flush surface.

Table 1: T-Test values kerbside waiting times categorised into time periods of varying vehicle intensity

Location	Day	Vehicular Intensity	Before or After	Number of crossings	Mean kerbside waiting time (s)	Change in kerbside waiting time	One-tailed T-Test value for decrease in waiting time	Statistical significance
Broadway	Tuesday	Low	Before	4	3.38	-62.7%	0.192	Not Significant
			After	8	1.26			
		Medium	Before	100	6.16	-14.0%	0.187	Not Significant
			After	93	5.30			
		High	Before	441	9.00	-42.8%	1.30×10^{-10}	Significant
			After	312	5.15			
	Saturday	Low	Before	7	1.89	67.2%	0.115	Not Significant
			After	7	3.16			
		Medium	Before	46	5.85	-16.4%	0.229	Not Significant
			After	49	4.89			
		High	Before	482	10.87	-51.2%	8.44×10^{-14}	Significant
			After	373	5.30			
Trinity Place /Albion Road arm	Tuesday	Low	Before	4	1.00			
			After	0				
		Medium	Before	51	7.25	-65.9%	4.12×10^{-7}	Significant
			After	47	2.47			
		High	Before	244	8.65	-50.3%	1.30×10^{-11}	Significant
			After	151	4.3			
	Saturday	Low	Before	9	4.11	14.4%	0.316221266	Not Significant
			After	2	4.7			
		Medium	Before	112	4.26	-44.6%	6.52×10^{-5}	Significant
			After	90	2.36			
		High	Before	194	8.29	-60.4%	2.20×10^{-14}	Significant
			After	174	3.28			

Table 2: T-Test values of kerbside waiting time between Broadway street layouts on the Tuesday survey

Location	Mean pedestrian waiting time (s)	Two-tailed T-Test between datasets		
		Median Strip	Flushed Surface	Trinity Place
Median Strip	4.63		0.040	0.049
Flushed Surface	6.14	0.040		0.001
Trinity Place	3.85	0.049	0.001	

Table 3: T-Test values of kerbside waiting time between Broadway street layouts on the Saturday survey

Location	Mean pedestrian waiting time (s)	Two-tailed T-Test between datasets		
		Median Strip	Flushed Surface	Trinity Place
Median Strip	4.72		0.059	0.00000069
Flushed Surface	6.02	0.059		0.00000029
Trinity Place	2.81	0.00000069	0.00000029	

Hypothesis 2: A greater ratio of pedestrian road crossings will take place on the newly flush surface area, compared to the rest of Broadway, than prior to the scheme.

Table 4 suggests that there is a highly statistically significant increase in the intensity of pedestrians using the flush surface area outside Christ Church on Saturday, compared to prior to the scheme, when the whole street had the same 100mm kerb up-stand. Figures 8 and 9 show the location of all sampled crossing movements during the Saturday survey; there is a greater congregation of crossing movements outside Christ Church in figure 9 compared to figure 8. An increase in pedestrians using the newly flush

surface area is also shown on the Tuesday survey, but is not quite statistically significant at the 95% level. Thus, hypothesis 2 can be accepted for Saturday, but not on Tuesday. Note that there has been an off-setting reduction in the intensity of pedestrian crossing movements along the rest of Broadway with the kerbs and narrow median strip.

Figure 8: Map showing all locations for crossing in the study area during the Saturday before survey (OS Mastermap Topography Layer, 2013)

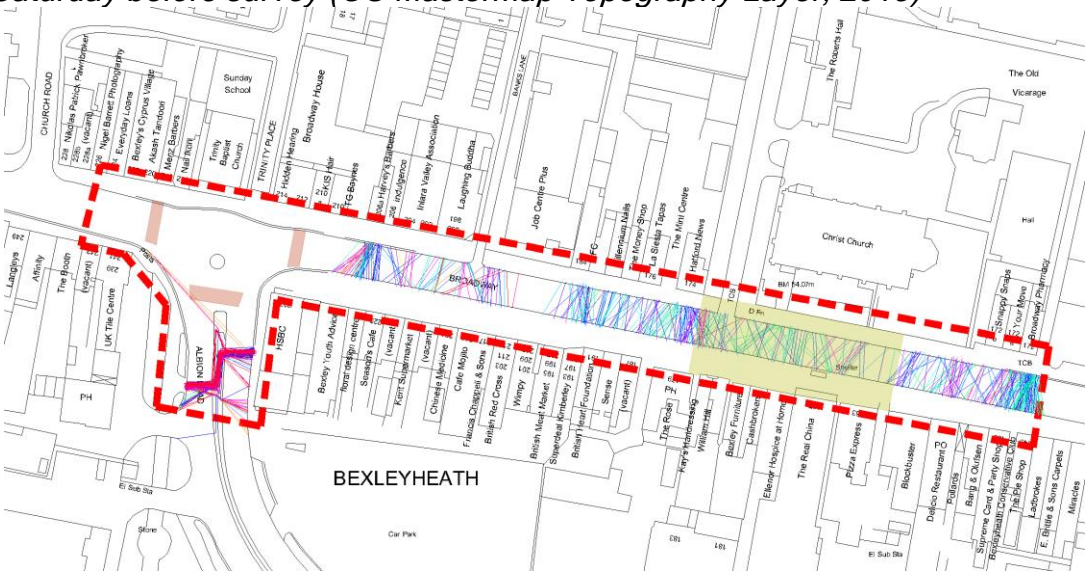
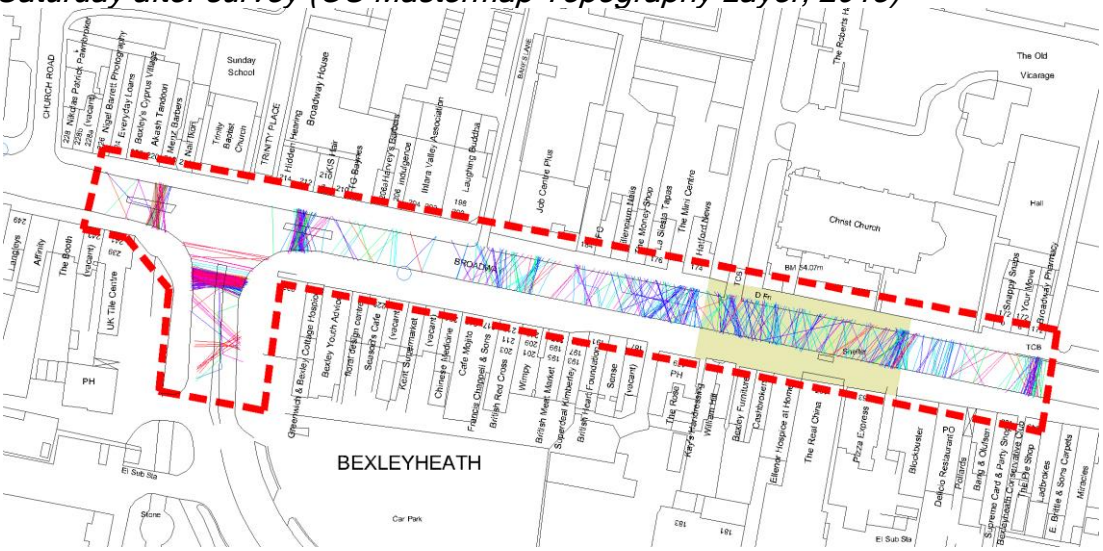


Figure 9: Map showing all locations for crossing in the study area during the Saturday after survey (OS Mastermap Topography Layer, 2013)



Key:

0000	0600	1200	1800
0100	0700	1300	1900
0200	0800	1400	2000
0300	0900	1500	2100
0400	1000	1600	2200
0500	1100	1700	2300

Flush Area Informal Crossing

Table 4: Chi-squared values of the ratio of road crossings on the flush surface area compared to the kerbed up-stand area of Broadway.

Day	Before or After	Total crossings per metre on (prospective) flushed surface area	Total crossings per metre on remainder of Broadway	Total percentage of crossings per metre on (prospective) flushed surface area to remainder of Broadway	Statistical significance of chi-squared test with Yates 2 x 2 correction
Tuesday	Before	2.19	2.70	44.73	Not significant
	After	2.61	2.50	51.09	
Saturday	Before	1.85	2.75	40.27	Significant
	After	3.04	2.33	56.55	

Hypothesis 3: There will be more pedestrians participating in 'place' activity along the street upon completion of the revitalisation scheme.

After assessing the activity across the study area during a day, an area immediately outside Christ Church and Hatfords News was identified as the main hub for place activity; it is depicted by the blue line in figures 10 and 11. The area incorporated the newly flush 'square' area and benches adjacent to the church wall.

Figures 10 and 11 also plot the location of place-related street activity. The main congregation of activity in figure 10 is around the Hatfords News shop, with some also around the neighbouring statue outside Christ Church. Figure 11 shows that the general focus remains in these areas following construction, although there appears to be a more even spread. Both surveys capture some scattered place activity around other areas, such as those waiting or smoking outside eateries, or those resting or sitting beside the Christ Church boundary.

Table 5 records the total street activity, including that which is fluid, such as walking through the street whilst on the phone, and instantaneous ones, such as making use of litter bins. The table shows that the total number of people carrying out place activity in this area was actually higher prior to the scheme's construction, despite new facilities to promote such activity being installed, such as benches. Based on these results hypothesis 3 can be rejected. However, both before and after surveys were carried out in December, with relatively poor weather conditions (cold and intermittent rain), so street activity would be low. It would be useful to repeat the survey in summer months, when the climate is more conducive to outdoor activity.

Table 5: Composition of before and after place activity and number of people taking part in activity.

Activity	Number of people partaking in activity	
	Before	After
Looking at adverts	18	16
Chatting	40	22
Vehicle loading (goods)	2	0
Vehicle loading (pedestrian)	4	6
Navigating	1	2
On phone - walking	47	33
On phone - loitering	8	3
Resting	13	7
Scooting	0	1
Sitting on bench	0	4
Smoking	2	2
Waiting	16	8
Use Bin	23	33
Uncovering scratchcard	1	0
Walking dog	2	3
Watching	1	0
Jogging	0	4
Total	178	144

Figure 10: Location of place activity prior to revitalisation scheme (OS Mastermap Topography Layer, 2013)

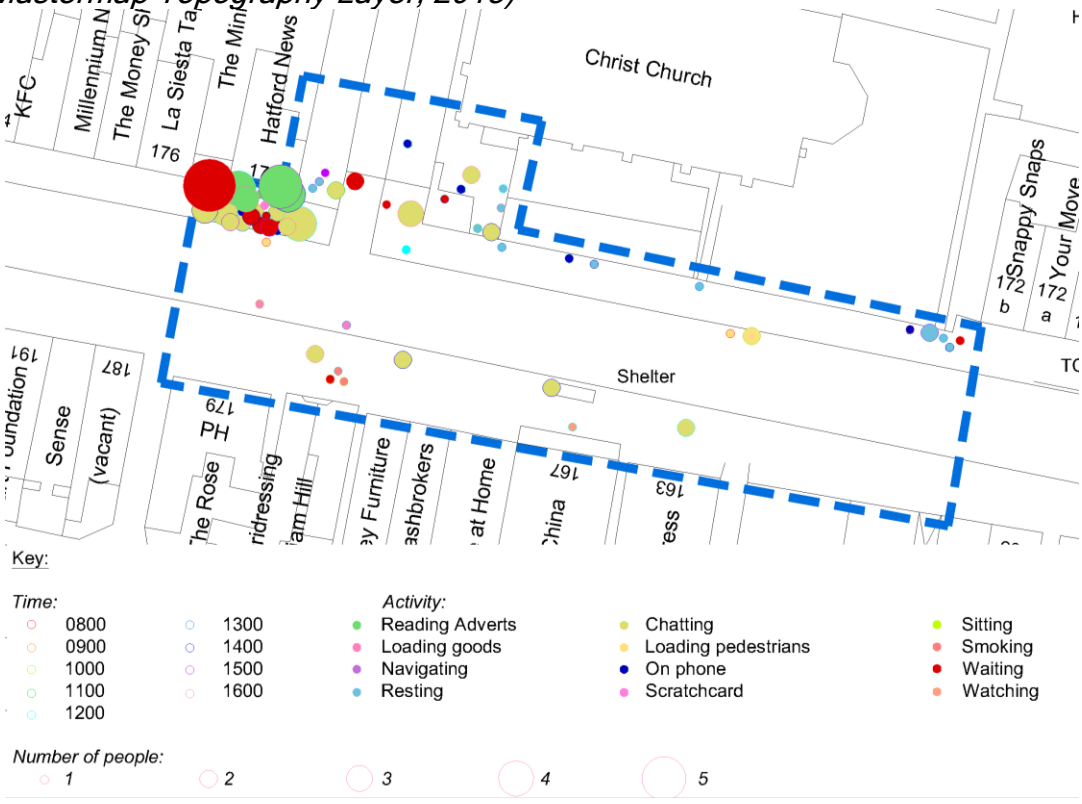


Figure 11: Location of place activity after revitalisation scheme (OS Mastermap Topography Layer, 2013)

4.2 Vehicles

Hypothesis 4: The number of vehicles travelling through the street will decrease following construction of the shared space scheme.

Table 6 indicates that the number of vehicles travelling along Broadway reduced between December 2012 and December 2013 for both the Tuesday and Saturday survey, although these reductions are not statistically significant.

Table 6: Change in daily vehicle count

Day	Total number of daily vehicles		Change
	Before	After	
Tuesday	14226	13188	-7.3
Saturday	16578	14850	-10.4
Chi-Squared value		3.6	
Degrees of freedom		1	
P-value		0.058	
Not Significant			

Hypothesis 5: Vehicle delay decreases once a 'shared' junction is implemented and pedestrian signals are removed.

Table 7 shows that hypothesis 5 can be rejected, as there has been no statistically significant *decrease* in vehicle delay upon implementation of a 'no

priority' junction at the Trinity Place junction. The Saturday sample shows a decrease in mean time to travel the area, but this is not statistically significant. Conversely, the Tuesday survey showed a significant increase in mean time, implying drivers face added delay to their journey.

In figure 12, the mean time to travel the 240 metre length on Tuesday is similar between the before and after survey until 11:00. The hourly mean times steadily increase for the after survey until 18:00; whereas the before survey times fluctuate, but tend to be lower than those of the after survey. On the other hand, figure 13 indicates that the main discrepancy between the Saturday before and after survey occurs from 13:00 and 14:00, which saw a much higher mean time in the before survey in the same interval.

Figure 12: Graph showing the mean sample time to travel length of Broadway pre- and post-scheme on Tuesday, with 95% confidence error bars

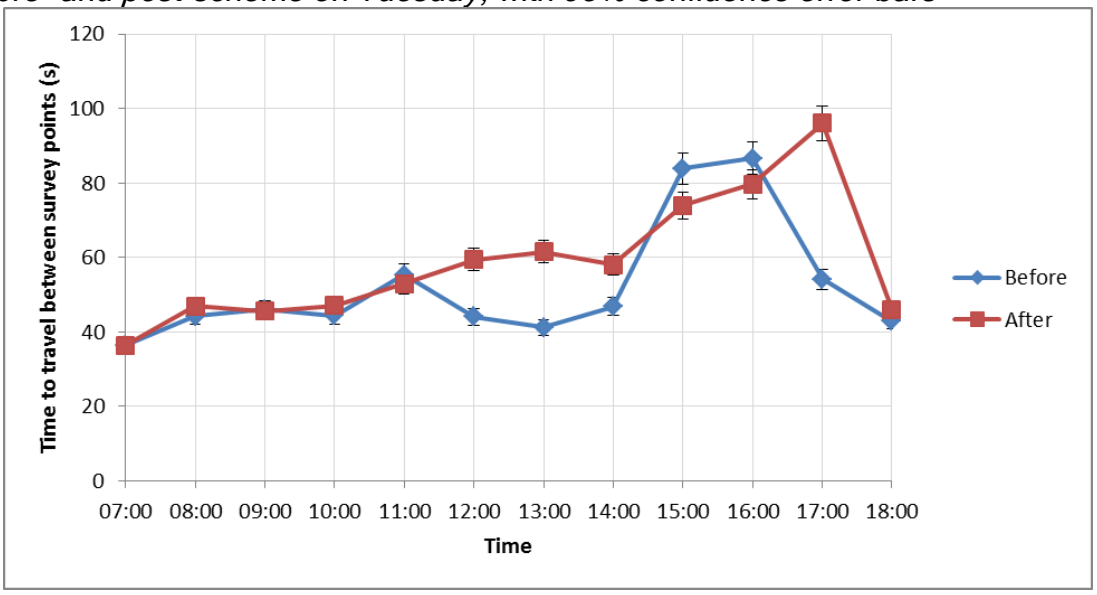


Figure 13: Graph showing the mean sample time to travel length of Broadway pre- and post-scheme on Saturday, with 95% confidence error bars

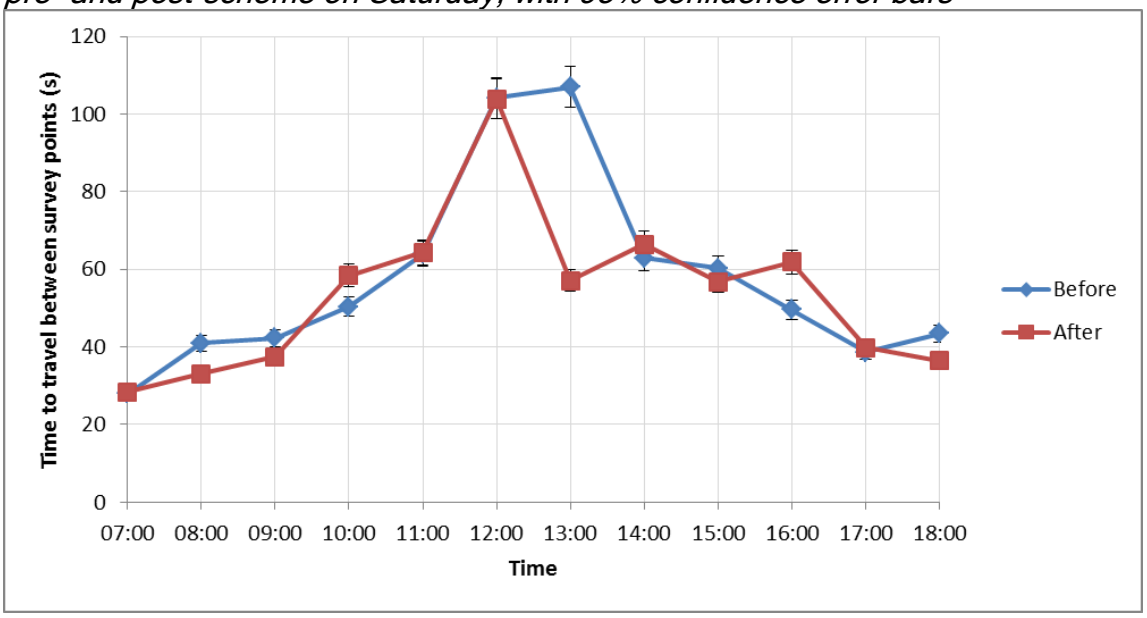
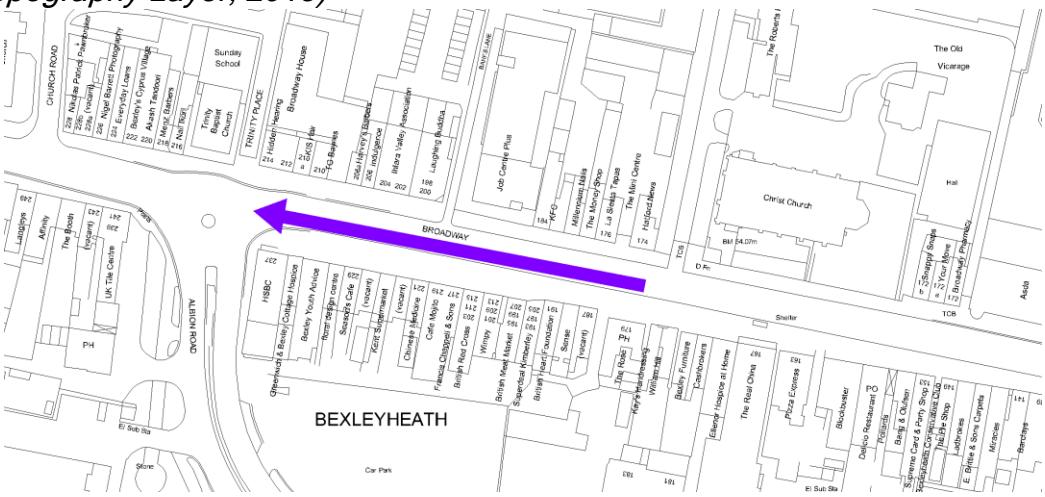


Table 7: Mean sample time to travel length of Broadway pre- and post-scheme

Day	Mean time for vehicle to travel area		One-tailed T-Test	Statistical Significance
	Before	After		
Tuesday	52.2	58.6	0.027	Significant
Saturday	57.6	53.7	0.141	Not significant

Hypothesis 6: Vehicle queuing will decrease upon implementation of the scheme.

Figure 14: Location of queue measured in hypothesis 3C (OS Mastermap Topography Layer, 2013)



Chi-squared analysis was used to compare the maximum queue lengths approaching the Trinity Place junction westbound along Broadway (shown in figure 14). The results of the Tuesday sample in table 8 show that there was no significant difference between the before and after survey. However, as table 9 shows, there was a highly statistically significant change in queue lengths on the Saturday. This is explained by much shorter queue lengths in the early Saturday afternoon of the post-scheme survey. The longest queue length of pre-scheme survey was that of 30 vehicles between 13:00 and 13:10 on Saturday. In summary, hypothesis 6 can be accepted for Tuesday, but rejected for Saturday.

Table 8: Chi-square test of pre- and post-scheme queue lengths on Tuesday

Time	Longest vehicle queue	
	Before	After
07:00	2	3
08:00	5	5
09:00	7	6
10:00	7	9
11:00	13	4
12:00	7	7
13:00	8	10
14:00	9	13
15:00	17	22
16:00	21	22
17:00	14	13
18:00	14	8
19:00	7	4
20:00	5	6
21:00	2	2

Data	
Level of Significance	0.05
Degrees of Freedom	14

Results	
Critical Value	23.6848
Chi-Square Test Statistic	15.37
p-Value	0.353
Not Significant	

Table 9: Chi-square test of pre- and post-scheme queue lengths on Saturday

Time	Longest vehicle queue	
	After	Before/Expected
07:00	1	2
08:00	2	3
09:00	7	4
10:00	14	9
11:00	9	11
12:00	21	30
13:00	30	9
14:00	20	15
15:00	24	7
16:00	12	7
17:00	16	11
18:00	6	7
19:00	3	6
20:00	5	4
21:00	3	4

Data	
Level of Significance	0.001
Degrees of Freedom	14

Results	
Critical Value	36.1233
Chi-Square Test Statistic	44.21
p-Value	3.47×10^{-5}
Statistically Significant	

4.3 Businesses

Hypothesis 7: Businesses will experience benefits as a result of shared space implementation.

Figures 15 to 18 chart some of the questionnaire responses from businesses before and after the Bexleyheath town centre scheme was carried out; the figures only show the responses from those that were surveyed both before and after, making a sample size of seventeen.

Figure 15 indicates that businesses were generally positive or ambivalent regarding the expected outcome of the street revitalisation scheme before it had commenced. However, opinions changed somewhat in the follow-up survey. The net rate of agreeing (percentage of businesses that strongly agree or agree minus those that disagree or strongly disagree) rose from 35% to 40%. Nonetheless, there appeared to be a split, with a higher number of those holding stronger views than in the before survey. Two of the three businesses that answered 'strongly disagree' in the after survey were identified as being those that were closing down due to poor sales. They were attributing this to lost custom due to subdued footfall during the construction process.

When considering the opinion of businesses on whether improvements to the street environment aid economic growth, the responses were slightly more positive in the after survey, as shown in figure 16. The net rate of agreement with statement rose from 59% to 64%. There were no businesses who strongly disagreed with the statement, despite there being occasions of this in the before survey. Nevertheless, changes to these answers between time periods are marginal.

Figure 15: Business responses to the statement: "The changes along Broadway and Trinity Place/Albion Place junctions (will be/are) an improvement to the street environment."

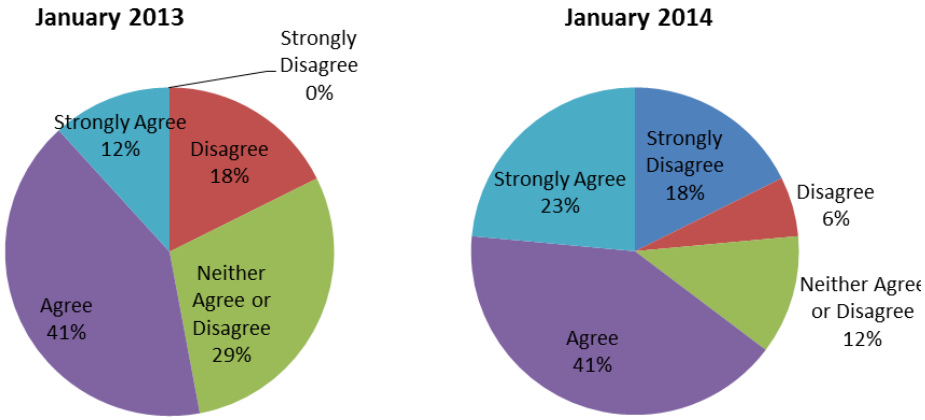
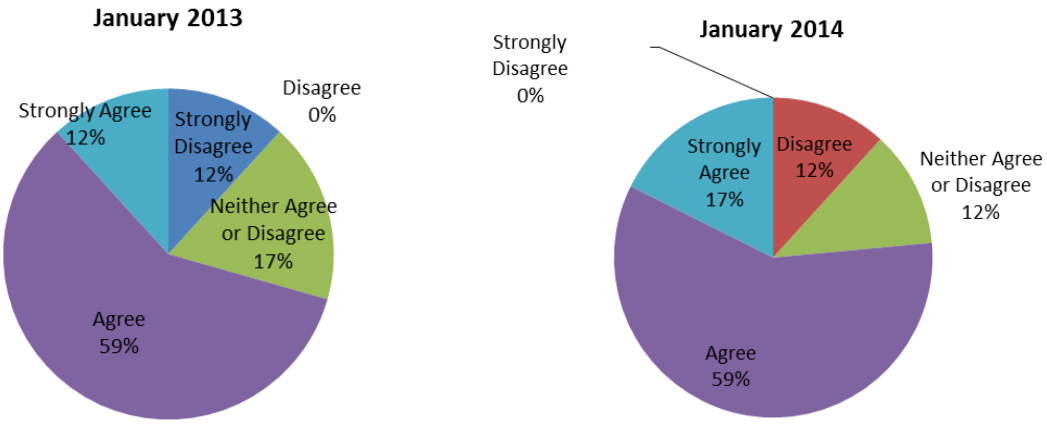


Figure 16: Business responses to the statement: "A well-presented street environment boosts economic growth and aids existing businesses."



During the before survey, over half the respondents were uncertain when they pondered whether the Broadway works would have a beneficial impact upon them, as shown in figure 17. Once this uncertainty was removed in the after survey, there was a polarisation of responses; the 'disagree'/'strongly disagree' remained at 29%, while the proportion recording 'agree' or 'strongly agree' side, from 18% to 47%. The net agreement rate rose from -11% to 18%.

This polarisation of attitudes towards the scheme is also signified in figure 18, in this case with the majority of businesses believing that the scheme was not a good use of funds. Although, as with responses to other questions, there was a slight increase in positivity after the scheme was complete. As the change in responses is fairly small, hypothesis 7 is rejected.

Figure 17: Business responses to the statement: "The scheme (will have/ has had) a beneficial impact upon my business".

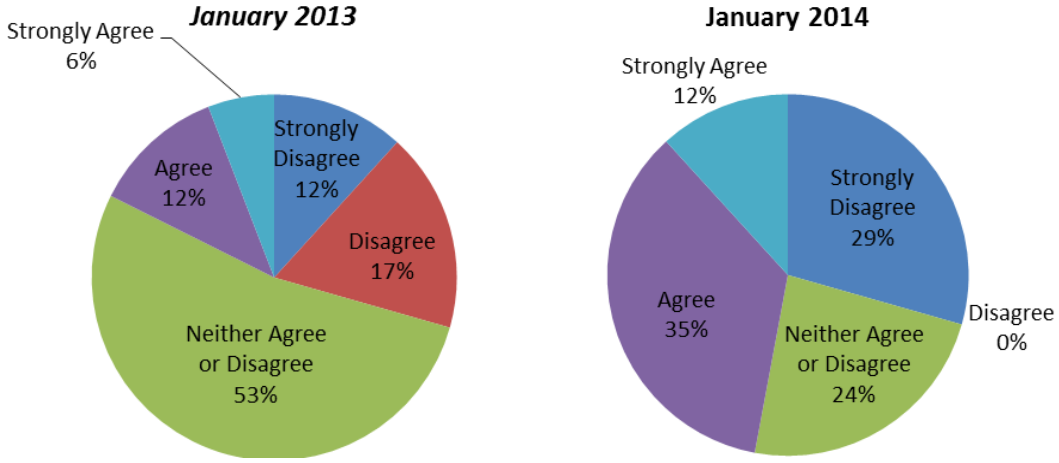
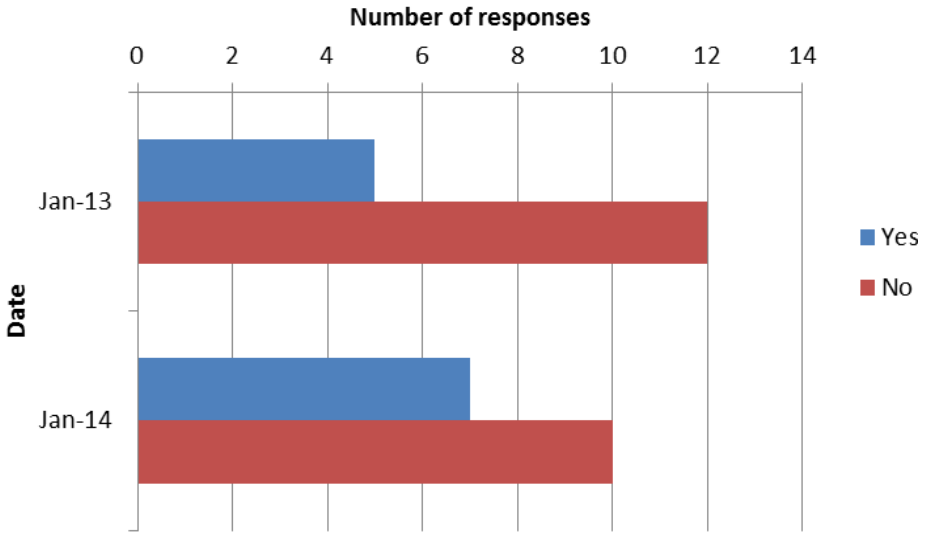


Figure 18: Business responses to the question: "The whole revitalisation scheme cost over £3 million and was funded by Transport for London and Bexley Borough Council. Do you believe that this is a good use of funds?"



4.4 Short and Long Term Changes

Hypothesis 8: A greater ratio of pedestrians at the Trinity Place junction will cross the road away from the informal crossings in the long-term

Figure 19: Map showing locations for crossing in the study area during the Saturday after surveys (OS Mastermap Topography Layer, 2013)

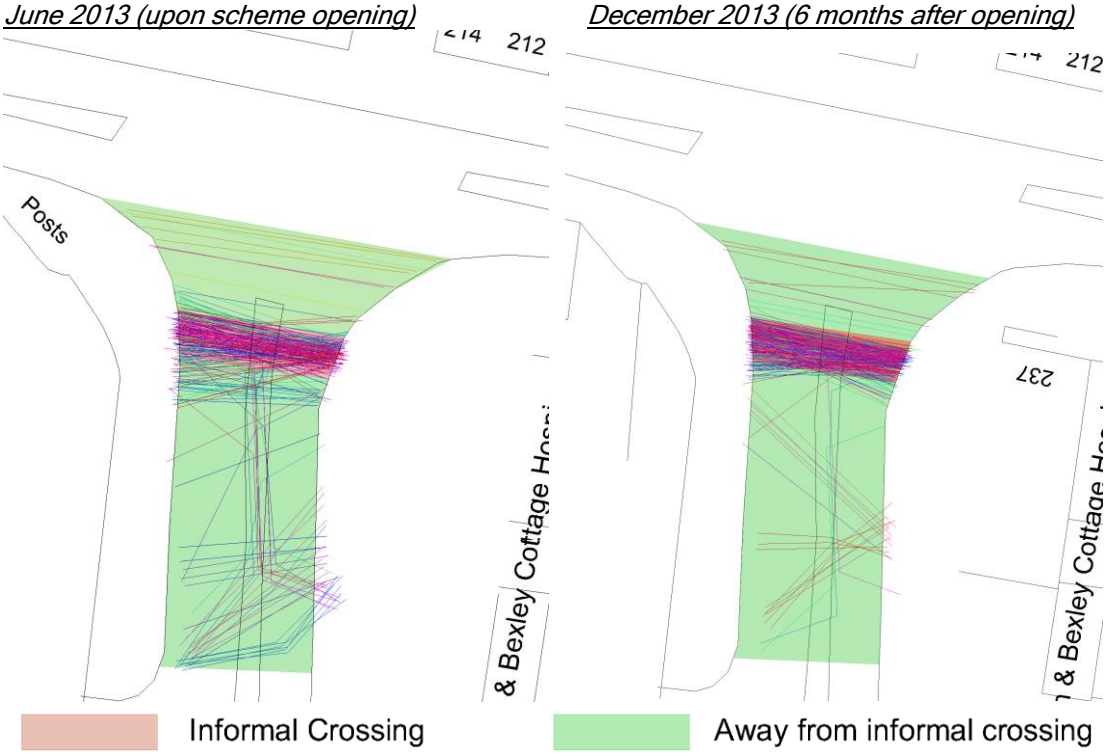


Figure 19 plots the crossing trajectories of a sample of pedestrians, in June and December 2013, where it is noticeable that there is a migration over time of movement *towards* the informal crossing point and away from the area to the east. Table 10 confirms that there is a highly statistically significant increase in the ratio of crossings on the informal crossing over the longer term. But this is opposite to what was hypothesised, so hypothesis 8 must be rejected. This finding needs to be caveated by the fact that the two post surveys were in June and then December, so there could possibly be some seasonal influence here as well.

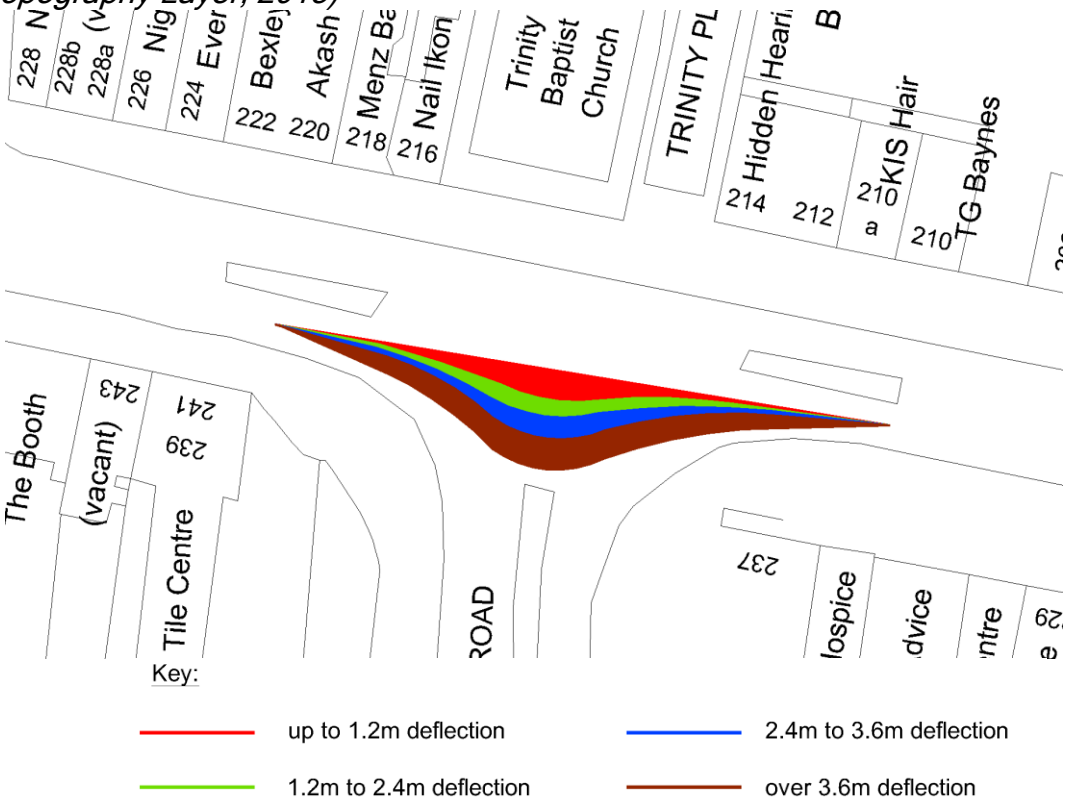
Table 10: Chi-square test with Yates' correction on the ratio of crossings on the Albion Road arm of Trinity Place occurring on informal crossing.

Date	Number of crossings on informal crossing area	Number of crossings outside informal crossing area	% of crossings on informal crossing area
Scheme opening	282	182	60.80%
6 months post-scheme	366	144	71.80%
Chi-squared value		12.686	
Degrees of freedom		1	
p -value		0.0004	

Hypothesis 9: Vehicles travelling straight across the junction will deflect less in the long-term

A formal roundabout (Figure 2) was replaced by a flush surface with a circular patterning (Figure 3).

Figure 20: Map showing deflections used for hypothesis 6B (OS Mastermap Topography Layer, 2013)



From observing the video surveys, it appeared that many vehicles were manoeuvring across the Trinity Place junction as if it were a roundabout, despite the removal of a central obstacle. Vehicle deflections from the most direct straight route across the Trinity Place junction were analysed for traffic travelling westbound. The number of vehicles which followed each of the four degrees of deflection shown in figure 20 were noted when the junction had recently opened and 6 months later.

Table 11 indicates that there has been a highly statistically significant change. As illustrated in figure 21, there were less severe vehicle deflection six months after the scheme was opened, leading one to accept hypothesis 9. It is suggested that this is because drivers became more familiar with the layout.

Figure 21: Graph showing change in deflection of vehicles travelling westbound over Trinity Place junction over time.

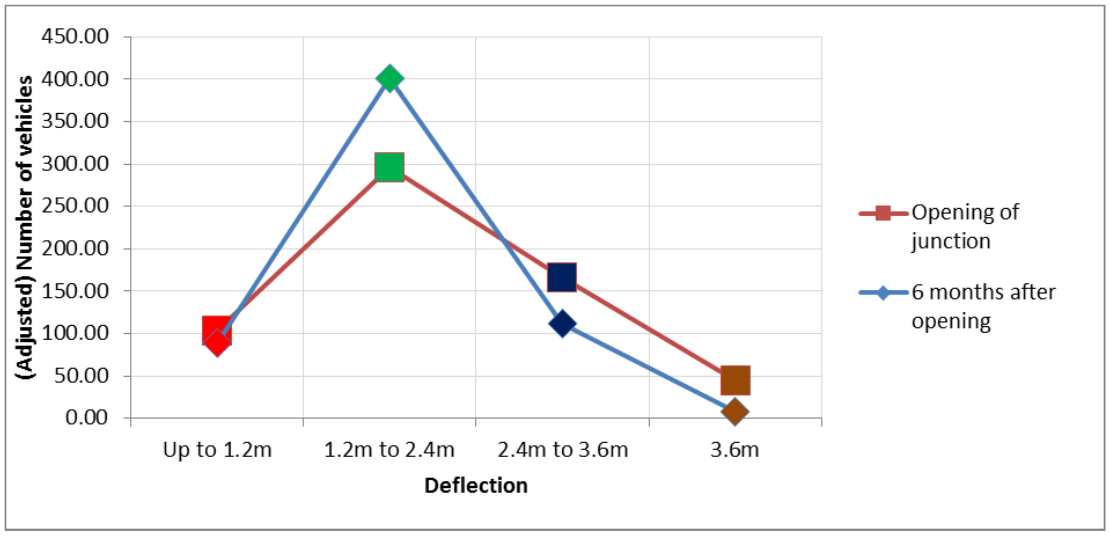


Table 11: Chi-square test on vehicle deflections travelling westbound across the Trinity Place junction.

Deflection	Number of vehicles	
	Jun-13	Dec-13
Up to 1.2m	109	89
1.2m to 2.4m	313	401
2.4m to 3.6m	176	112
3.6m	48	8
40 to 49	646	610

Data	
Level of Significance	0.001
Degrees of Freedom	3

Results	
Critical Value	16.2662
Chi-Square Test Statistic	87.91
p-Value	6.2×10^{-19}
Significant	

<u>Hypothesis 10: Drivers are more likely to give-way to pedestrians on informal crossings in the long-term as both user groups become more familiar with the layout.</u>

Figure 22 along with table 12 overwhelmingly suggest that drivers are more likely to give-way to pedestrians in the long-term on the informal crossing of Albion Road, leading one to accept hypothesis 10. Over 70% of drivers proceeded across the informal crossing whilst pedestrians were waiting to cross when the scheme first opened, but this reduced to 38% 6 months later – a highly significant difference.

All results in hypotheses 8 to 10 indicate pedestrian and driver behaviour change over time as each user familiarises themselves with a new layout.

Figure 22: Chart showing change in number of driver's giving-way to pedestrians on the Albion road arm of the Trinity Place junction.

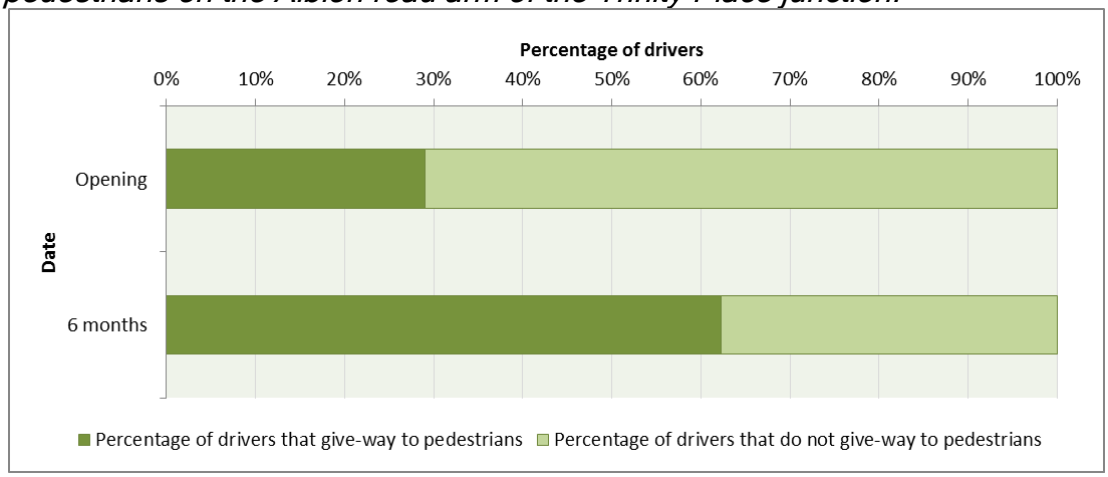


Table 12: Chi-square test with Yates' correction on the number of drivers giving way to pedestrians on the Albion Road arm of the Trinity Place junction.

Date	Number of drivers to give-way to pedestrians	Number of drivers not to give-way to pedestrians	% of drivers that give-way
Scheme opening	124	303	29.0%
6 months post-scheme	244	148	62.2%
Chi-squared value		89.374	
Degrees of freedom		1	
p -value		<0.0001	

5. DISCUSSION

In the full study, twenty-two individual hypotheses were tested, of which five were confirmed. A further five were partially statistically significant (i.e. on one day but not both, or for some areas and not others), whereas twelve were rejected entirely. After implementation of the Bexleyheath Broadway shared space scheme, the hypotheses that were fully supported were:

- Pedestrian delay at the kerbside will be lower when waiting to cross
- The speed of pedestrians crossing the carriageway will be lower
- Striding pedestrians will travel at a lower speed
- Vehicles travelling straight across the Trinity Place junction will deflect less in the long-term
- Drivers are more likely to give way to pedestrians on the Trinity Place informal crossings in the long-term

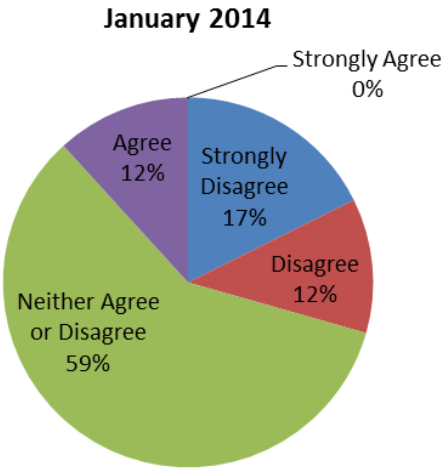
From the confirmed hypothesis it appears that the shared space environment at Bexleyheath has made road crossing a quicker and more comfortable experience. Both the waiting time and total crossing time is lower since the new layout has been implemented. This reduction in waiting time can be attributed to two key factors.

Firstly, the median strip on Broadway provides a buffer between eastbound and westbound traffic that allows pedestrians to break their crossing movement. This is used as a pause in 6-8% of crossing movements, as opposed to the negligible numbers that stopped in the middle of the carriageway in the old layout that did not have a median strip. It is used by pedestrians despite its regular use by drivers, who use it to overtake parked cars and buses dwelling at bus stops. It balances the needs of motorised and non-motorised users and has thus reduced the vehicle dominance that was previously inherent on Broadway.

Secondly, drivers are giving-way to pedestrians, particularly on the informal crossings adjacent to the Trinity Place junction. By December 2013, two-thirds of vehicles that had the opportunity to give way to pedestrians did so. This had risen significantly from June 2013, when the junction first opened, indicating that pedestrians and drivers have reached a natural agreement. Surprisingly, in the long-term, pedestrians were seen to be more likely to use the informal crossing area on the Albion Road arm, than seek an opportunity to cross away from it; but this may reflect the much higher willingness of drivers to give way to pedestrians at this point than elsewhere.
The Trinity Place junction, where these informal crossings were situated, had the shortest waiting time for pedestrians wishing to cross. One unexpected result was that pedestrians waited longer to cross in the 'square' area of Broadway with the flush surface by Christ Church than in the 'link' median strip area. It had been expected that the flush shared surface would have raised drivers' awareness of pedestrians, thus creating a more comfortable crossing area, similar to Trinity Place. But it could reflect the fact that by Christ Church pedestrians have to cross the full width of the carriageway in one go, whereas elsewhere along Broadway and at the Trinity Place junction there is a median strip.

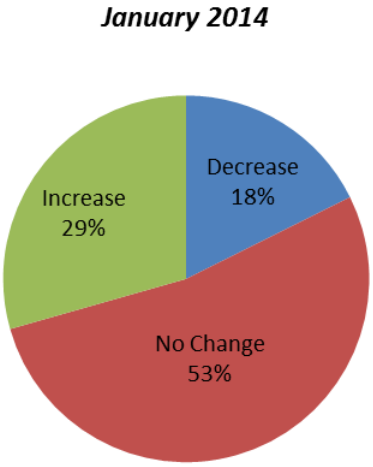
Despite the positive signs, there are still areas for improvement. There has been criticism in the local press about the scheme from motorists who feel that the informal crossings have hindered motorists and that a driver behind another vehicle cannot see the informal crossing ahead (Wood, 2014). In the business survey many businesses complained that the street was unsafe, with only 12% believing that the street has been made safer upon completion of the scheme (figure 23). Despite this, no business could recall an accident occurring on the street in the 6 months since completion. However, drivers are treating the junction less as a roundabout in the long run, by deflecting less when travelling straight through. Authorities need to be cautious of this trend, as it may be a sign that the initial ambiguity experienced by drivers when using the junction, may evolve into higher speeds and a dangerous approach as they become more confident.

Figure 23: Business responses to the statement, "My customers feel safer driving and walking along the street now than before the scheme" in January 2013.



The level of footfall is an indicator where an increase was expected to be seen, particularly with respect to visitors to the study area when compared against the figures for Broadway shopping mall in a pedestrianised area to the east of the scheme. However, when comparing figures from December 2012 against December 2013, a significant fall in footfall along Broadway was observed - with little change at the shopping centre. This is likely to be because the road-works experienced on Broadway disrupted the flow of pedestrians during the period January to June 2013, with numbers of pedestrians failing to return to the pre-levels of December 2012. Despite this observed reduction, 29% of businesses believed there had been an increase in footfall, with only 18% believing that there had been a fall (see figure 24). However, more importantly, more recent figures comparing June 2013 and June 2014 show that there has been an increase in footfall. So it appears that shoppers and street users are returning to the area, after some delay. It is important that local officials continue to closely monitor these footfall levels, to assess the longer term impact of the scheme in achieving its objective of 'revitalising' the area.

Figure 24: Business opinion of pedestrian footfall between January 2013 and January 2014.



In terms of public safety, reported crime in the study area has reduced at a greater rate than that of the surrounding area.

Due to challenging economic times, it is difficult to gauge the overall impact of the scheme on businesses. Construction work was deemed to be mainly responsible for a 7.1% reduction in reported retail sales from January to May 2013 (Christie, 2013), but there are signs that business has increased since. In responding to the survey, many people were openly angry at the effect the works had on their business. However, some have started to see the positives of the scheme and were cautiously confident that the rewards would arrive in the long-term. Footfall is recovering along the street and the local authorities are trying to persuade shoppers back to the town centre by providing incentives, such as free parking on certain weekends. Increased boarding of buses along Broadway is indicating that there are early signals that a night-time economy is emerging. A few new restaurant establishments have opened and the local nightclub has re-branded itself since the scheme was completed.

6. CONCLUSION AND EVALUATION

6.1 Achievements

This study of the Bexleyheath Broadway shared space scheme has provided a comprehensive analysis of the effects of the changes in the street layout on a range of different users of the space. The scheme itself is achieving many of its aims: pedestrian movements at road junctions have considerably improved and there has been a radical change to the public realm. The main aim yet to fully materialise is that of an improved economy for local businesses. There has been a fairly high recent turnover of retailers which could reflect a changing character of the area, stimulated by the scheme.

This study has analysed just one shared space scheme, but it has three distinct design components and the extensive use of video cameras, before and after scheme implementation, has enabled a far greater depth of analysis than has been possible in most other shared space scheme evaluations. It has been a comprehensive study from which it has been possible to propose a set of indicators for assessing the impact of other schemes. These are shown in figure 25 and comprise methods used in this study, as well as new suggested methodologies, such as GPS trackers and speed gauges. However, as in this study, much of the data will best be captured using video surveys parts of this indicator framework can be used as required by the scheme developer, as they see fit. It is desirable to continue assessment beyond the first year of implementation and at regular intervals to track changes over time. This will ensure any secondary and long-term effects that have not been picked up in the study earlier are identified. If research shows that initial scheme objectives have not been met, remedial action can be designed to improve the situation.

6.2 Recommendations for Policy

It has been found that removing formal roundabouts – as well as pedestrian traffic signals - reduces pedestrian delay on town centre routes, without unduly increasing vehicle delays, even if there is a relatively high (approximately 14,000 daily) vehicular flow on Broadway east of Trinity Place. It is therefore recommended that informal junction designs and pedestrian crossings, such as those at the Trinity Place junction, are considered for public realm improvement schemes – with one-lane approach arms and some form of median strip or pedestrian refuge between the two carriageways. The effects of introducing such a layout will be site specific and will depend on both pedestrian and vehicular flow.

A further recommendation would be to promote the use of median strips on town centre high streets or other areas where there is a high mix of vehicles and pedestrians. These can either have a kerbed upstand, where widths allow, or can be flush with the carriageway surface as with Bexleyheath Broadway. They visually break-up the streetscene, encouraging drivers to travel at slower speeds, whilst also providing a refuge point at which pedestrians crossing the street can break their movement. The indications of benefits shown in this study are promising, but further analysis of similar median strips is required to confirm their suitability, particularly regarding the use of these areas by vulnerable pedestrians.

Based on the apparent negative effect of road-works in subduing pedestrian footfall, business activity and vehicular flow in Bexleyheath, there needs to further work in promoting stakeholder engagement with affected businesses. Businesses in Bexleyheath town centre, particularly on Broadway, suffered economically during the construction phase, as traffic queues, delays and street severance from the positioning of worksites meant their properties were difficult to access. Despite activity slowly recovering since completion and a generally positive outlook for the future from businesses, many were unhappy at the communication received before and during works. It is therefore recommended that local councils work closer with those businesses adjacent to the street to minimise disruption, provide better communication and, in severe cases, provide compensatory measures to offset the negative effects from road-works. As business does not recover immediately after the construction phase, these measures will be required for subsequent months. This will improve business owners' morale, will give users a greater sense of ownership of the scheme and may help promote companies to invest in their business in line with the street-works.

Figure 25: Shared space impact indicators

Number	Objective	Data Required	Method	When to carry out?
1	What is the ratio of pedestrians crossing the road compared to footfall?	Footfall	Video survey	Before
		Number of crossings	Visual observation	After: yearly
			Footway counter	
2	What is the pedestrian waiting time at the kerbside?	Individual pedestrian waiting times	Video survey	Before
			Visual observation	After: 2 years
3	What is the speed of pedestrians crossing the carriageway	Tracking pedestrian movement	Video survey	Before
		Time taken by pedestrian to cross	Visual observation	After: 2 years
		Road widths	GPS data	
4	What is the trajectory taken by pedestrians crossing the footway?	Tracking pedestrian movement	Video survey	Before
			Visual observation	After: 2 years
			GPS data	
5	Is here increased use the street by people with restricted mobility?	Number of pedestrians with restricted mobility	Video survey	Before
			Visual observation	After: 2 years
6	What is the speed of pedestrians walking through the street?	Speed of pedestrian or time passing between two designated points.	Video survey	Before
			Speed gauges.	After: 2 year
7	What is the footfall of the street?	Number of pedestrians using footway	Footway counter	Before
			Video survey	After: yearly
8	Do pedestrians feel comfortable using the space?	Survey responses	Questionnaire	Before
				After: 2 years
9	What is the number of vehicles using link or junction (including cyclists)?	Turning or traffic counts	Air-switch detectors	Before
			Video survey	After: yearly
10	What is the speed of vehicles using a link?	Vehicle speed data	Air-switch detectors	Before
			Radar survey	After: yearly
11	How long does it take vehicles to travel the space? (i.e. vehicle delay)	Time taken to pass between two designated points	Video survey	
12	If public transport vehicles use the space, how many people board and alight in the space?	Number of people boarding	Bus user survey	Before
		Number of people alighting	Electronic or GPS storage	After: 2 years
		Number of services	Visual observation	
13	How often are new facilities provided utilised? (e.e benches, cycle stands, bins)	Quantity of furniture	Video survey	After: yearly
		Volume of use	Visual observation	
14	How many different place activities occur in the space?	Quantity and type of street activity	Video survey	Before
			Visual observation	After: 2 years
15	What is the change in business rates or property prices in the location compared to the surrounding area?	Local rates	Local index	Before
				After: yearly
16	Do businesses feel the street layout has improved their custom?	Survey responses	Questionnaire	Before
				After: 2 years
17	What are the business or housing vacancy rates in the space and surrounding area?	Number of empty properties	Local index	Before
				After: yearly
18	What are the accident statistics?	Local accidents rates available from police or loca	STATS19 data	Before
				After: 3 years
19	What is the crime rate on the street, surrounding area and district?	Local crime rates	Local index	Before
				After: yearly

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[1] The dissertation that this study has been composed from a final year MSc Transport study awarded by UCL and Imperial College London. The study won the 2014 Voorhees-Large Prize, which is awarded to the best Transport dissertation for a UK run course.