Llywodraeth Cymru
Welsh Government

Side Road Zebra Crossings Trials in Wales

Road User Behaviour and Perceptions Report

August 2023

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1. Executive Summary

The Transport Research Laboratory (TRL) were commissioned to undertake the trial of non-prescribed zebra crossing markings, located at the mouth of the junction, on side roads in Cardiff. The Welsh Government wanted to understand the impacts of these zebra crossings on road user behaviour, safety, and associated user perceptions.

Methods

The study involved monitoring the impact of the trial crossing on road user behaviour employing an innovative AI-based optical sensor system to produce a digital interpretation of road user movements and positions; and research into user perceptions through surveys and workshops.

The impact study used a before-after experimental design, to assess how the installation of the trial markings affected key indicators of behaviour such as propensity of drivers to give way, waiting and crossing times of pedestrians, distance between vehicle and pedestrians, vehicle movement, and vehicle speed. The order in which pedestrians and vehicles used the crossing space during each crossing event was used as a proxy indicator for which party gave way.

The user perception study involved an on-street structured interview conducted with pedestrians who had just crossed the trial crossing; a real-world driving trial followed by a post-drive structured interview with selected drivers; and a focus group with organisations representing disabled people.

Main findings

Observations from the optical sensors showed that, after the trial markings were applied, there was a substantial and statistically significant drop (60% at Bishops and Hawthorn, and 39% at Evansfield) in the number of cases where the pedestrian went second, providing strong evidence that there was a significant increase in propensity to give way.

Other positive outcomes were a statistically significant increase in the number of pedestrians that crossed at the desire line; an overall reduction in vehicle speeds as they approached the crossing; and an increase in the distance between a vehicle and pedestrian at the crossing. The distribution of the time gap between the first road user leaving the crossing area and the second road user entering it remained similar at all three sites in both phases, suggesting that there was no increase in ‘near misses’ after the implementation of the trial crossings. Additionally, significantly more pedestrians were also clearing the crossing area before the vehicle reached it.

The presence of the trial crossing was recognised by a majority of all user groups as a crossing, and there was a clear acknowledgement that the pedestrian had the right of way; although some users raised concerns that other road users may not be aware of the priority.

While many users expressed a preference for a more conventionally located and designed crossing further down the side road, this needs to be balanced with the evidence that the trial crossings did in fact work as intended, and that the concerns

expressed are likely to be allayed with greater familiarity, especially if such crossings become commonplace. There would however seem to be a case for awareness raising, in particular of the recent changes to the Highway Code[1] that give greater priority for pedestrians crossing at side-roads.

Recommendations

Consideration needs to be given during scheme design to the concerns raised by people with disabilities, specifically to ensure that side road crossings are free from obstruction and parked vehicles, that crossings are only marked between parallel kerbs, with tactile paving correctly maintained to identify the crossing location, and more generally that alternative crossing provision is available away from the junction for those who would generally prefer not to cross at side roads, in particular those with visual impairment.

While there were no observations indicating increased risks to any road users, longer term safety monitoring is recommended. The user research identified a few additional parameters that could be observed in future trials, such as more detailed investigation of the implications of the trial crossing in the dark; and observing impact on parking behaviour at the kerb near crossings with markings.

[1] The Highway Code. (2022). Available at: THE HIGHWAY CODE - For cars, pedestrians, cyclists, motorcyclists and horse riders (highwaycodeuk.co.uk) Last accessed 16 January 2023.

2. Introduction

Welsh Government commissioned TRL to undertake the trial of non-prescribed zebra crossings on side roads in Cardiff. The WG is keen to understand the impacts of these zebra crossings on road user behaviour, safety and associated user perceptions.

A non-prescribed zebra crossing uses the prescribed black and white markings without all the other features of the prescribed crossing (see Table 1). By not including the zigzag markings, and the consequent minimum set-back distance, it is possible to install the crossing on pedestrians' desired walking line, directly across the mouth of the junction. The simplified design requirements, in particular not including illuminated beacons, would also reduce the implementation and maintenance costs of providing new crossings.

Table 1: Key differences between a prescribed and the non-prescribed zebra crossing

	
Standard zebra crossing • Has a series of alternate black and white stripes on the carriageway • A yellow globe is positioned at each end of the crossing (commonly referred to as a Belisha beacon) • Give-ways lines and zigzag markings • The requirement for at least two zigzag markings creates a minimum set-back distance of around 4.8 meters	**Trial zebra crossing** • Has a series of alternate black and white stripes on the carriageway • No Belisha beacon • Give way markings • No zigzag markings • No minimum distance, could be flush with the end of the side road

This study aimed to explore the general public's understanding of the use of the non-prescribed zebra crossing and how they behave around them. This study, therefore, investigated the following:

1. Impacts of the non-prescribed zebra crossing on key indicators of user behaviour at the crossing (i.e., safety, propensity of drivers to give way, waiting/crossing times); and
2. User perceptions of the new, non-prescribed zebra crossing, considering both the general public (both pedestrians and drivers) and users with disabilities.

3. Methods

Figure 1 provides an overview of the methods used to address the two research questions. The figure also indicates the various contributors who supported the respective tasks at different stages of the project. The impact study used a before-after study with monitoring undertaken using an AI-based video camera system, described in Section 3.1 and road user perceptions were investigated through three different tasks detailed in Section 3.2.

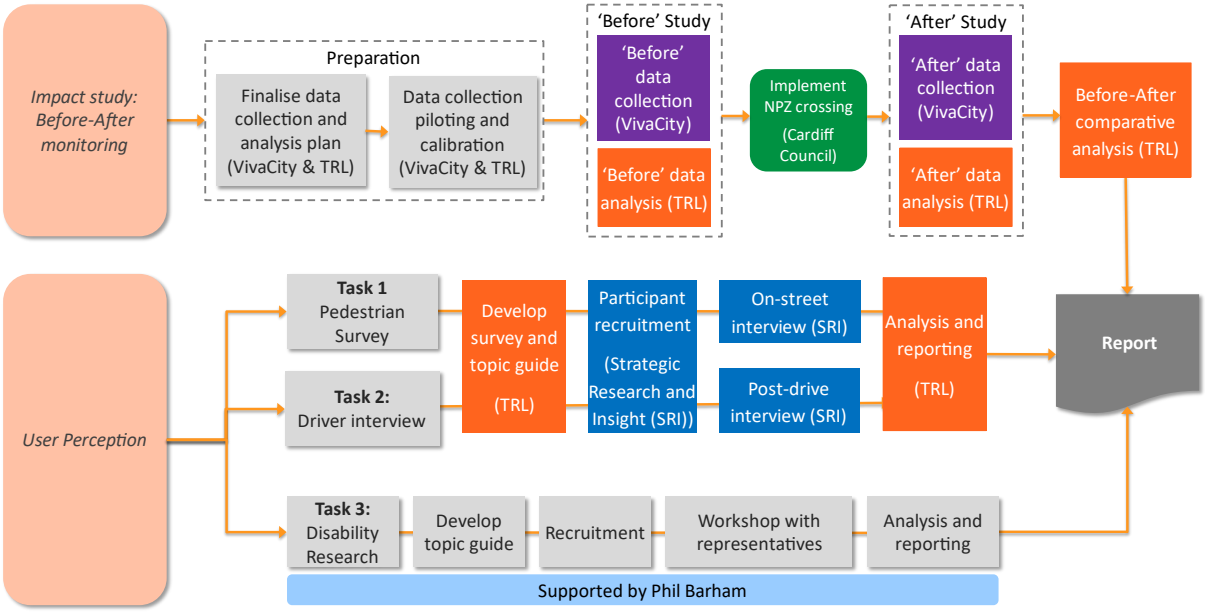


Figure 1: Overview of research methods

Three trial sites were selected in Cardiff by the Welsh Government:

1. Bishops Road/Merthyr Road
2. Station Road/Evansfield Road
3. Station road/Hawthorn Road East

An example of the trial crossing is shown in Figure 2. The technical drawing of the three sites is provided in Appendix A.

Figure 2: Example of the trial crossing at Location 2

3.1 Impact study: before-after monitoring

TRL had previously conducted similar work for Transport for Greater Manchester (TfGM)[2]. In the previous study, the assessment of who gave way and the level of conflict in each interaction was a judgement made by the video analyst. An innovative aspect of the Welsh Government trial was the use of an AI-based optical sensor systems provided by VivaCity to collect data on road user behaviour. This uses machine learning algorithms to analyse images from optical sensors and produce a digital record of road user movements and positions. VivaCity sensors were installed at the trial sites to gather and analyse data before and after the trial crossings were implemented.

Time-coded records of pedestrian and vehicle positions, movements, and interactions, as well as paths of road users, proximity of pedestrians to vehicles and speed of movement of both pedestrians and vehicles were collected automatically for each crossing event. To avoid counting events when pedestrians crossed with no vehicle to consider, interactions were only logged if both pedestrian demand to cross and the presence of turning vehicle(s) were identified simultaneously. Demand to cross was determined by a pedestrian moving in the direction of the crossing whilst within the designated crossing zone, to avoid recording pedestrians who were simply walking along the pavement when they had no desire to cross. If the pedestrian did not use the dedicated waiting area their first timestamp within the crossing area was used instead.

Only vehicles within the pedestrian crossing horizon were considered as interacting with the pedestrian. This horizon was defined from the moment demand to cross was established until the pedestrian had exited the crossing area, plus a 5-second buffer.

See Section 4.2 for more information on the crossing zones.

For each crossing event, the following indicators were captured:

[2] Non-prescribed Zebra crossings at side Roads Technical Annex 7: Observations of conflict and giving-way during on street trials: https://beeactive.tfgm.com/walking/side-road-zebras/

- Who went first after the start of each crossing event (used as a proxy for propensity to give way);
- Pedestrian waiting and crossing times;
- Path taken by pedestrian when crossing;
- Speed at the crossing of the nearest vehicle to the pedestrian (i.e., the last vehicle that passed before the pedestrian crossed, or the first vehicle after the pedestrian crossed, depending upon which gave way);
- Closest distance from pedestrian of the first vehicle that passed before or after the pedestrian; and
- Time gap: the difference in time between the first road user entering the crossing area and the second road user doing so

The speed, closest distance and time gap indicators were captured as they would be expected to affect how safe the pedestrians would feel when crossing.

The system also recorded the turning movement of vehicles, the number and classification of vehicles present, and the number of pedestrians present.

Interactions were captured from 0700hrs to 1900hrs at two timepoints: (1) before the trial crossing was implemented and (2) after it was implemented. Each phase had 2 weeks data collection.

At the Evansfield and Hawthorn sites, 'before' data were collected between 7th November and 20th November 2022. At Bishops, 'before' was collected between 31st October and 13rd November 2022. At all three sites 'after' data were collected over the same period, between 28th November and 11th December 2022.

3.2 User perceptions and understanding

To understand how road users perceived and understood the crossings, research was undertaken on site with pedestrians and drivers recruited as members of the public, and with members of a range of organisations that represent people with disabilities. The road user research was undertaken after the trial crossing markings were installed. Participants were asked about their understanding of priority at the crossing, their perceptions of safety and convenience of the crossings, how they used the crossing (anticipated use for the disability group) at such crossings, and areas for improvements on the trial crossing design. Table 2 provides a summary of the different recruitment and data collection method used for each user group.

All TRL research involving human participants must have written ethics approval before it can go ahead. The intention and result of the TRL ethics procedure is that research undertaken by TRL satisfies the ethical standards of professional bodies such as the British Psychological Society, the Market Research Society, and funding bodies such as the EPSRC and ESRC. This project was reviewed and approved through a TRL Ethics Panel consisting of the Project Manager, Technical Reviewer and a trained ethics reviewer from outside the project team. The review process included submitting and checking all surveys, topic guides, and recruitment process.

Table 2: Overview of recruitment and data collection methods for user perception

User group	Sample recruitment	Data collection method
Pedestrians	Users of the trial crossing on the road after they crossed. On-street recruitment.	Structured interview
Drivers	Recruit sample of drivers to drive routes that include trial sites followed by a survey.	Structured interview conducted post-drive
Users with disabilities	Member of groups who represent users with various disabilities.	Workshop

Pedestrians

Pedestrians were approached on street after they had crossed the side road using the trial crossing. Researchers approached pedestrians with a short questionnaire and conducted a structured interview to record participants' responses to the questions. A structured interview is a quantitative research method where the interviewer asks a set of prepared closed-ended questions in the form of an interview, which they read out exactly as worded. The questions are also asked in the same order for every participant. The questionnaire included a mixture of multiple choices and open-ended questions where participants were asked to explain their choice. The questionnaire is provided in Appendix B. Participants had the option to respond to the survey in Welsh or English. We have only included the English version of the questions in the Appendix below. The participants were required to be over 18 years old and were incentivised to take part by being able to enter a prize draw to win £200. The target sample size was at least 33 responses at each of the three sites.

Due to the small sample size for this analysis, differences between groups of participants (e.g., by age, gender, or location of crossing) were not examined. The qualitative data, from the open questions, was collected and analysed for key themes. A thematic analysis approach was taken, where common themes were drawn across participants' responses. This allowed for additional feedback and insight into the participants' quantitative answers. Anonymised quotes are provided to give examples of participants responses.

Drivers

Unlike pedestrians, drivers could not practicably be asked to stop and undertake a survey on site, hence, a different method was developed for this group. A sample of drivers was recruited before the trial and were asked to drive along a specified route before completing a structured interview about their experience. Drivers were recruited through a market research database. An initial recruitment questionnaire was sent out to residents in Cardiff on the database via email. Participants that wished to participate and met all the qualifying criteria were asked to indicate their availability between the 13th – 15th December 2022, between 7am and 6pm. The qualifying criteria for drivers required participants to be over the age of 18, have a valid driver's license, have a valid MOT and insurance policy, and have access and be familiar with using Google Maps for navigation. Participants were offered £50 cash for their time and participation upon completing the post-drive interview. The recruitment form is provided in Appendix C.1. Similar to the pedestrian survey, all respondents had the option to respond to the survey in Welsh or English. We have only included the English version of the questions in the Appendix.

As part of the ethics review, it was determined that, as the trial was conducted on a public road, confirmation that an individual possessed a valid driving license, MOT and insurance policy was sufficient to determine their eligibility to drive and participate in the trial. Furthermore, to avoid drivers being distracted by having to use an unfamiliar navigation system, we wanted to ensure that all participants were very familiar with the Google Maps application that was used to provide the specified driving routes. For this reason, we asked respondents to indicate which navigation application they were most familiar with and only those who selected Google Maps were allowed to take part in the trial.

Participants who fulfilled the recruitment criteria and were available for any of the timeslots were invited to meet a researcher at Llandaff North and Gabalfa Hub. They were asked to drive their own car to the meeting point without any passengers. At Llandaff North and Gabalfa Hub, a researcher verified the identity of the participant and provided them a link with the appointed route. The URL led the participant on to the Google Maps application on their personal devices and navigated the driver from the starting point (Llandaff North and Gabalfa Hub) across the three sites, and back to the Llandaff North and Gabalfa Hub where participants were asked to complete a short questionnaire about their experience. The questionnaire included a mixture of multiple choices and open-ended questions where participants were asked to explain their choice. The full questionnaire is provided in Appendix C.2. With four possible vehicle movement (see Table 3) at each of the three sites, there was a total of 12 conditions. To ensure all 12 conditions were captured by driver participants, four routes (A, B, C, and D) were developed (see Table 4) in which a driver would drive through each of the three sites at least once. The target sample size was 20 drivers. The full route is provided in Appendix C.3.

Table 3: Description of four different vehicle movement

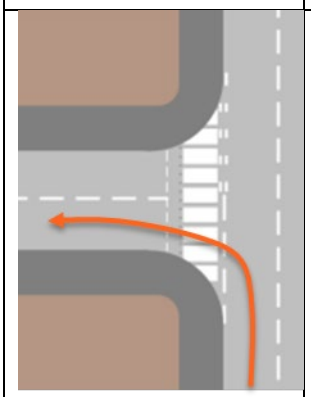
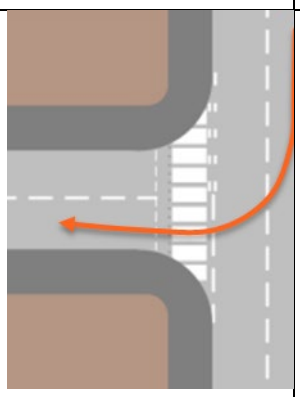
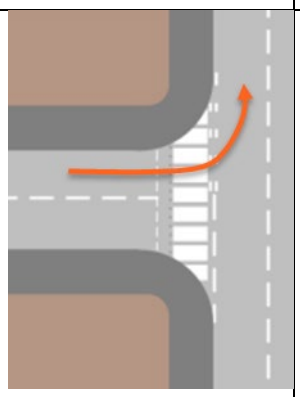
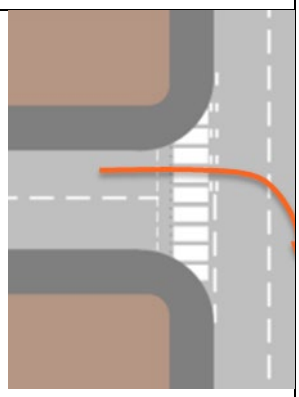
Into side road (left)	Into side road (right)	Out of side road (left)	Out of side road (right)
			

Table 4: Conditions and variables of each route

Route / Site	A	B	C	D
1	Into side road (right)	Out of side road (left)	Into side road (left)	Out of side road (right)
2	Out of side road (left)	Into side road (right)	Out of side road (right)	Into side road (left)
3	Into side road (right)	Out of side road (left)	Out of side road (right)	Into side road (left)

Similar to the pedestrian group, the differences between sub-groups of participants (e.g., by age, gender, or region) were not examined due to the small sample size. The qualitative data, from the open questions, was collected and analysed for key themes. A thematic analysis approach was taken, where common themes were drawn across

participants' responses. This allowed for additional feedback and insight into the participants' quantitative answers. Anonymised quotes are provided to give examples of participants responses.

Users with disabilities

Having a dedicated task to collect feedback from organisations representing disabled people is important as they have different concerns from the general population. TRL contacted a range of organisations and individuals with knowledge of the perspectives of disabled people with different needs and priorities and invited them to participate in a visit to the trial sites followed by a workshop. Ethical considerations precluded any form of trial in which vulnerable members of the public could be recruited and asked to use a non-standard design of road crossing. It is common for those working for organisations with an interest in a certain disability to have lived experience of that disability, and that was the case for several of the participants engaged in this part of the study. This approach was taken because representatives would be able to provide a broad understanding of the issues faced by people associated with the respective disability organisation. The target sample should represent a good cross-section of disabled people but with an emphasis on neurodiversity and sensory impairment by organisations representing people in Wales.

As well as contacting organisations directly, the 'snowballing' method was used, with individuals who were initially contacted disseminating information about the project and inviting other representatives or experts to take part in a workshop through their own local contacts. Snowball sampling is a non-probability sampling method where currently enrolled research participants help recruit future subjects for a study. While the focus of this recruitment effort was on engagement in the workshop, follow-up calls were made to organisations not responding, from early January 2023. In addition, all invitees were encouraged to subsequently share with the project team any further thoughts they might have regarding non-prescribed zebra crossings. The topic guide used for the workshop is provided in Appendix D.

Another recruitment objective was to secure the involvement of at least one local Access Group. This is because Access Groups typically comprise of members with a wide range of disabilities, including wheelchair users, whose needs tend not to be specifically represented by as many organisations as people with sensory impairments and people who are neurodiverse, for example. Although there are relatively few Access Groups in South Wales, contact was made with the two such organisations that are local to Cardiff - Newport Access Group and Torfaen Access Forum – as well as with Access Association Wales.

The workshop involved a site visit prior to the discussions. Participants were asked to meet at Llandaff North and Gabalfa Hub on the 8th of December 2022. The site visit involved the trial crossing at the junction of Station Road and Hawthorn Road East. This crossing was chosen because of its proximity to the venue of the workshop. The crossing happened to have the least complex lay-out of the three crossings involved in the trial, but this was not felt by the project team to be detrimental to the research, given that this enabled participants to focus on the concept of non-prescribed crossings.

4. Results: Impact study – before-after monitoring

4.1 Number of crossing events recorded

As explained in Section 2, indicators were recorded for individual crossing events where both pedestrian(s) and vehicle(s) were present; i.e., a pedestrian was detected moving towards the crossing within one of the waiting areas, or on the crossing itself; and at least one vehicle passed over the crossing area up to 5 seconds after the pedestrian cleared it. Vehicles travelling along the main road that were not turning into the side road were not captured.

In this dataset, 40,247 crossing events involving interactions between a pedestrian and vehicle were recorded. Table 5 shows a breakdown of the sample by site and whether before or after the installation of the zebra markings.

Table 5: Sample size

Site	Without zebra	With zebra
Bishops	9,260	9,996
Evansfield	6,185	5,731
Hawthorn	1,347	1,422

4.2 Pedestrian crossing path

Investigation of the path that pedestrians took when using the crossing can help to determine the extent to which pedestrians followed the line of the crossing or crossed elsewhere. The crossing path was estimated by recording the start and endpoints of the path taken by the pedestrian, which was logged in the data. Figure 3 shows the zone referencing schema which is further detailed in Table 6 below.

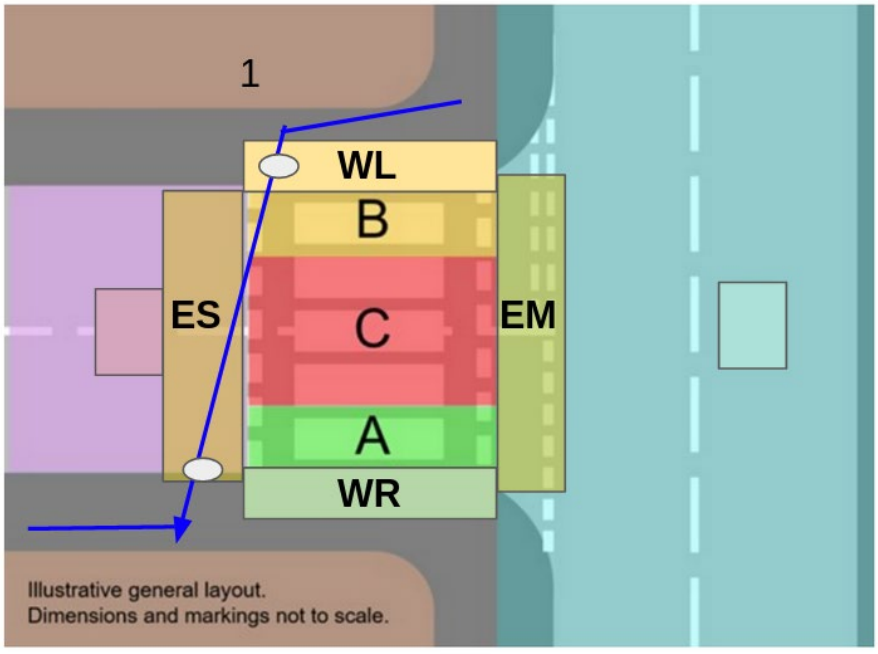


Figure 3: Zone referencing schema

Table 6: Locations on and around the crossing

Reference	Description
A	First quarter of distance across zebra with the main road to the right as the crossing is entered from the footway, across the full width to any limit markings.
B	First quarter of distance across zebra with the main road to the left as the crossing is entered from the footway, across the full width to any limit markings.
C	Remaining space between part reference A and B.
WL	Waiting Area Left (looking from side road to main) on pavement
WR	Waiting Area Right (looking from side road to main) on pavement
ES	Crossing Area Extension towards Side Road
EM	Crossing Area Extension towards Main Road

Forty-seven combinations of the start and end points were recorded. Only interactions with one pedestrian are presented in Figure 4 below as interactions that captured more than one pedestrian affect the accuracy of estimated start and end points. More than 75% of the records captured interactions with one pedestrian, which still provides a large sample size to draw significant insights about the pedestrian movement along the crossing.

After the implementation of the trial crossings, the proportion of pedestrians using crossing zone (ABC) only increased at all sites (from 1% to 9%). The percentage increase at Hawthorn was lower than other sites (1% to 3 %). It might be due to much less sample interaction captured at Hawthorn.

To check whether pedestrians crossing movement was linked to the change in the zebra crossing, a chi-squared test of independence was performed to assess the relationship between implementation of the non-prescribed Zebra crossing and the original routes (forty-seven combinations) in each site. There was a significant relationship between the two variables (p-value < 0.05) in all sites. The trial crossing can therefore be concluded to have had a significant impact on pedestrians' path, at all three sites, with an increase in the proportion following the line of the crossing.

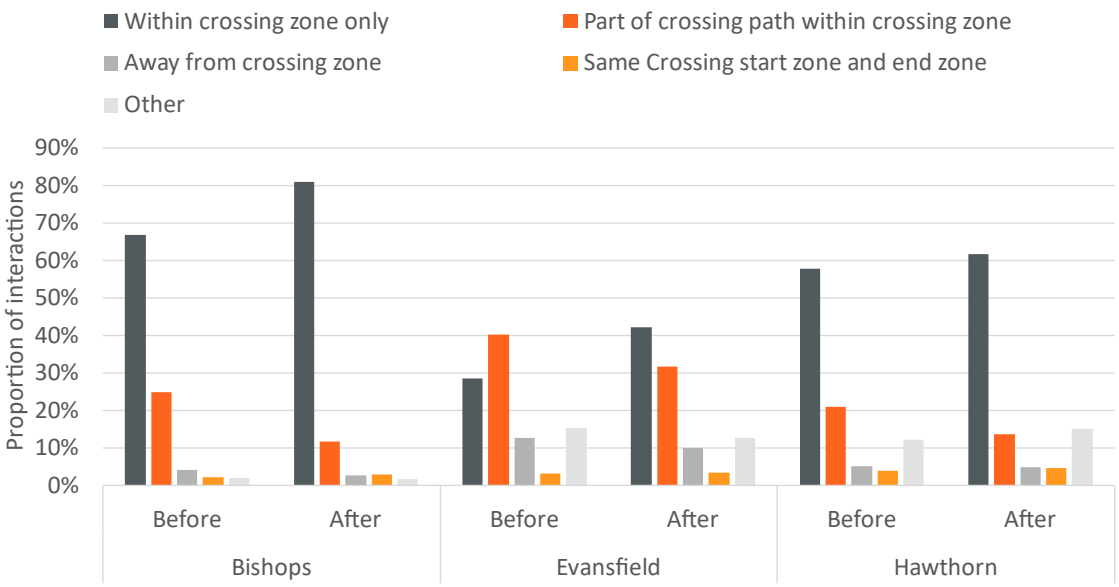


Figure 4: Pedestrian crossing path[3] [4]

4.3 Vehicle direction

Where a crossing event occurred, the direction of movement of vehicles was recorded. The observations indicate that whilst vehicles were observed to go in all directions (in and out of the side road, left and right). Figure 5 shows the distribution of vehicle direction by sites and phases. The distribution between with and without trial crossing was very similar. There was no obvious evidence that vehicle direction changed following the introduction of the trial crossings, whether because of an external factor or by encouraging drivers to change their routes.

[3] Routes with low occurrence or uncertain direction (e.g. started from side road but ended in middle zone, from ES to C) were classified into 'Other'.

[4] Some interactions (<1% of all interaction) with pedestrians started and ended in the same zone, grouped into 'Same Crossing start zone and end zone'. The possible causes could be tracking or detection issues, other zones being heavily occluded by parked or stationary vehicles and track switching.

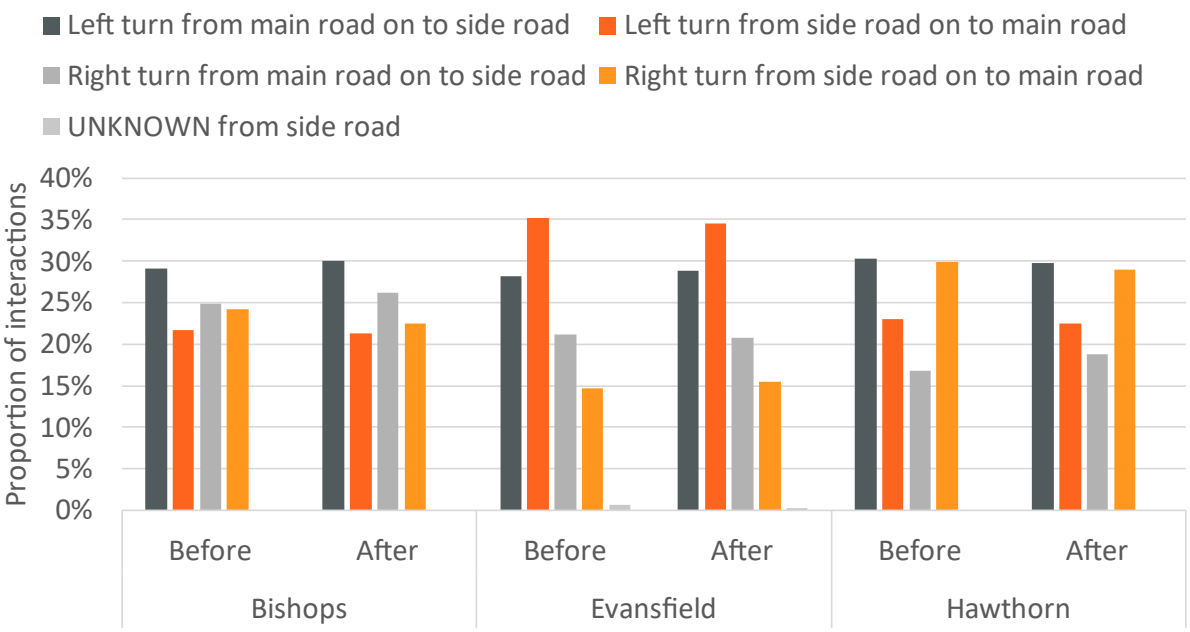


Figure 5: Vehicle direction by site and phases

4.4 Propensity to give way

As explained in Section 3.1, when a crossing event was detected, the VivaCity system recorded the order in which the pedestrian or vehicle passed the crossing. The proportion of pedestrians going second provides a proxy indicator of how often they had to give way. Figure 6 compares the numbers and percentages of each user group that went second, before and after the trial markings were applied. The main findings are:

1. At all sites, the vehicle was recorded as going second in a majority of the crossing events, both before and after the zebra markings were applied.
2. After the trial crossing was implemented, the number and percentage of vehicles going second increased at each site: by nearly 20% at Bishops, 5% at Evansfield and 8% at Hawthorn.
3. The proportional change in the number of pedestrians going second was much greater, falling by more than half at (60%) Bishops and Hawthorn and by 39% at Evansfield.

The chi-squared test of independence confirmed that the introduction of the trial crossing markings had a statistically significant association with the observed behaviour at each site (the likelihood that the association does not exist is 5%).

On the assumption that the proportion of pedestrians that went second reflects the extent to which they had to give way, it can be concluded that the introduction of the trial crossing resulted in a statistically significant reduction in the proportion of pedestrians that gave way at all three sites.

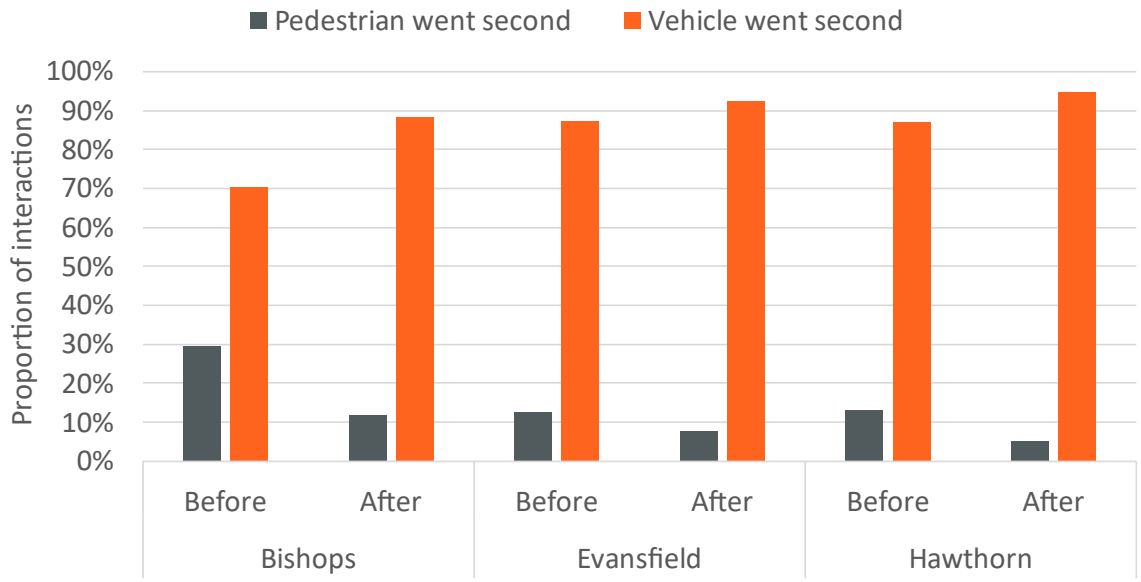


Figure 6: Give way behaviour by sites and phases

It is important to note that the observed proportion of vehicles going second, especially in the 'before' sample, was substantially higher than the proportion of vehicles observed to give way in previous TRL work[5]. However, it is important to take account of the assumptions used to define the crossing events that were included in the sample. As explained in Section 3.1, a crossing event required both detection of a pedestrian and the presence of a vehicle within a time horizon defined from the moment of pedestrian detection until the pedestrian has exited the crossing area, plus a five second buffer. If the value chosen for the buffer was too generous, then crossing events could be recorded where the pedestrian was able to cross without the driver needing to slow significantly or stop, in which case the proportion of vehicles going second could over-state the proportion that actively gave way. NB: this consideration would not affect the count of crossing events in which the pedestrian was recorded as going second.

Furthermore, the crossing events could also be affected by the use of the defined pedestrian waiting area: any pedestrians waiting further away from the side of the crossing than zones WR or WL would not be counted until they started to cross, which could under-count the proportion of pedestrians that are giving way (and also under-count waiting time).

Nonetheless, as the same sample criteria were applied before and after, the very large, and statistically significant, reduction in the proportion of pedestrians going second provides strong evidence that pedestrians gained a significant improvement in priority following the installation of the trial crossing.

[5] In a previous trial of side road zebra crossings, using a different methodology (details in section 3.1), for Transport for Greater Manchester (TfGM), less than half of the vehicles gave way to pedestrians before implementation of the zebra crossing markings.

4.5 Give way behaviour by turning direction

Research questions in previous work for Transport for Greater Manchester (TfGM), undertaken in a driving simulator, noticed drivers had a differing propensity to give way dependent upon their turning direction, with drivers emerging from the side road being more likely to give way to crossing pedestrians. However, this was not seen in this project. As seen in Table 7, the percentage of giving way whilst turning from the side road was similar to giving way when turning in to the side road in all three sites, for both with and without the trial crossing. This observation may be due to the different methodology (3.1) for defining crossing events and which party went first.

Table 7: Vehicle give way behaviour by sites, phases and turning direction

		Bishops		Evansfield		Hawthorn	
Movement	**Measure**	**Before**	**After**	**Before**	**After**	**Before**	**After**
Left turn from side road on to main road	Sample	2014	2132	2178	1981	310	319
	Number giving way	1381	1903	1906	1811	269	295
	% Giving way	69%	89%	88%	91%	87%	92%
Right turn from side road on to main road	Sample	2240	2248	908	888	402	412
	Number giving way	1540	1974	800	848	363	394
	% Giving way	69%	88%	88%	95%	90%	96%
Left turn from main road on to side road	Sample	2697	3001	1744	1656	408	424
	Number giving way	1945	2715	1533	1534	349	404
	% Giving way	72%	90%	88%	93%	86%	95%
Right turn from main road on to side road	Sample	2309	2615	1311	1193	227	267
	Number giving way	1650	2227	1128	1085	191	254
	% Giving way	71%	85%	86%	91%	84%	95%
UNKNOWN from side road	Sample	-	-	44	13	-	-
	Number giving way	-	-	39	13	-	-
	% Giving way	-	-	89%	100%	-	-

4.6 Waiting time / Crossing time

The time the pedestrian spent at the waiting area before using the crossing and the time taken to cross the road were recorded by the VivaCity system. These parameters provide an indicator of whether the trial crossing affected the delay to pedestrians when crossing the side road.

Figure 7 and Figure 8 shows the distribution of waiting time and crossing time respectively. Although the data indicates that waiting time and crossing time remained similar after the introduction of the trial crossing, a small change can be observed in the distributions of both waiting time and crossing time. The proportion of participants waiting for less than ten seconds increased, by 1 to 3 percentage points, for both parameters at all three sites, while the numbers waiting for longer times fell. For crossing time, more than 95% records completed crossing the road within 10 seconds at each site, in both phases. For waiting time, more than 95% of records waited under 10 seconds at each site, in both phases.

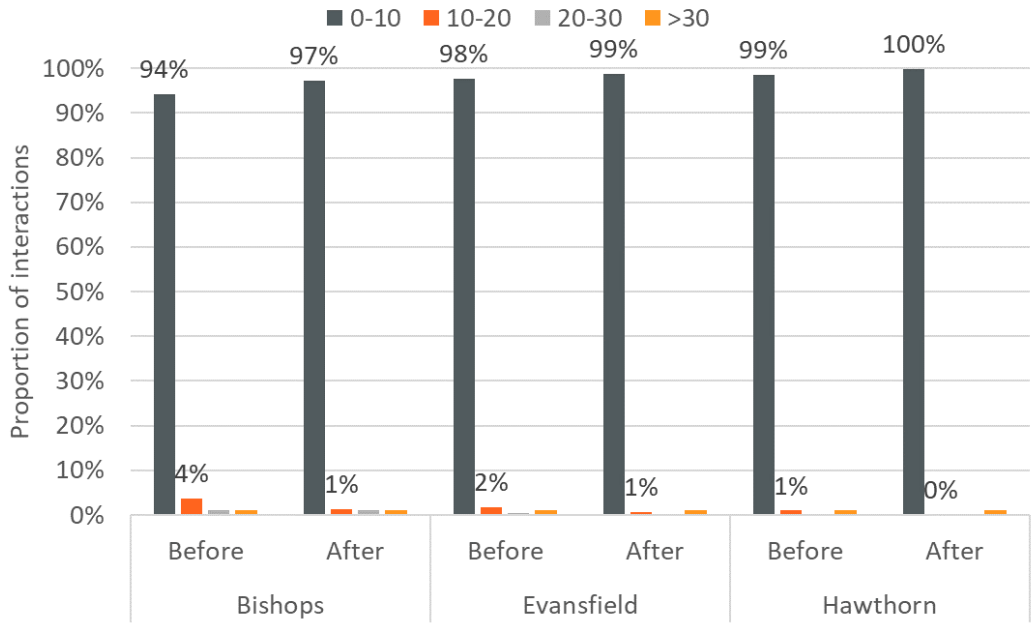


Figure 7: Distribution of waiting times (seconds)

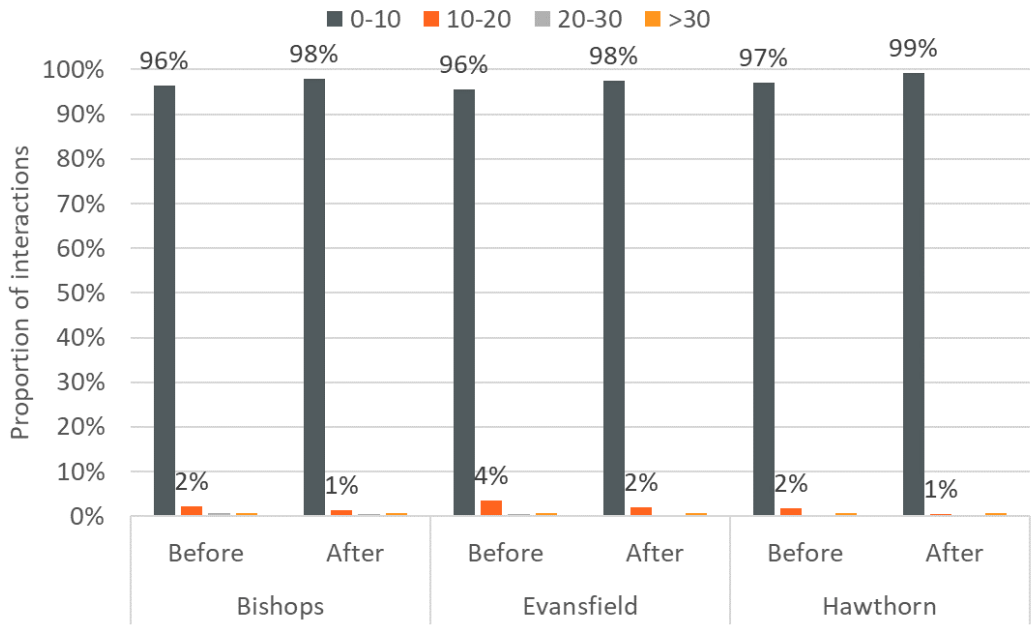


Figure 8: Distribution of crossing times (seconds)

4.7 Time gap

The time gap is defined as the time interval between a pedestrian and a vehicle at the crossing (i.e., the time between the first road user entering the crossing area and the second user entering it). A shorter time gap could be perceived as a greater risk by pedestrians – this an indicator of 'near misses'. Around 90% of the records show the time gap to be under 10 seconds at each site, in both phases. Most of the interactions were recorded with time gap less than 10 seconds. After the implementation, although small percentage changes can be observed in interactions with less 10 second time gap at Bishops and Evansfield, the overall distribution of the time gap remained similar as before in each of the three sites.

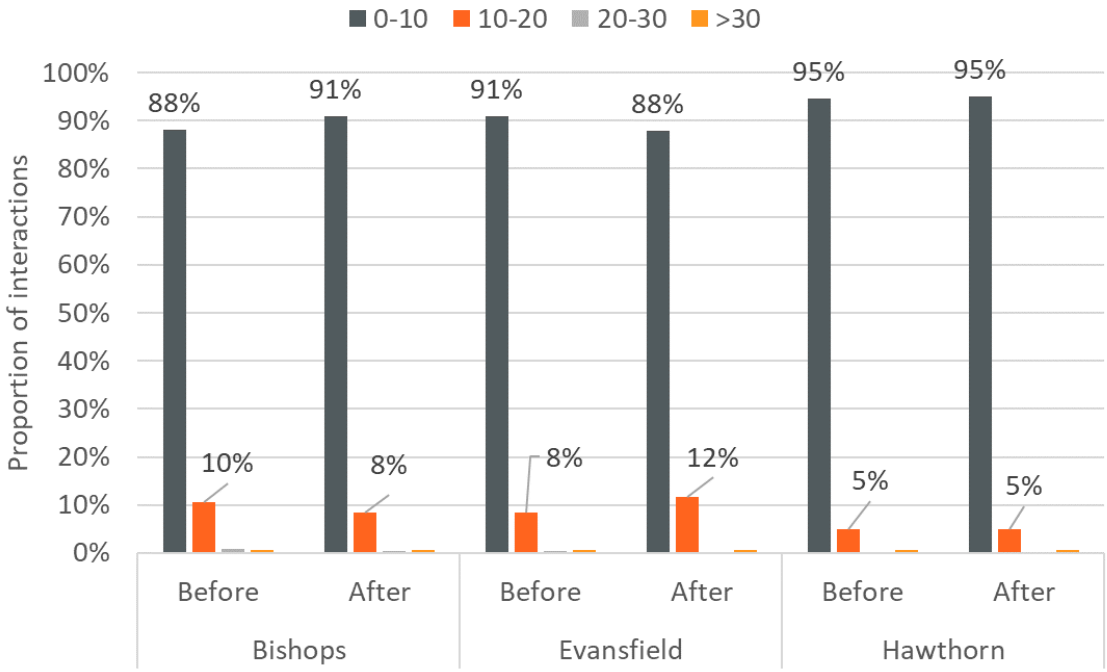


Figure 9: Distribution of time gap (seconds)

4.8 Closest proximity of vehicle to pedestrian

It would be expected that a pedestrian's perception of safety would be affected by the proximity of vehicles while they are crossing. A significant number of interactions in the shortest distance band could indicate near-misses. The VivaCity system recorded the shortest distance between the pedestrian and the nearest passing vehicle in each crossing interaction. Figure 10 shows the distribution of minimum passing distances before and after the implementation of the trial crossing. The percentage of interactions with the shortest distances '<1m' and '1 – 3m' decreased after the implementation of the crossings. The chart also shows the percentage of pedestrians that cleared the crossing before vehicle got to the crossing area (zone ABC), which increased at all sites.

To check whether closest distance was actually linked to the change in the zebra crossing, a chi-squared test of independence was performed to assess the relationship between implementation of the trial crossing and the closest distance in each site. There was a significant relationship between the two variables (p-value < 0.005) in all sites. It can therefore be concluded that the trial crossing had a statistically significant impact on the proximity of vehicles to crossing pedestrians, with vehicles generally further away for the majority of crossing events.

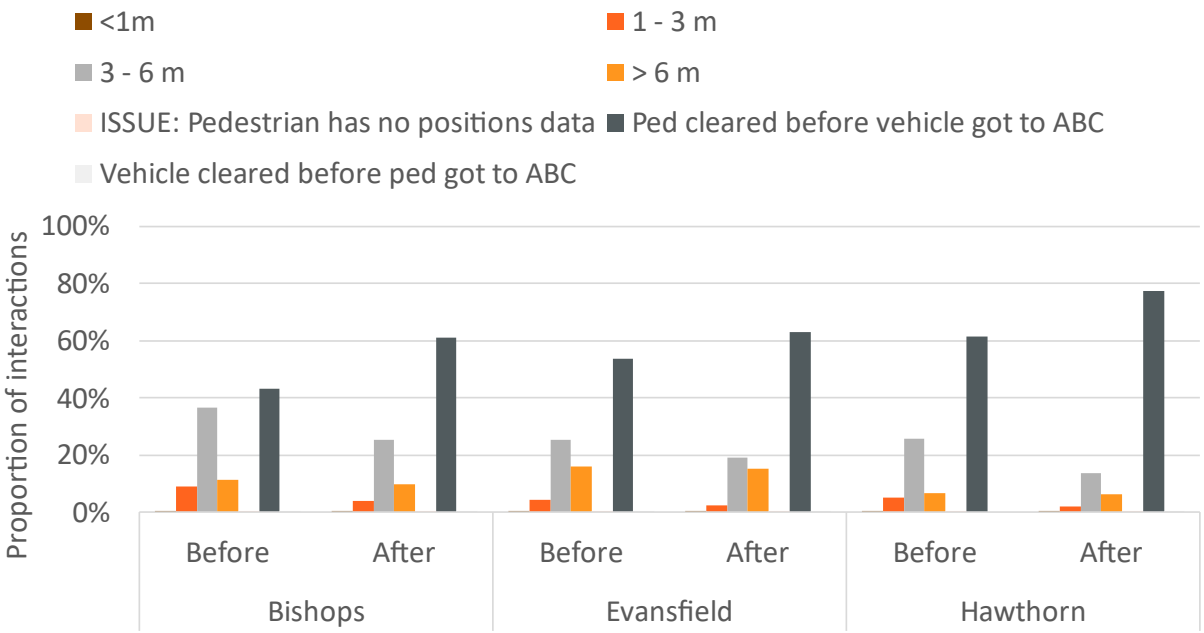


Figure 10 Closest proximity of vehicle to pedestrian (metres) by sites and phases

4.9 Vehicle speed

Vehicle speed is another factor that would be expected to affect pedestrians' perception of safety. The system recorded the speed of vehicles that were passing over the crossing area immediately before or after the pedestrian. Figure 11 shows the distribution in vehicle speeds at the Bishops site before and after implementation. Figure 12 and Figure 13 show the other two sites. A clear shift in the distribution towards lower speeds can be observed. The percentage of interaction with vehicle speeds in the range 1 to 2 m/s increased after the implementation in every site (from 5% to 20%). Meanwhile, the percentage of interactions with higher vehicle speeds tended to decrease after the implementation.

To check whether vehicle speed before implementation was significantly different from that after the implementation, a two-sample t-test of independence was performed in each site. The p value obtained from the t-test is significant ($p < 0.05$) in every sites. Therefore, it can be concluded that there was a statistically significant reduction in vehicle speeds at the crossing after the implementation of the crossing markings at each site.

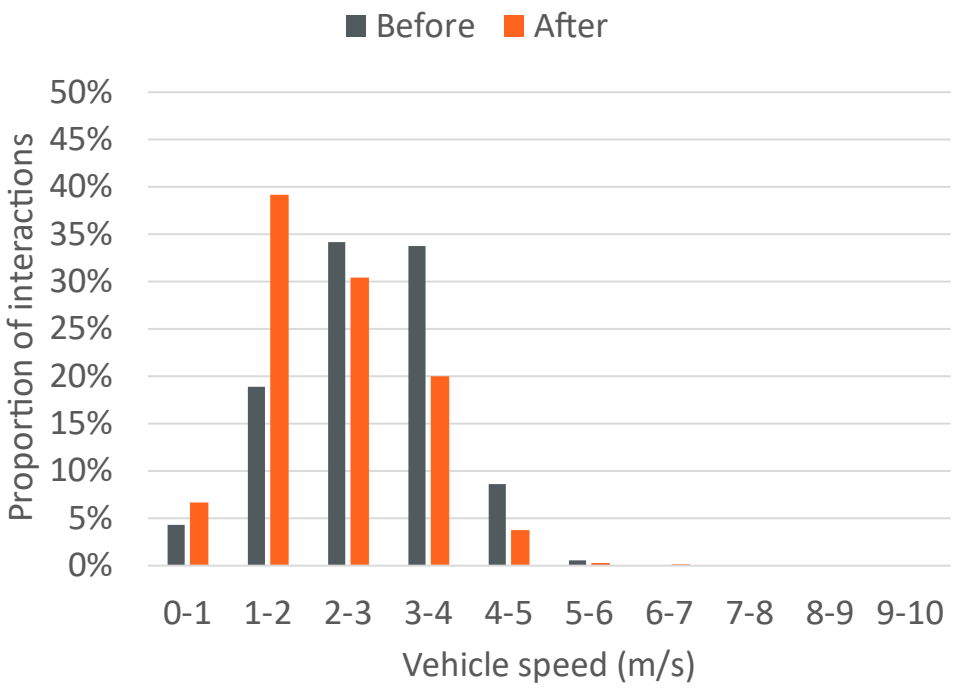


Figure 11: Distribution of vehicle speed at Bishops (m/s)

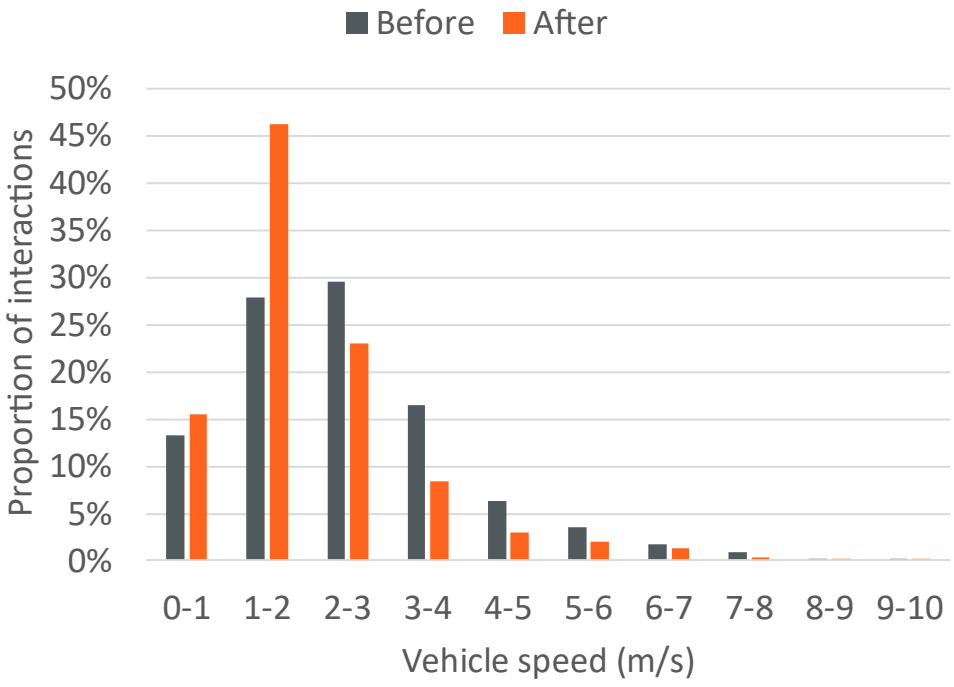


Figure 12 Distribution of vehicle speed at Evansfield (m/s)

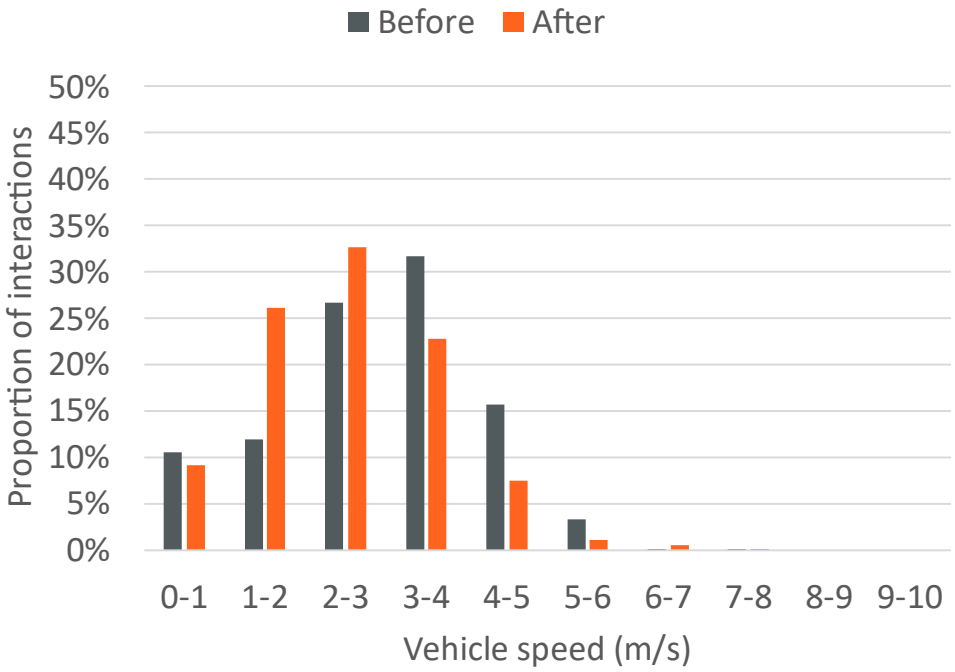


Figure 13 Distribution of vehicle speed at Hawthorn (m/s)

5. Results: User perceptions

5.1 Pedestrian survey

Demographic of participants

A total of 103 pedestrians were approached by researchers at the side of the road after crossing the road using the trial crossing and invited to complete a survey regarding their experience using the crossing. The sample achieved an even split of 50 males (48.5%), and 53 females (51.5%) (see **Figure** 14).

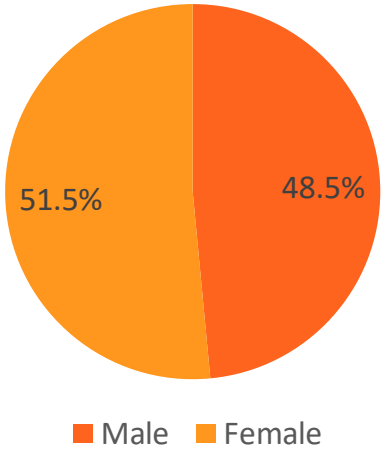


Figure 14: Gender distribution of pedestrians

Of the pedestrians, 9.7% (N=10) reported being aged between 18-24, 3.9% (N=4) were aged between 25-34, 21.4% (N=22) were aged between 35-44, 14.6% (N=15) were aged between 45-54, 15.5% (N=16) were aged between 55-64, 19.4% (N=20) were aged between 65-74, 14.6% (N=15) were aged 75 and over and one pedestrian (0.9%) chose not to disclose their age (See Figure 15)

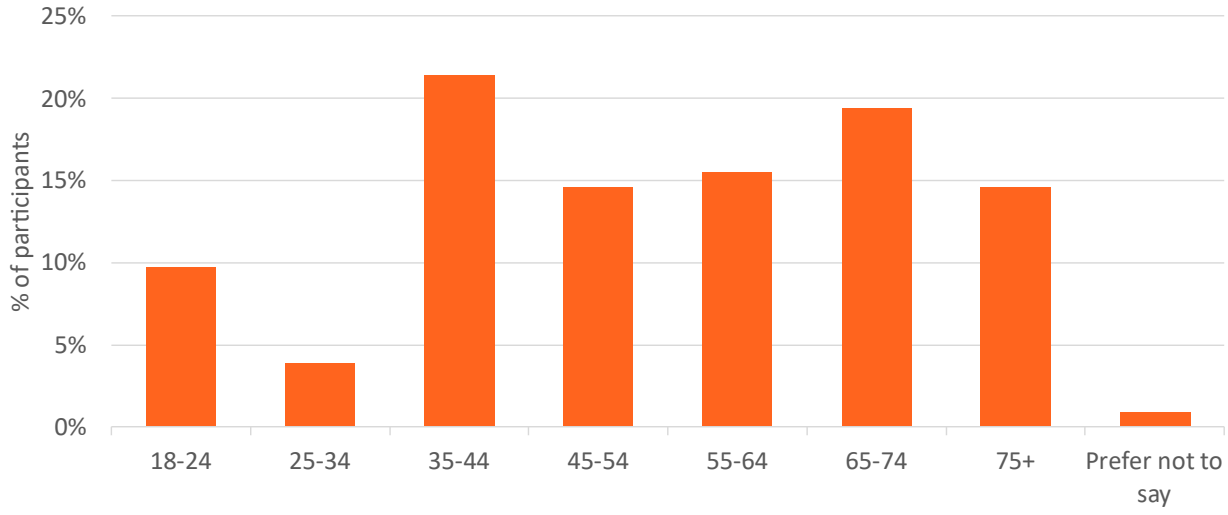


Figure 15: Age distribution of pedestrians

Pedestrians were asked in the survey if they could disclose any physical or mental disabilities that may impact their mobility. Ten[6] (9.7%) pedestrians reported having some form of long-term physical or mental disability (with two pedestrians reporting multiple disabilities/illnesses) while 93 (90.3%) reported not having any physical or mental disabilities or illnesses. The disabilities reported included:

- Mobility difficulties (N=8)
- Age-related mobility difficulties (N=1)
- Serious long-term illness (N=3)
- Visual impairments (N=1)
- Other (N=1, specified a history of strokes)

See Figure 16 for a visual representation of this information.

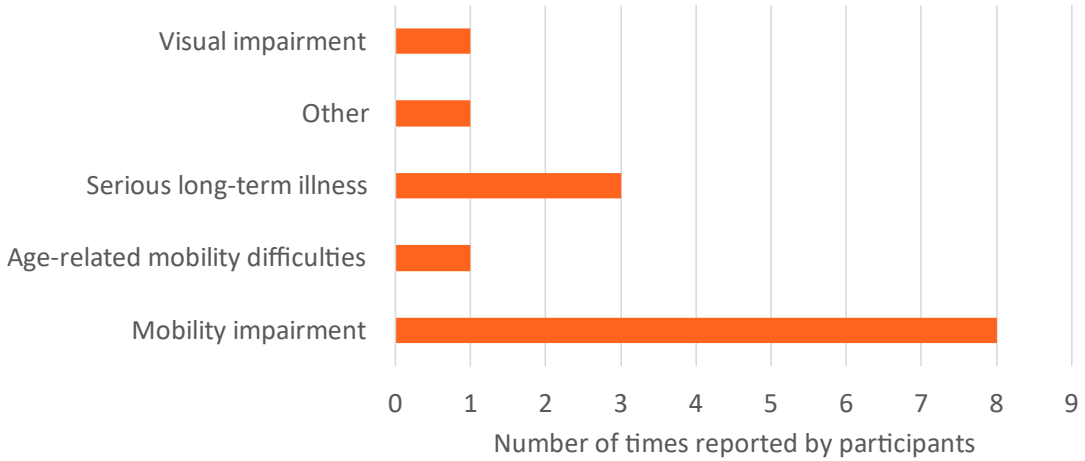


Figure 16**: Conditions and disabilities reported by pedestrians**

Pedestrians were approached to participate at all three trial crossing sites. Overall, 31 pedestrians were approached at Evansfield, 42 pedestrians at Bishops and 30 pedestrians at Hawthorn (see Figure 17).

[6] The breakdown of disabilities indicated do not add up to ten as two pedestrians ticked three boxes each.

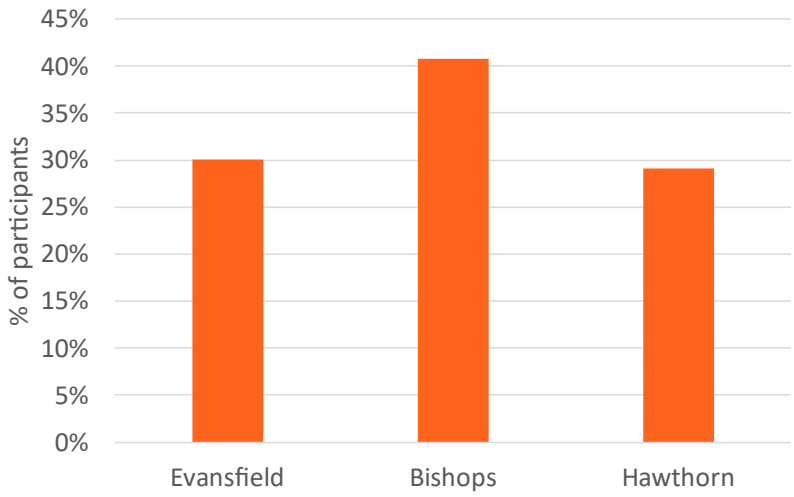


Figure 17**: Number of pedestrian respondents according at each trial site location**

Safety

Participants provided mixed responses on how safe or unsafe they felt whilst using the trial crossing with 15 reporting they felt very safe, 36 reporting they felt quite safe, 18 reported they felt quite unsafe and 20 felt very unsafe. Fourteen of the 103 pedestrians reported they felt neither safe nor unsafe (see **Figure** 18).

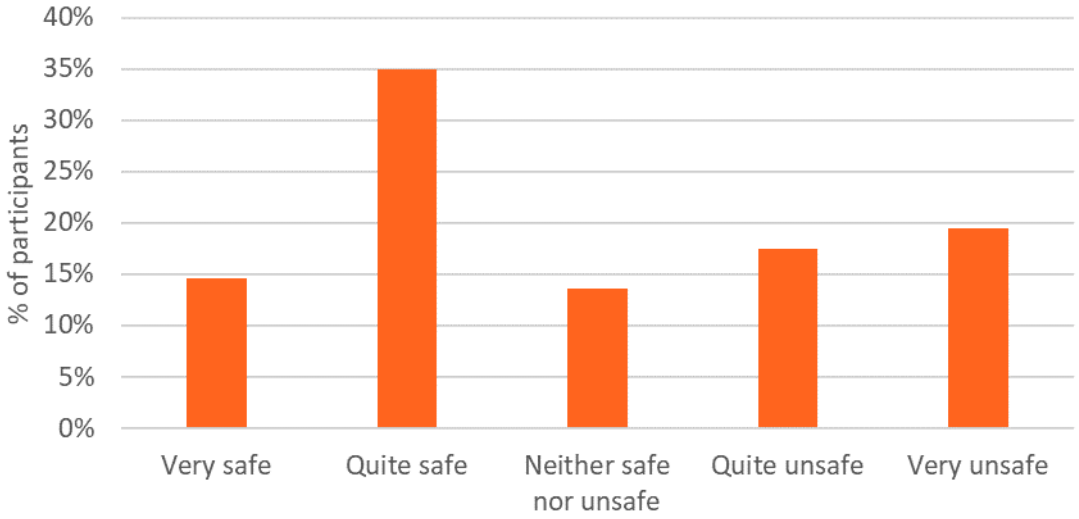


Figure 18: Pedestrians' perceived safety when using the trial crossing

Factors that contributed to feeling safe

Of those pedestrians that reported feeling very safe using the trial crossing, eight explained that they felt this way because they now had **priority when crossing** the road. One pedestrian who reported feeling quite safe mentioned that they felt more confident knowing the cars must now stop for them.

> *"It's my right of way"* (Pedestrian 76)

> *"Cars have to stop"* (Pedestrian 38)

Five pedestrians who reported feeling quite safe (N=4) and very safe (N=1) reported that they had no trouble with road users as the street was clear when they were crossing. They reported that if **no vehicle was approaching the crossing**, they had no reason to feel unsafe.

> *"There was no traffic approaching"* (Pedestrian 11)

There was some mention that the trial crossing being marked with the **zebra crossing lines** contributed to feeling safer and this was mentioned by two pedestrians who reported feeling quite safe.

> *"Because it's a marked crossing"* (Pedestrian 71)

A further five pedestrians commented that they felt safer with a trial crossing in comparison no crossing. However, they did not provide a reason as to why.

> "I feel very safe now there is a crossing" (Pedestrian 64)

Factors that contributed to feeling unsafe

Fifteen pedestrians reported that their feelings of safety were restricted by **untrustworthy road users**. Pedestrians stated that as the trial crossing is new, drivers may not know about it and therefore will not acknowledge it as a crossing.

> *"I see what goes on as I live nearby, and motorists don't know it's there"* (Pedestrian 8)

> *"Motorists are not used to it yet"* (Pedestrian 96)

Other pedestrians stated that drivers rarely acknowledge zebra crossings anyway and as a pedestrian you need to be very wary when crossing as you cannot trust a vehicle will stop for you.

> *"New laws to allow pedestrians to cross are not adhered to by drivers"* (Pedestrian 9)

> *"Because cars don't always stop"* (Pedestrian 80)

Five pedestrians mentioned that the trial crossing had missing elements and four of these pedestrians highlighted the missing beacons. They mentioned that this contributed to them feeling unsafe as they were worried about the trial crossing's visibility for road users without the beacons and also how dark the crossing would be at night.

> *"No lights on it and bad at night"* (Pedestrian 48)

> *"It's not up to standard as there are no pelican crossing lights"* (Pedestrian 17)

The NPZ crossing's **location** was the most significant reason why pedestrians reported feeling unsafe using the crossing. This was mentioned by 31 pedestrians. Pedestrians worried about how visible the trial crossing was for cars using the nearby junction and questioned if pedestrians could be seen by these road users. A few pedestrians mentioned a blind corner in close proximity to the trial crossing and discussed how pedestrians can also not see ahead to use the crossing safely.

"Too close to the junction so cars find it difficult to see pedestrians" (Pedestrian 41)

"You can't see cars coming off the main road and they can't see you" (Pedestrian 43)

Some pedestrians also mentioned that the junction may become congested as road users using the junction will be forced to stop in the middle of the road to let pedestrians cross and therefore disrupt traffic.

"Any car turning in half stops before the crossing, so their car sticks out in the main" (Pedestrian 10)

This made some pedestrians feel nervous as they expressed how road users may be coming towards the trial crossing at different angles and traffic may have to wait for them.

"There are cars coming from all angles" (Pedestrian 75)

There were recommendations from 47% of the pedestrians to move the trial crossing further up the road so as to avoid blocking the junction and to allow both pedestrians and road users to have a clear view of the crossing.

Behaviour

Out of the pedestrians, 72 reported there were no vehicles on the trial crossing when they were using it and 31 reported that there was a vehicle.

Of the pedestrians that reported there was no vehicle on the crossing, i.e. that the crossing was unobstructed, 48 reported that they carried on walking and crossed the road straight ahead, 15 stopped at the side of the road to check for approaching vehicles and then crossed once a vehicle has stopped for them, eight stopped at the side of the road to give way to approaching vehicles and then crossed when it was clear and one pedestrian couldn't recall what they did (see Figure 19).

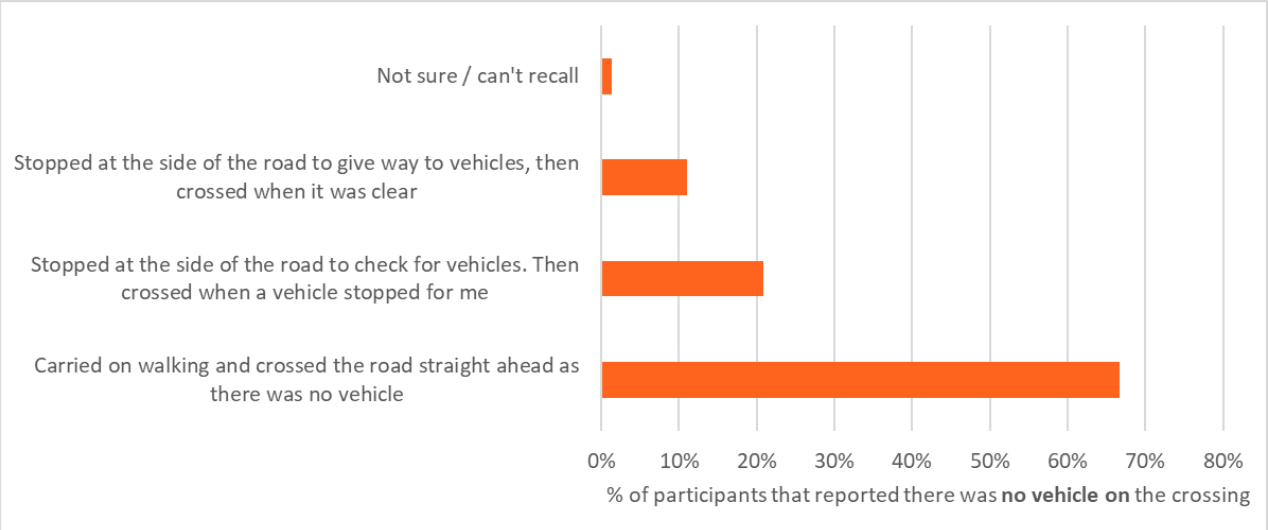


Figure 19: Actions taken by the pedestrians that reported there was no vehicle on the trial crossing when they approached

Reasons for actions following approaching the trial crossing

Twenty-one of the pedestrians who reported they carried on walking provided the reason that there were **no oncoming vehicles**, while another 13 said there were **no vehicles**, so they had no need to stop before crossing. These responses suggest that pedestrians may have misinterpreted the question to be asking if there was any vehicle approaching, and not just on the crossing.

> *"No vehicles approaching"* (Pedestrian 77)

> *"Didn't see anything"* (Pedestrian 92)

Those that reported stopping at the side of the road to wait for a vehicle to stop before crossing reported their reasoning as **needing time to check the road was clear** before walking.

> *"Always check"* (Pedestrian 80)

> *"Looked both ways" (Pedestrian 67)*

One participant reported needing to check due to the risk of how close the junction was. Another pedestrian reported needing more time to check before crossing due **to obstructing vehicles** near the crossing.

> *"Couldn't see because of van"* (Pedestrian 56)

Only one pedestrian that reported stopping to give way to vehicles reported doing so as a vehicle was approaching the crossing.

> *"A car was nearby"* (Pedestrian 85)

Of the pedestrians that reported there was a vehicle on the trial crossing, seven carried on walking and crossed the road by going behind the vehicle, 12 stopped at the side of the road to wait for the vehicle to move before crossing as they had right of way and 12 stopped at the side of the road and gave way to all oncoming traffic before crossing once clear (see Figure 20).

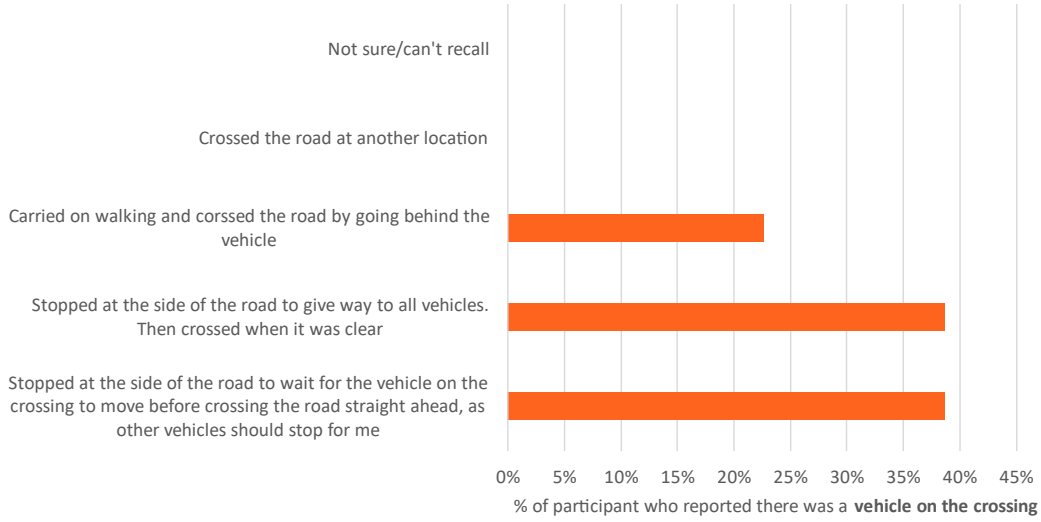


Figure 20: Actions taken by the pedestrians that reported there was a vehicle on the trial crossing when they approached

Two pedestrians who reported that they carried on walking provided the reasons that the **vehicle on the trial crossing had passed** them and continued on thus enabling them to cross. One pedestrian mentioned that the car had passed and was not reversing so they felt they could safely cross.

> *"It didn't look as though they were going to reverse and is safer to do that"* (Pedestrian 18)

The pedestrians that stopped at the side of the road to wait before crossing as they believed vehicles should stop for them mentioned that they thought the **vehicle already on the trial crossing had right of way**. However, they said that **vehicles approaching should stop for them**. Four pedestrians stated they let the car already on the crossing continue. One of these pedestrians mentioned that the vehicle was reversing so they waited for this manoeuvre to be completed before crossing.

> *"Car was reversing on to crossing"* (Pedestrian 49)

> *"The vehicle had the right of way"* (Pedestrian 17)

Three pedestrians stated that the vehicle on the trial crossing stopped to let them cross.

> *"They gave way"* (Pedestrian 59)

Of those that reported stopping at the side of the crossing and giving way to all vehicles, four provided reasons. These reasons included **oncoming vehicles**, **vehicles not stopping** for the pedestrian to cross, and wanting to **be sure the oncoming vehicles had seen them** before crossing.

> *"Vehicle did not stop for me"* (Pedestrian 60)

> "*To be sure the car had seen us*" (Pedestrian 72)

It should be noted that of the 103 pedestrians who completed this survey, 34 did not provide a reason for what they did when using the trial crossing. Therefore, the themes identified are from a limited sample.

Importantly, regardless of the presence of a vehicle on the crossing at the time, over half (53.4%) of the pedestrians acted as they had priority, either by carrying on walking straight ahead when there was no vehicle, or by walking behind the passing vehicle. There were limited explanations provided by this portion of respondent about their behaviour, and of those that did provide a response explained that they did not see other oncoming vehicles hence did not stop to check and carried on walking.

Priority: who has right of way

When asked who they thought had priority using the trial crossing, **the majority of the pedestrians (85.4%) reported that pedestrians have priority using the crossing** and that motor vehicles and cyclists must give way to pedestrians using the trial crossing. Four of the pedestrians reported that motor vehicles and cyclists have priority and that pedestrians must wait at the side of the NPZ crossing. Ten pedestrians reported that they did not know who had priority using the NPZ crossing (see **Figure** 21).

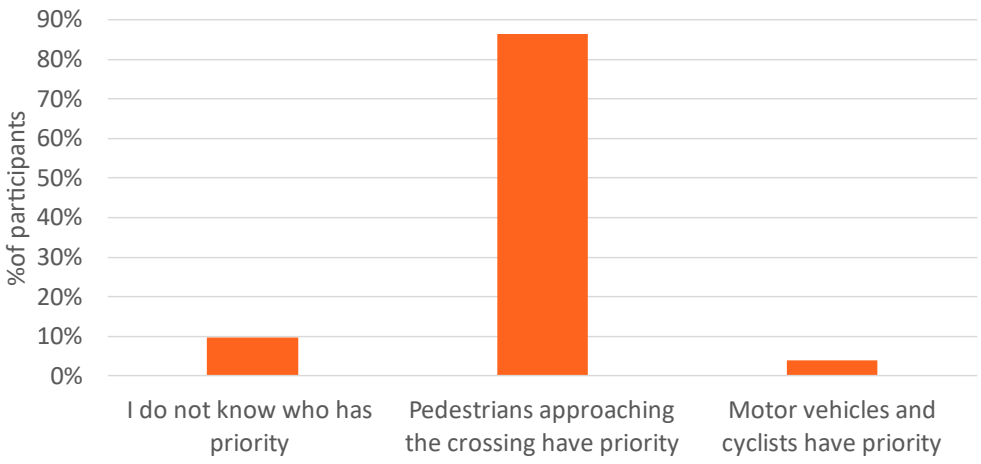


Figure 21: Perception of who has priority using the trial crossing according to pedestrians

Participants were asked if they recognised the trial crossing as a pedestrian crossing in their survey. They were given a 5-point Likert scale from strongly agree to strongly disagree and were asked to rate how much they agree or disagree with the statement.

Participants' reported understanding of who has priority is supported by responses to another question asked about clarity (see Figure 22). Pedestrians were asked to what extent they agreed with the *statement "It is unclear who has priority (me or the vehicle) at this crossing"* on a scale of strongly agree (it is very unclear) to strongly disagree (it is very unclear). Slightly over half (56.3%) of the pedestrians disagreed (strongly disagree 7.8%; disagree 48.5%) with the statement. While about a quarter (26.2%) of the pedestrians agreed (strongly agree 3.9%; agree 22.3%) that it was unclear. 18% of the pedestrians neither agreed not disagreed with the statement.

Participants were also asked about their level of agreement with the *statement* "*The location of this crossing confuses me".* Just over half (52.4%) of pedestrians disagreed with the statement (strongly disagree 2.9%; disagree 49.5%) and 34% of pedestrians agreed (strongly agree 7.8%; agree 26.2%) with this statement. 13.6% of pedestrians neither agreed nor disagreed that the location of the trial crossing confused them (see Figure 22).

A contrary statement was used to prevent response bias by respondents to ensure they have indeed read and understood the statement instead of selecting all agree or disagree statements. When asked about their level of agreement to the opposite statement *'I recognise this as a type of pedestrian crossing'.* Almost all (94%) of the pedestrians agreed (strongly agreed 35.9%; agree 58.3%) that they did recognise this type of crossing as a pedestrian crossing with only 2.9% disagreeing (strongly disagree 1%; disagree 1.9%). 2.9% of pedestrians reported they neither agreed nor disagreed with the statement (see Figure 22).

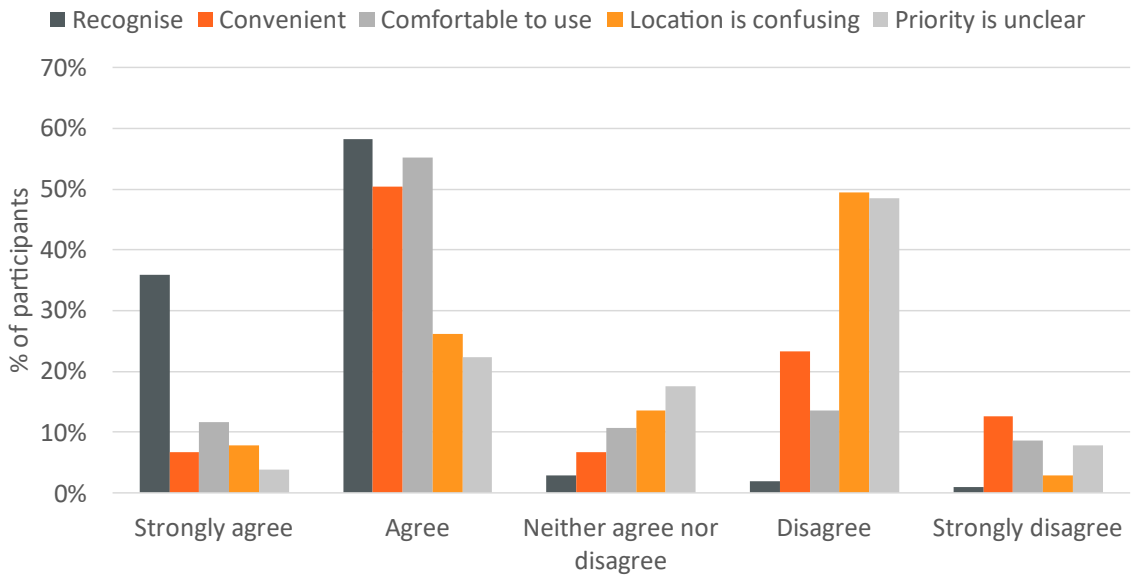


Figure 22: Summary of responses to agreement statements

The pedestrians were also asked if they noticed anything different about the trial crossing. According to the survey, more than half (55.3%) of pedestrians reported noticing something different, and less than half (41.7%) reported not noticing anything different. 2.9% of pedestrians reported that they were not sure. Two main themes emerged from pedestrians' reasons for why they thought something was different about the trial crossing including **lack of beacons** and **different road markings**. Thirty-five pedestrians reported noticing that the trial crossing did not have standard zebra crossing beacons.

> *"No flashing beacon"* (Pedestrian 11)
>
> *"No beacons to alert you"* (Pedestrian 56)

Sixteen pedestrians reported some form of difference in the road markings of the trial crossing such as dotted lines, no zigzags and narrower lines.

> *"Yellow straight lines aren't usually there and broken white lines on either side"* (Pedestrian 10)
>
> *"Got narrower lines"* (Pedestrian 54)

Four pedestrians commented that the trial crossing location was different to a standard zebra crossing as it is in **close proximity to a junction.**

> *"It's very close to the junction. I would have expected it further along"* (Pedestrian 75)

Preference, convenience, and likelihood

In order to find out preference, pedestrians were asked to what extend they agreed or disagreed with the following statements:

1. 'I would prefer the trial zebra crossing to be used at side roads

2. ‘I would prefer the standard zebra crossing to be used at side roads’
3. ‘I would prefer if there was no zebra crossing present at side roads’

Figure 23 provides a summary of their responses. 70% of the participants disagreed (disagree or strongly disagree) with the *statement 'I would prefer if there was no zebra crossing present at side roads'*, suggesting that there was a strong preference to have some form of crossing at the side road. Similarly, about two fifth of the participant agreed (strongly agree or agree) that they would prefer *‘the trial zebra crossing’* or *‘the standard zebra crossing’* to be used at the side roads.

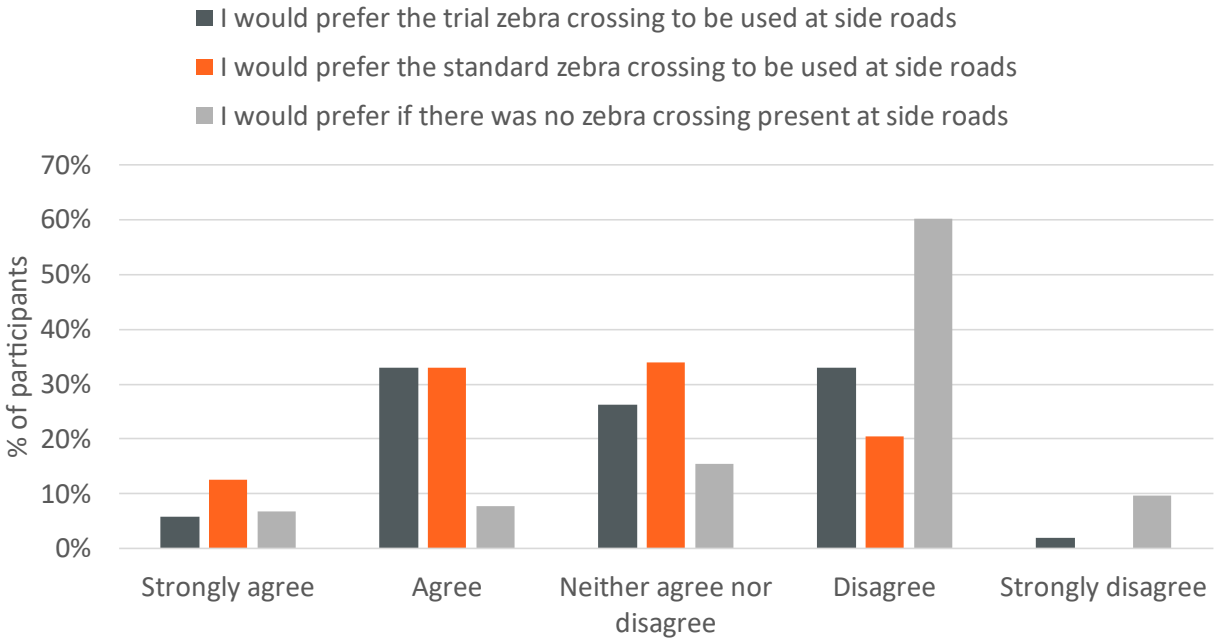


Figure 23: Preference of a crossing at side roads

This is also supported by responses to another question asked about convenience of the location of the crossing (see Figure 22). Pedestrians were asked to what extent they agreed with the *statement “The location of the crossing at the mouth of the junction is convenient to use”* on a scale of strongly agree (it is very convenient) to strongly disagree (it is not very convenient). Slightly over half (57.3%) of the pedestrians agreed (strongly agree 6.8%; agree 50.5%) with the statement. While 36% of the pedestrians disagreed (strongly disagree 12.6%; disagree 23.3%) that it is convenient. 6.8% of the pedestrians neither agreed not disagreed with the statement.

Finally, pedestrians were also asked to what extent they agreed with the statement *‘I feel comfortable using the trial crossing to cross the road’*. Over half (67%) of pedestrians agreed that they felt comfortable (strongly agree 11.7%; agree 55.3%) and just under a quarter disagreed (strongly disagree 8.7%; disagree 13.6%). 10.7% of pedestrians neither agreed nor disagreed with the statement (see Figure 22)

Design changes

Participants were asked if they would like to see any design changes made to the trial crossing. Just over half (56.3%) of pedestrians reported that they would like to see changes made to the design of the trial crossing, and 35% reported they would not

like to see any design changes. 8.7% of pedestrians reported that they were not sure (see **Figure 24**).

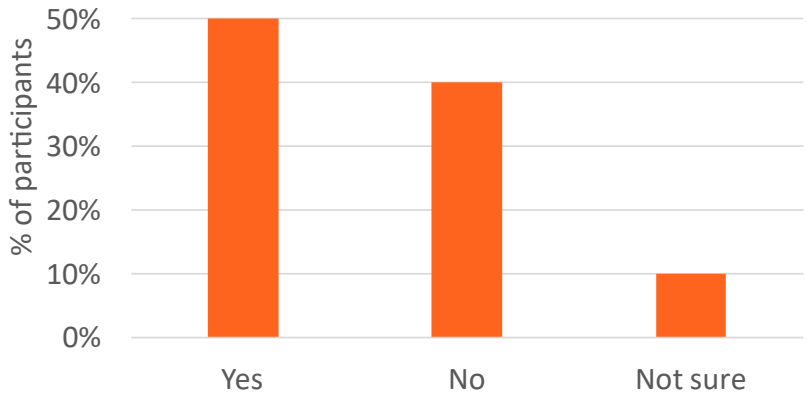


Figure 24: Desire for design changes according to pedestrian group

The themes that emerged from those pedestrians who gave suggestions for changes to be made included changing the trial crossing's location, the addition of beacons, street signs to warn road users and clearer road markings for road users.

The trial crossing's location was the most widely reported change that pedestrians suggested with 27 discussing the theme in their recommendation. **Location** was mentioned as a risk due to being so close to the junction making pedestrians feel unsafe.

> *"It's too near the junction if someone stepped onto it, a car turning braked suddenly = accident"* (Pedestrian 12)

Pedestrians reported wanting the trial crossing moved further up the side road to ensure road users notice the crossing and any pedestrians using it.

> *"Locate it further away from the main road"* (Pedestrian 71)

> *"That it be further up the road not at the mouth of the junction"* (Pedestrian 100)

Another theme identified was the **addition of beacons** or some form of lights to the trial crossing. This was mentioned by 23 pedestrians. Pedestrians reported that including lights to make this crossing more similar to a standard zebra crossing would help road users to identify it as a pedestrian crossing. (NB: the current requirements for a standard zebra crossing preclude a fully compliant crossing from being installed at a side road; however, the participants would not necessarily be aware of this).

> *"Poles beacons to show people it's there"* (Pedestrian 7)

> *"Belisha beacons. I'm for consistency, people know what standard zebra crossings are"* (Pedestrian 11)

Pedestrians also wanted some form of **street signs** to inform people it was a pedestrian crossing and state who has right of way. Signage was mentioned by seven pedestrians in conjunction with the themes stated above.

> *"Full-on zebra crossing would alert drivers and signage"* (Pedestrian 45)

> *"It should not be on a junction it should have signage warning drivers"* (Pedestrian 62)

Finally, three pedestrians mentioned wanting different **road markings** such as zigzags so as to make the trial crossing look more like a standard zebra crossing and extended double yellow lines to prevent cars parking so close to the crossing.

> *"Should get rid of vertical lines. Makes them look less official"* (Pedestrian 61)
>
> *"Extend double yellow lines so either side of the crossing is kept clear."* (Pedestrian 56)
>
> *"Warning signs, Beacons or zigzags"* (Pedestrian 8)

Other design changes mentioned by one or two pedestrians included having a traffic light to help with visibility, a speed bump to slow cars down or removing the crossing all together.

5.2 Driver trial and survey

62 people responded to the recruitment survey, of which 35 people qualified to participate in the trial. Of the 35 participants to qualify 20 were selected on a first-come-first-served basis. These 20 respondents were then invited to drive a specified route that included all three trial sites. As described in the methods (Section 3.2.2), there were four routes in total (A, B, C, and D). The drivers were assigned to one of four routes. Five participants took part in each route to ensure an equal split of conditions. Additionally, the trials were conducted at different times of the day to allow participants to experience different daylight and traffic conditions. Nine participants drove the routes during off-peak hours and 11 drove the routes during peak hours (7am - 9:30am, 12pm - 2pm, 4pm - 6:30pm). After completing the drive along the appointed route, participants completed a post drive survey asking them about their experience from the perspective of a driver.

Demographic of drivers

This sample included an even split of 10 males and 10 female drivers, as was the recruitment target. Of the drivers, 25% (N=5) reported being aged between 25-34, 35% (N=7) reported being aged between 35-44, 30% (N=6) reported being aged between 45-54, 5% (N=1) reported being aged between 55-64 and 5% (N=1) reported being aged between 65-74 (see Figure 25).

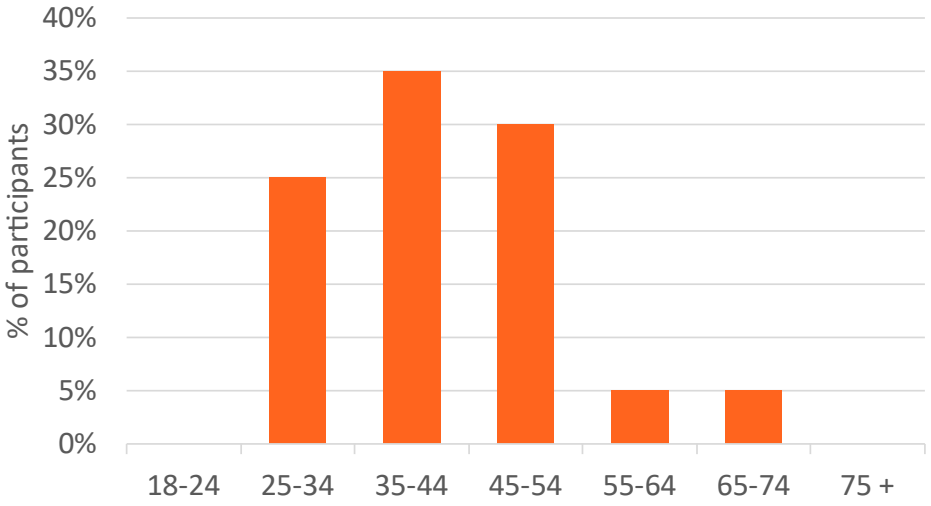


Figure 25: Age distribution of drivers

All drivers reported having had their driving licence for 10 or more years. Of these drivers, 95% reported driving on average more than once a week and 5% reported driving once a week.

Safety

When asked how safe the drivers felt turning into the side road passing the trial crossing there was a mix of responses with just under half (45%) of drivers reporting feeling safe (very safe 10%; quite safe 35%) and 35% of drivers reporting feeling unsafe (very unsafe 15%; quite unsafe 20%). Just under a quarter of drivers (20%) responded that they felt neither safe nor unsafe in this situation (see Figure 26).

Similarly, when drivers were asked how safe they felt turning out of the side road passing the trial crossing responses were also mixed with Just under half (45%) reporting they felt safe (very safe 15%; quite safe 30%). 30% of drivers reported feeling unsafe (very unsafe 15%; quite unsafe 15%). Again, 20% participants responded that they felt neither safe nor unsafe in this situation and 5% of drivers stated they were not sure of their answer. These findings differ from the results from surveys conducted from a previous trial for Transport for Greater Manchester (TfGM), which found that drivers' perceived safety varied considerably with the turning movement of the vehicle; and was the lowest for right turns into the side road. However, unlike the previous study, which used simulated video, the participants in this study were reporting on their experience in the real world, so the results are likely to be a better reflection of perceived safety.

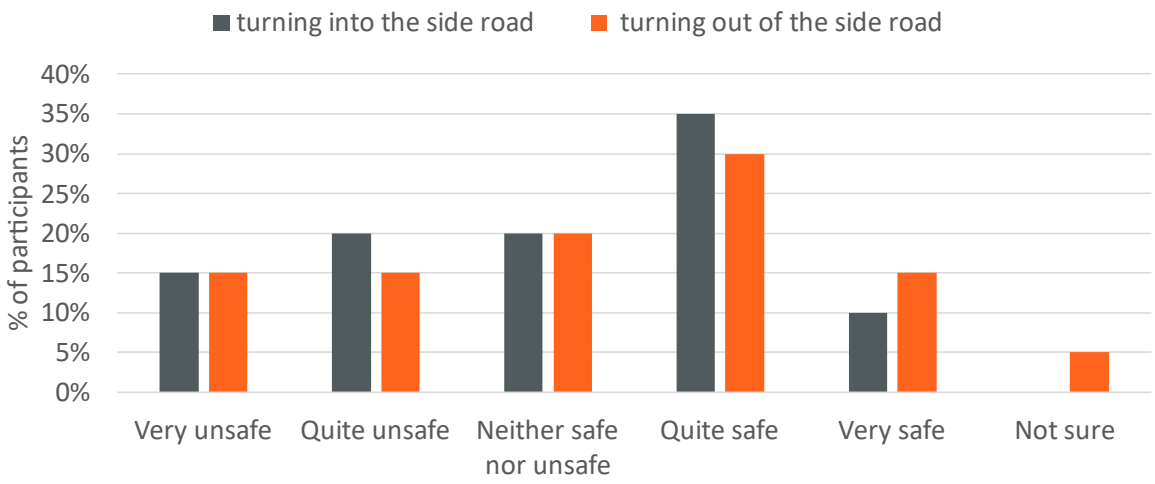


Figure 26: Perceived safety reported by drivers when turning in or out of the side road

Factors that contributed to feeling safe

One driver stated that although they felt neither safe nor unsafe turning out of the side road, the trial crossing being situated **nearby a junction** made them feel safer as it encouraged them to be more alert to pedestrians.

> *"As the crossing was on the junction, extra care was needed to ensure a safe manoeuvre was carried out. As the junction was close, speeds were low and needed to be observant of pedestrians, so felt it was safer, but there were no pedestrians to cross when I approached the crossing and junction"* (Driver 16)

Another driver who also felt neither safe nor unsafe also highlighted that they felt they had to be more alert towards pedestrians.

> *"I felt I had to be more alert to pedestrians when turning out"* (Driver 5)

This could suggest there are safety benefits to the crossings location as it limits speed and encourages observation checks although it should be noted both of these drivers did not report feeling safe turning out of the side road so more could be done to promote feelings of safety.

Factors that contributed to feeling unsafe

On the other hand, reasons for why drivers felt unsafe also included the location of the crossing. Some drivers felt that the trial crossing was **too close to a junction**. This was mentioned by four participants:

> *"Awkwardly close to junction. You need to sit back unsighted from the junction and bolt out when you think it's clear ... or just ignore crossing and sit over the crossing"* (Driver 15)

One driver believed that there is a risk if drivers are to stop at the junction before the trial crossing and mentioned the possibility of a collision.

> *"The siting of the crossing means you are still on main road as you turn in so risk to contact from behind"* (Driver 7)

One driver mentioned the additional risk factor of **parked cars** which reduced the visibility of the trial crossing meaning they did not identify the crossing before passing it.

> *"One junction was so busy with parked cars and sharp bends I was looking around for traffic rather than white paint on the road and did not realise it was a junction until I was halfway over"* (Driver 13)

It should be noted that only nine drivers out of the 20 provided a reason for feeling safe or unsafe in this survey resulting in limited themes being identified.

Visibility

Drivers were asked to rate the visibility of the trial crossing from very easy to very difficult to identify to identify when approaching in a vehicle. Over half (60%) of drivers reported that it was easy to identify the trial crossing when approaching in a vehicle, 20% of drivers reported it was very difficult 20% and 15% reported it was difficult. 5% of drivers reported that they were not sure (see **Figure 27**).

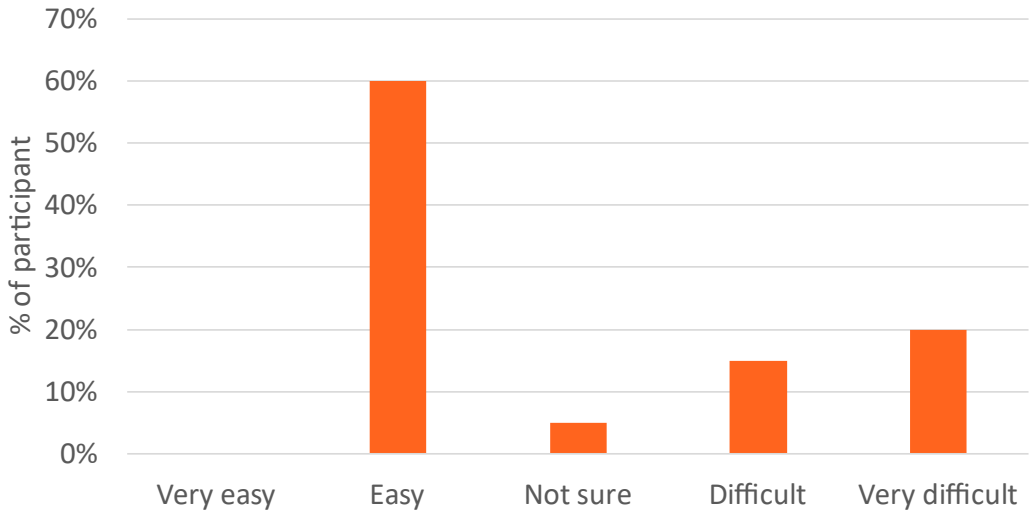


Figure 27: Drivers' response to how easy or difficult it was to identify the trial crossing

Behaviour

Of the drivers, 40% reported that there were pedestrians at some of the trial crossings when they approached and 60% reported that the road was clear at all the crossings.

Drivers were asked how easy or difficult it was to make their decision to give way when they approached the side road *with* the trial. Overall, half of the drivers considered this decision very easy (15%) or easy (35%) to make, one fifth (20%) of drivers considered it very difficult (5%) or difficult (15%) and just under a third (30%) of drivers reported this decision was neither easy nor difficult to make (see Figure 28).

Similarly, drivers were asked the same question regarding when they approached a side road *without* any pedestrian crossing. Just under two thirds (65%) of drivers considered this decision very easy (15%) or easy (50%) to make and one fifth (30%) of drivers considered it very difficult (5%) or difficult (15%). 15% of drivers reported this decision was neither easy nor difficult to make.

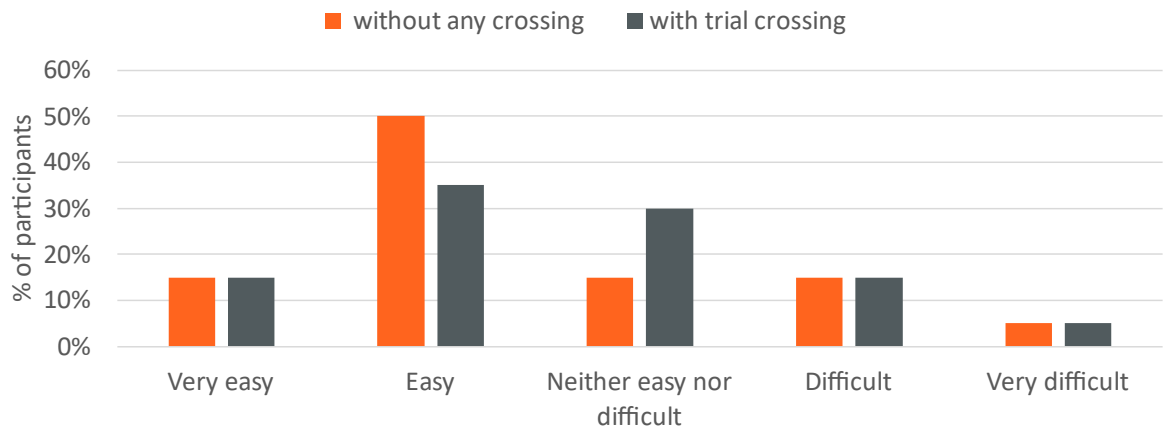


Figure 28: Ease in decision making when giving way, with or without crossing

When there is trial crossing at side roads

When asked to provide reasons for how easy or difficult the decision to give way was, three drivers that reported this decision as either very easy or easy stated that they **recognised the trial crossing as a pedestrian crossing** and therefore, understood they needed to give way.

> *"As the road markings are similar, I naturally slowed down to observe the pedestrians wished to cross the road"* (Driver 16)

> *"Once I eventually identified it as a pedestrian crossing, I applied the same rules as existing crossings."* (Driver 11)

Of those drivers that found this decision difficult or very difficult, two reported that the trial crossing has **poor visibility**. One of these drivers mentioned parked cars near the trial crossing and that combined with a lack of beacons meant they were unsure if it was a pedestrian crossing.

> *"Cars are parked right up to the crossing and without poles to alert you very difficult to spot till last second"* (Driver 12)

Two drivers also mentioned the **location** of the trial crossing influencing the difficulty of their decision. These drivers felt under pressure to make a decision as to whether or not to give way as they were very close to the busy junction. They felt that if they were to stop, they would not have sufficient space.

> *"Tried to give way but led to having to make quick decisions due to proximity to junction."* (Driver 10)

It should be noted that of the 20 drivers who completed this survey, only 10 drivers provided a written reason explaining why their decision was easy or difficult to make.

When there is no crossing at side roads

Four drivers reported that the decision would be very easy or easy as they would not stop for the pedestrians. Drivers mentioned that **stopping could be potentially dangerous** for the driver, the pedestrian and other road users as other road users may not anticipate their vehicle to stop to allow the pedestrian to cross.

> *"I would continue as stopping could cause a hazard to vehicles behind me who were not expecting me to stop."* (Driver 10)

These drivers stated that they **assumed they have right of way if there is no marked pedestrian crossing** and therefore, they would not give way to pedestrians.

> *"Unless already crossing have assumed there is no right of way"* (Pedestrian 15)

Two drivers reported that **road markings and signs** are what they depend on when making the decision as to whether to give way. One of these drivers reported that there being no signs as to whom must give way contributed to this decision being difficult for them.

Priority: who has right of way

When drivers were asked who they thought had priority using the trial crossing, 90% of them reported that pedestrians have priority using the crossing and that motor vehicles and cyclists must give way to pedestrians using the trial crossing. Only one of the drivers reported that motor vehicles and cyclists have priority and that pedestrians must wait at the side of the trial crossing and another that they did not know who had priority using the trial crossing (see Figure 29).The distribution of responses were similar to that of the pedestrian group for the same question.

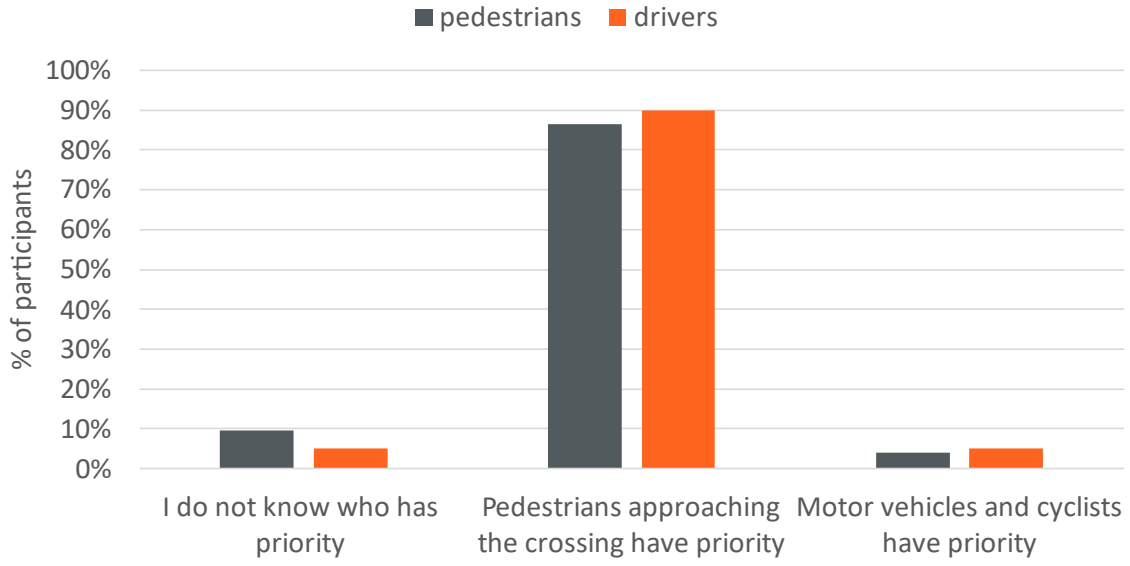


Figure 29: Perception of who has priority using the trial crossing according to pedestrians and drivers

Design changes

Drivers were asked if they would like to see any changes to the design of the trial crossing. Half of the drivers answered 'yes' they would like to see changes made and 40% of drivers said 'no' they would not like to see changes made. 10% of drivers were not sure (See Figure 30).

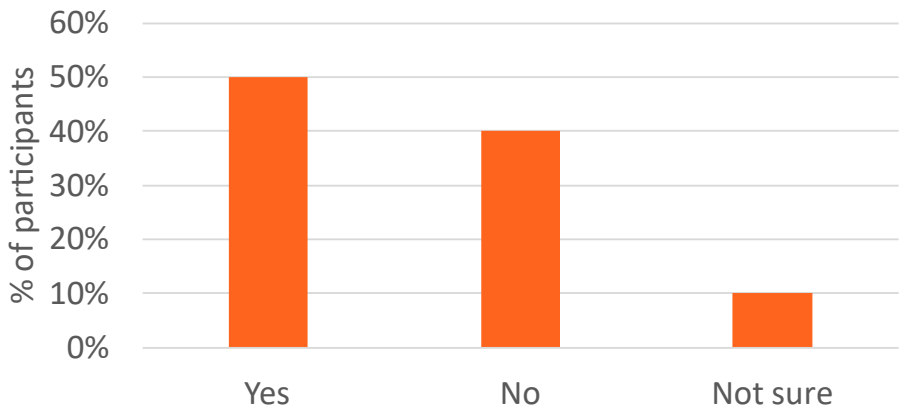


Figure 30: Desire for design changes according to driving group

Of the 20 drivers, ten explained what design changes they would like to see. The greatest theme to emerge was to **move the trial crossing further away from the junction**. Drivers suggested that this would increase the visibility of the crossing and would give more room for the vehicle manoeuvre. Moving the NPV crossing's location was mentioned by six drivers.

> *"A larger gap before the junction to give room for one vehicle at a time"* (Driver 5)
>
> *"Set further back into side roads to allow clear distance for cars and pedestrians"* (Driver 7)
>
> *"For the driver, put it five meters back to allow a car go be able to see the junction rather than guess"* (Driver 15)

Four drivers also suggested that introducing lights, such as beacons or cat eyes, and introducing clearer road markings could both increase the visibility of the crossing and stop vehicles from parking too close to it.

> *"A flashing yellow light which are normally on crossings of this kind would be useful, especially at night. Also, maybe some cats eyes or similar in the road to make it more visible at night as well as road markings used on traditional zebra crossings"* (Driver 16)
>
> *"Zig zag lines on approaches to stop parking and proper lighting poles to be seen 100 yards down the road"* (Driver 12)

One driver suggested removing the crossing all together as they reported the crossing was not at all visible to them.

"Abandon this idea. Use regular zebra crossings if needed. These poor man zebra crossings blend into the road. The roads already have enough faded and pockmarked white paint. You need a better solution." (Driver 13)

5.3 Disability workshop

The workshop, and forum engagements largely provided an insight into challenges that pedestrians with a visual impairment face when crossing roads and their feedback on the trial crossing design, particularly people who are blind, partly sighted, or use a guide dog, as they made up majority of the contributors. There was one representation from a wheelchair user, and two disability design experts. Some feedback was received via emails after the workshop was completed; these responses were reflective of challenges faced by neurodivergent persons, people with hearing impairment, and people with learning disabilities.

Participants engaged

Site visit and discussion (Cardiff, 8 December)

The six participants in this event represented Guide Dogs Wales (two people), Sight Life (formerly Cardiff Institute for the Blind - two people), Torfaen Access Forum, Access Design Solutions and the Access Association Wales. This group included a one participant who had no sight at all, a partially sighted guide dog user, a powered wheelchair user, Guide Dogs' orientation and mobility specialist and others with expertise of accessible design and the needs of disabled people. Of the two people who had agreed to attend the Workshop but were unable to on the day, one was a hearing-impaired representative of the Wales Council for Deaf People and the other was a guide dog user who was to represent RNIB Cymru. The former, however, a local resident who was familiar with one of the trial crossings that was not used for the site visit, was subsequently able to express his views on non-prescribed crossings, by email.

Presentation and discussion at the Wales Vision Forum (Online, 29 November)

An invitation was accepted to make a presentation about the project at the Wales Vision Forum Meeting, and to elicit the views of attendees in relation to trial crossings. The Forum was hosted by the Wales Council of the Blind, an 'umbrella' organisation for sight loss in Wales. The meeting was well-attended. Organisations represented at the meeting were Guide Dogs (both an Engagement Manager and a Policy & Campaigns Manager), the Macular Society (the Regional Managers for both South Wales and North Wales), Visual Impairment Breconshire, Ceredigion Association for the Blind, Vision Support, Sight Cymru, Visual Impairment Merthyr and Wales Council of the Blind.

Perceptions shared via email due to unavailability

A few organisations were unable to join the workshop due to unavailability. The topic guide was shared with them, and they were welcomed to share their perceptions on the trial crossing via email. We received feedback via email from the following organisations:

- Autism Wales (AW) provided some insights into the needs of autistic and neurodivergent people.

- Age Cymru supports the aims of active travel for older people and gathered views from older people in their network.

Their feedback has been incorporated in the findings below.

Safety

At the time of the site visit, there was a delivery van parked on the footway adjacent to the crossing. This raised the issue of potentially having unclear sight lines from such crossing points for pedestrians. Based on the situation during the site visit, participants, who had vision, were unable to see any oncoming vehicles from behind the parked van and noted that in such cases, vehicles would not be able to see the pedestrian until they reach the junction which can make users feel unsafe and vulnerable crossing at the junction regardless of a pedestrian crossing.

An AW representative mentioned that people who are autistic or neurodivergent often experience heightened levels of anxiety, and non-prescribed crossings may alleviate some of this anxiety by providing them with a clear path when crossing side roads where they would otherwise not have a clear crossing. They added, however, that it may be difficult for them to judge the speed of cars pulling into the side road from the main road, which could heighten anxiety in terms of judging whether to cross. The anticipated position of non-prescribed crossings at the mouth of a junction will allow less time for making this decision, which could increase anxiety.

One workshop participant concluded that the non-prescribed crossing was no more or less safe than any other type of crossing, adding that two important factors contributing to the safety of crossings were consistency of design and the training of blind and partially sighted people in how to use them. Another participant felt that 'the negatives' of non-prescribed crossings outweighed the advantages, while another feared that such crossings might lead more vulnerable users to adopt a false sense of security, encouraging them to step onto the crossing without properly looking for oncoming vehicles.

Finally, a potential safety benefit was highlighted – that the presence of non-prescribed crossings might discourage the practice of parking on, and near, junctions; it was suggested that the crossings would provide more of a disincentive to obstructive parking than double yellow lines.

Behaviour

While participants were not expected or asked to cross the road using the trial crossing, all the participants made an attempt to use the crossing to provide insight based on their thought process when crossing at the junction.

A concern expressed by several participants was that the very aim of trial crossings, which is to enable pedestrians to follow the 'desire line' that approximates, as far as possible, a straight line to their destination, contradicts their preference to 'indent'[7] when crossing a side road. While majority of the participants were speaking from their understanding of others with visual impairment, they also noted that this was also true

[7] Indenting refers to the practice of making what is usually a 90° turn when encountering a side road, in order to cross the side road at a point several yards away from the junction with the more major road.

for other disabled groups as well, such as those with hearing impairment and wheelchair users. There are several reasons for indenting, but all relate to the enhancement of safety, or perceived safety, which is considered to outweigh the disadvantages of having to walk a few extra paces. Indenting may be practised by any pedestrian, either consciously or instinctively, but it might be expected to be characteristic of pedestrians who feel more vulnerable.

Participants provided various reasons for their preference on indenting, which largely related to facilitating the process of negotiating traffic on the side road. For example, indenting further away from the junction reassures participants that the driver is less likely to be distracted with other aspects of the junction (e.g., checking for oncoming traffic, and making the turn at the junction) and more likely to be able to focus on the road directly ahead, thus making the pedestrian more visible to approaching motorists on the side road, which allowed them more time to assess on-coming vehicles.

It was also highlighted that people with visual impairment tend to rely on sound of the traffic, while someone with auditory impairment, or limited flexibility (e.g., a wheelchair user) would rely on clear sight to determine whether it is safe to cross. If indenting by a sufficient distance from the side road, this simplifies the process of crossing the road while observing traffic on the side road, without the complication of monitoring vehicles that might turn into the side road from the more major road.

Another reason for indenting is to ensure that a road can be crossed between two straight and parallel kerbs. This is particularly important for pedestrians who have little or no vision, helping the pedestrian to follow the shortest route to the other side. More importantly, it avoids the danger of veering off at an angle from the crossing line, potentially into the flow of vehicular traffic on the major road. The fear of veering into traffic when crossing a road was emphasised during both the site visit and the workshop. At the trial crossing, it was noted that the blisters paving on each side of the road were very worn out, making it harder to identify where they could make a direct kerb-to-kerb crossing.

Another view expressed was that the trial crossings, and their impact of more closely following footway users' desire lines, might have the unintended consequence of encouraging illegal footway use by scooter users and cyclists, to the detriment of more vulnerable footway users, such as blind and partially sighted people.

Priority

Following the site visit it was generally felt that there was uncertainty regarding which road users had right of way. It was also emphasised that, for pedestrians' right of way to be recognised, drivers need to be able first to detect pedestrians waiting at the crossing. As several of the contributors pointed out, some pertinent changes to *The Highway Code*[8], covering England, Scotland and Wales, were introduced on 29 January 2022, which gives priority to crossing pedestrians at side roads:

> *" [Rule 206]… turning at road junctions; you should give way to pedestrians who are crossing or waiting to cross the road into which or from which you are turning"*

[8] *The Highway Code*. (2022). Available at: THE HIGHWAY CODE - For cars, pedestrians, cyclists, motorcyclists and horse riders (highwaycodeuk.co.uk) Last accessed 16 January 2023.

"[Rule H2] …At a junction you should give way to pedestrians crossing or waiting to cross a road into which or from which you are turning"

Nonetheless, while the guidance ("should") includes giving way to pedestrians that are waiting, the legal requirement for Zebra crossings ("must") applies only ".. when a pedestrian has moved onto a crossing" [Rule 195]. *The Highway Code* makes it clear that pedestrians are advised to cross only when:

"…traffic has stopped from both directions or the road is clear…"

This advice is echoed by that provided by Guide Dogs, which emphasises to guide dog users that, despite the changes to *The Highway Code*, they should continue to take control of the situation by only crossing when they feel it is safe to do so[9]. Part of this advice is that crossing users should not assume that they are

"…totally safe to proceed when a single car offers to give way."

Doubts about motorists' knowledge about the right of way rules stemmed from the perceived lack of knowledge about *The Highway Code* changes. There was general agreement among the group that the dissemination of the rights of way rules, and other information relating to non-prescribed crossings, would be key to making them safe for everyone to use. This response was reiterated by individual feedback sent via emails.

Preference, convenience, likelihood

The general view expressed by the Wales Vision Forum was that blind and partially sighted people will always welcome the convenience of having more crossings, as it provides assurance that vehicles are more likely to give way to pedestrian at a pedestrian crossing than without one. However, that it is important for the presence and function of the crossing to be clear.

A guide dog user participating in the workshop, who lived very close to the trial crossings featured in the project and was very familiar with all two other crossings featured in the wider project, was delighted with the sudden appearance of the crossings, which they had used a great deal and had enjoyed using. This participant suggested that having the crossings in the other two locations was preferable to having no crossing at all, since they had both been installed at fairly busy junctions; it made crossing them with a guide dog easier and gave them some assurance as to their safety. Another of the participants described having a "50/50" view of the convenience of using the crossing, applauding the presence of a crossing-point with a dropped kerb, while expressing doubt as to whether drivers would be aware of the crossing's presence.

The workshop participants were asked about their likelihood of crossing the side road

1. At the mouth of the junction, in the absence of any pedestrian crossing in place
2. At the mouth of the junction, in the presence of a non-prescribed crossing

There was a consensus among the group that a blind or partially sighted person would not cross the side road at the mouth of the junction if there were no crossing marked. The reasons given were: 1) a sightless person will not know that there is a crossing

[9] Available at: What A Guide Dog Is Trained To Do | Guide Dogs Last accessed 16 January 2023.

there; 2) most people would find the traffic from the more major road too noisy to enable them to detect a ‘clear’ road and make an informed decision about crossing; 3) most people would prefer to indent slightly into the side road, to reduce the noise from traffic on the more major road and make themselves more visible to approaching vehicles. Part of the rationale for indenting is the expectation that drivers will be less distracted after passing the junction, with a single road to negotiate.

During the discussion of the likelihood of crossing the side road at the mouth of the junction, the wheelchair user stated that their decision would largely depend on the availability and location of a dropped kerb, as they would need to use this, regardless of their perceptions of safety and their ability to observe oncoming vehicles. They also stated that they would find indenting preferable, because moving the crossing to a link reduces the number of directions from which traffic might approach, so they can see approaching traffic by only having to look left and right, without the need to look over their shoulder as well.

A very similar response as above was obtained when asked about the likelihood of crossing the side road at the mouth of the junction **with a trial** crossing marked. With the exception of the guide dog user, who said they would very happily use the zebra crossing at the mouth of the junction, and felt that others would too, as they felt safer with the crossing being there than without it. They added that their prior use of the other trial crossings, and the use of a guide dog, increased the certainty of their response.

The wheelchair user reiterated the importance of the presence and location of a dropped kerb in their decision as to whether to cross but stated that having a crossing marked would make them feel safer if the dropped kerb and crossing were both positioned at the mouth of the junction.

Design changes

Even though most respondents noted the value of having the crossing in the direction of the desired walk line, concerns were raised about the safety of the crossing close to the main road. These tended to be around a possible lack of visibility of the crossing and pedestrians (i.e., the driver of an approaching vehicle will not be able to detect the markings on the road from a distance), and the lack of a safe stopping point for vehicles turning into the sideroad from the main road.

In this respect, some of the suggestions made by participants to improve the design included moving the crossing a car’s length down the sideroad, using measures to reduce the speed of vehicles on the main road, and assessing the suitability of the environment in terms of traffic volume and speed before using the new crossing design on a sideroad.

Another suggestion for improving the safety of the crossings was that parking regulations would need to be enforced, alongside a communications campaign, to prevent drivers from parking on the footway and on double yellow lines in the vicinity of the crossing. There was a brief discussion as to whether trial crossings would be safer if they were combined with ‘table crossings’, with the conclusion being that such crossings would be less safe, as they might encourage some drivers to encroach upon the footway.

It was also noted that while the site visit was conducted during the daylight, an unlit road would make it difficult for drivers and pedestrians to detect the zebra markings at night. As such, it was suggested that Belisha beacons would help to identify the crossing at night. It was suggested communications campaign should focus on raising awareness of local residents when new crossings are introduced, or signposts should be installed ahead of the crossing to inform driver of the trial crossing when it is newly installed.

Some workshop participants expressed optimism that the environment of a 20 mph zone would be conducive to trial crossings functioning as they should, given that it would be easier for issues of priority and right of way between motorists and some pedestrians to be ‘negotiated’, with slow-moving traffic.

6. Discussion of findings

Impact study: before-after monitoring

The counts from the VivaCity AI-based digital sensor show that the junction at Bishops Road had the greatest number of crossing events, both before and after the zebra crossings were installed, followed by Evansfield, and then Hawthorn.

After the implementation of the trial crossings, the proportion of pedestrians using only the crossing zone while crossing the road increased at all sites (from 1% to 9%). In other words, the zebra markings encouraged more pedestrians to take the direct route across the mouth of the junction than did so without the trial crossings.

To investigate how the introduction of the trial crossing affected the propensity of drivers to give way, the party that went second (pedestrian or vehicle) was recorded by the VivaCity sensor for each crossing event detected. After the implementation of the trial crossing, there was a statistically significant decrease in the percentage of crossings in which the pedestrians went second, with the Bishops and Hawthorn site seeing the highest reduction, of almost 60%. This strongly indicates that a higher proportion of drivers were giving way to pedestrians with the zebra markings.

As discussed in Section 4, it is possible that the time threshold used to define the presence of a vehicle in crossing events may have resulted in the sample including a proportion of events when the vehicle was recorded as having gone second, but the pedestrian could have crossed safely without the driver having to slow or stop. This indicator might therefore inflate the number of vehicles actively giving way. For future trials it would be recommended that the time thresholds used are reviewed. However, this consideration does not apply to the count of pedestrians that went second, so the observed reduction in the number of pedestrians going second can safely be regarded as a good indicator of greater propensity to give way. It is also possible that the high pedestrian flows at these sites, combined with a 20mph speed limit, may encourage a greater level of propensity to give way in the first place.

The evidence that drivers were more likely to give way is supported by changes in other indicators that were used to identify safer driving behaviours and reduced risks to pedestrians. There were statistically significant increases in the distance between a vehicle and pedestrian at the crossing, and statistically significant reductions in vehicle speed. Overall, the distribution of the time gap between the first road user leaving the crossing area and the second road user entering it remained similar at all three sites, suggesting that there was no increase in ‘near misses’ after the implementation of the trial crossings. Additionally, significantly more pedestrians were clearing the crossing area before the vehicle reached it.

It would be expected that if pedestrians were given priority more frequently that they would spend less time waiting to cross. The observed waiting time and crossing time remained similar after the introduction of the trial crossing; however, a small change was observed in the distributions of both waiting time and crossing time, with a reduction in the number with the longest waits and a corresponding increase in the number with the shortest crossing and waiting times. It is possible that the waiting time results were affected by pedestrians waiting further away from the crossing than the defined waiting zone used to capture data.

User perceptions

The presence of a trial crossing affected the way different users said they would behave at the junction. A majority of the participants stated that they did indeed recognise the markings as a pedestrian crossing. The majority of both pedestrians (85.4%) and drivers (90%) reported that pedestrians have priority using the crossing and that motor vehicles and cyclists must give way to pedestrians using the trial crossing. Over half (53.4%) of the pedestrians acted like they had priority on the crossing, either by carrying on walking straight ahead when there was no vehicle, or by walking behind the passing vehicle. However, their open-ended responses suggest that they had already scanned the vicinity and made a judgement that there were no other vehicles approaching, hence they did not feel the need to stop and check for vehicles. In contrast, findings from the disability focus group suggest that, while they understood the priority on a pedestrian crossing, they did not feel confident that drivers would actually give way to pedestrians in practice, especially at the junction.

Pedestrians' understanding of priority rules was also reflected in their reported feelings of safety when using the crossing. 50% of the pedestrians reported feeling safe using the crossing, and their explanations related to the presence of a crossing that indicated they had the right of way. This made them feel reassured that drivers would stop for them. Feedback from disability organisations suggested that neurodivergent road users and guide dog users would prefer having the crossing markings as it could potentially help alleviate anxiety around crossings by making clear the rules on priority.

For the 37% of pedestrians who reported feeling unsafe, reasons included the location of the crossing near the junction and lack of trust in other road users (although perceived lack of trust in other road users is not specific to the design of the trial crossing). This reasoning also echoed the responses from the disability focus group on why they would feel unsafe using the crossing. Additionally, disabled users also noted their preference and likelihood to indent at any junction to reduce the number of directions they need to look; to reduce traffic noise from the main road to better detect oncoming traffic; and to ensure that the road can be crossed between two straight and parallel kerbs, rather than at the radiused mouth of the junction (where crossing perpendicular to the kerb could result in walking into the main carriageway). Wheelchair users in particular will look for a dropped curb regardless of the proximity of it to the junction.

Drivers were asked about their feelings of safety when turning into or out from the side road. This question was specific about turning direction as the previous TfGM study found that driver's perception of safety varied substantially with the turning movement of the vehicle. However, of the drivers in this real-world trial, just under half reported feeling safe making a turn in either direction while about 30-35% of the respondents reported feeling unsafe in either of the turning movement. The proximity of the crossing to the junction was again noted as the main reason for feeling unsafe as drivers said that they found it difficult to gauge when they could turn. However, over half (60%) of drivers reported that it was easy to identify the trial crossing when approaching in a vehicle. There is some evidence from the driver survey to suggest that having the markings made it easier for half of the drivers to decide when to give way, as compared to when there were no markings.

Almost half of the pedestrians (47%) and the drivers (50%) suggested moving the crossing markings further up the road, at least a car's length away from the junction,

to allow both pedestrians and road users to have a clear view of the crossing. Because of disabled users' preference to indent when crossing in general, their recommendation was also to move the crossing further up the road. Having well-maintained blister tactile paving will also benefit disabled users who use it to understand the trajectory of their movement and to give them confidence that they cross from one straight kerb to another. 40% of pedestrians and 15% of the drivers suggested adding Belisha beacons for better visibility of the crossing in the dark. Some of the disabled user groups highlighted this during the site visit in the day.

It should be noted that the user feedback recommending moving the crossing down the side road, and adding features such as beacons, is effectively returning to the standard Zebra crossing and loses the primary benefit of the non-prescribed crossing of giving pedestrians a direct route on their desire line, minimising delay and walking distance. As the trial crossings are new in the UK (although commonplace elsewhere in Europe) such feedback may simply reflect a preference for the familiar. It is important to put these subjective concerns in context with the findings from the impact study that the trial crossing appears to function as intended, giving pedestrians greater priority without evidence that risks have increased.

This study did not explore the impact of the trial crossing on parking behaviour along the kerb and road user behaviour in the dark, as only a portion of the recordings were during darker hours. These would be useful areas for inclusion in future trials, as discussed in the recommendations section below.

7. Recommendations

The research conducted in this trial provide strong evidence that the side road zebra markings achieved the objective of increasing pedestrian priority, while the observed reduction in vehicle speed, and increases in the distance between a vehicle and pedestrian at the crossing, suggest that there are some safety benefits. No observations indicated any additional risks. It is therefore recommended that the trial sites remain in place for longer term safety monitoring.

Additionally, implementing non-prescribed zebra at additional sites would allow more datapoints to be collected from a greater range of locations. A precautionary approach would be to select sites that are similar to the trial sites in terms of having high pedestrian flows, relatively tight (low radius) geometry and low vehicle speeds (i.e. 20mph limits).

The concerns of the user group will need to be mitigated through clear communication and educational campaigns to raise awareness about the new markings, and changes in the recent Highway Code that give greater priority for pedestrians crossing at side-roads. The user research identified a number of design features that would help to mitigate some of the perceived risks for the most vulnerable road users. In particular, the importance of locating the crossing between parallel kerbs rather than on a curve, correct and well-maintained tactile paving, clear sightlines and avoidance of obstructions; and preventing vehicles from parking. There were also suggestions that signs or road markings should be added (for example, TSRGD[10] Diagram 7014) to warn drivers of the new crossing installed. This would help to address both driver and pedestrians' concerns around safety and anticipation of new markings.

The use of an AI-based visual sensor was an innovative element of this trial. It has shown itself to be a resource-efficient method for collecting large samples of crossing events, in comparison with manual video data extraction. It is recommended that this method is used in future trials, ideally with further experimentation with the time-based criteria used to define the proximity of a vehicle during a crossing event.

The interaction between time of day and behaviour was not analysed for this study as only a small portion of the records were captured in the dark. Future trials could investigate the interaction between vehicles and pedestrians at different times of the day.

Obstruction of the crossing at side road by vehicles parked along the kerb was raised during the site visit and workshop conducted by the disability focus group. Future trials should consider monitoring parking behaviour along the kerb that can obstruct pedestrian and oncoming vehicles view field.

[10] Traffic Signs Regulations and General Directions

Trial site

Figure 31: Technical drawing of the three installation sites

Location 1 - Station Road/ Evansfield Road

Location 2 - Bishops Road/Merthyr Road

Location 3 - Station Road/ Hawthorn Road East.

Pedestrian survey

Indicator	Instructions for survey form
*	This question is mandatory and requires an answer to continue. Optional questions are indicated in red text.
☐	Multiple Choice Question – Only 1 answer
○	Multiple Choice Question – multiple answers
Text in blue	These are skip logic or other instructions to set up the survey
Hyperlink text	Links to open in a separate tab
	Each section should be on a new page.
_____	Free text box

Introduction

Researcher on site will introduce the study/survey to participants verbally. A copy of the privacy notice can be handed to them in physical leaflet format or sent via email after completing the survey.

Hello, my name is ... from Strategic Research and Insight (SRI), and I am conducting research on behalf of the Welsh Government and the Transport Research Laboratory (TRL), an independent transport consultancy.

We're speaking to local people in the area to understand your views of the Zebra crossings bring trialled in Cardiff, like the one you have just crossed. It shouldn't long to complete now as I only have 16 questions to ask you, and we are keen to get your opinions of these new crossings as a user of them. We are also offering to enter you into a free prize draw (should you wish to) with a chance to win £200, if you take part now.

I can assure you all responses are anonymous and will be used to understand views from across the community. You can stop participation at any time without giving a reason. If you do this, we will not save or use any of the data that you have provided up to that point.

Do you have a few minutes free just to answer some questions please?

Interviewer note: Respondents must be aged 18 or older to participate in this survey. The survey will take approximately 5-10 minutes to complete.

If they have any questions or would like to know more information regarding this project, please contact Bharti Gupta (the Project Lead at TRL) at bgupta@trl.co.uk or they can speak to the Project Manager at the SRI office – Mrs Saadiah Hood, her email is saadiah@strategic-research.co.uk

Begin

Hoffech chi gwblhau'r arolwg hwn yn y Gymraeg neu'r Saesneg? / Would you like to complete this survey in English or Welsh?

- ☐ English / Saesneg [Use English version]
- ☐ Cymraeg / Welsh [Use Welsh version]

Survey questions

1. Was there a vehicle on the crossing when you approached the junction?
   - ☐ Yes [go to q2 and skip q3]
   - ☐ No [go to q3 (skip q2)]
2. When you approached the crossing, which of the following did you do next? *
   - ☐ Stopped at the side of the road to wait for the vehicle on the crossing to move before crossing the road straight ahead, as the other vehicles should stop for me.
   - ☐ Stopped at the side of the road to give way to all vehicles. Then crossed when it was clear.
   - ☐ Carried on walking and crossed the road by going behind the vehicle.
   - ☐ Crossed the road at another location
   - ☐ Not sure / can't recall

   Please explain the reasons for your answer (optional):

   _____

3. When you approached the crossing, which of the following did you do next? *
   - ☐ Carried on walking and crossed the road straight ahead as there was no vehicle
   - ☐ Stopped at the side of the road to give way to vehicles, then crossed when it was clear.
   - ☐ Stopped at the side of the road to check for vehicles. Then crossed when a vehicle stopped for me.
   - ☐ Crossed the road at another location
   - ☐ Not sure / can't recall

   Please explain the reasons for your answer (optional):

   _____

4. On a scale of 1 (*Very Unsafe*) to 5 (*Very Safe*), how safe or unsafe did you feel using this crossing? *

1	2	3	4	5
Very unsafe	Quite unsafe	Neither safe nor unsafe	Quite safe	Very safe

   Please explain the reasons for your answer (optional):

   _____

5. Did you notice anything different about the zebra crossing you have just used? *

☐ Yes

☐ No

☐ Not sure

If yes, what was different about the crossing (optional):

_____

6. Which one of the following statements do you think is the way this crossing **should** be used***:**

Motor vehicles and cyclists have priority. If a vehicle is approaching the crossing, pedestrians must wait until the road is clear in both directions before attempting to cross.	☐
Pedestrians approaching the crossing have priority. If a pedestrian is approaching the crossing, vehicles and cyclists must wait until the pedestrian has finished crossing before moving.	☐
I do not know who has priority. I am unsure on whether pedestrians or vehicles/cyclists have priority on this crossing.	☐

7. How much do you agree or disagree with the following statements from strongly agree to strongly disagree? *

[choice matrix; select 1 per row]	Strongly agree	Agree	Neither agree nor disagree	Disagree	Strongly disagree
I recognise this as a type of pedestrian crossing					
It is unclear who has priority (me or the vehicle) at this crossing					
The location of the crossing at the mouth of the junction is convenient to use					
The location of the crossing causes me confusion					
I feel comfortable using this crossing to cross the road					

	
Standard zebra crossing • Has a series of alternate black and white stripes on the carriageway. • a yellow globe is positioned at each end of the crossing (commonly referred to as a Belisha beacon); • give ways lines and zigzag markings • set-back from the mouth of a side road	**Trial zebra crossing** • removes all standard features on the left • the crossing markings will be located at the mouth of the road junction at the dropped curbs

8. How much do you agree or disagree with the following statements from strongly agree to strongly disagree? *

[choice matrix; select 1 per row]	Strongly agree	Agree	Neither agree nor disagree	Disagree	Strongly disagree
I would prefer the trial zebra crossing to be used at side roads					
I would prefer the standard zebra crossing to be used at side roads					
I would prefer if there were no zebra crossing present at side roads					

9. Would you like to see any changes to the design of this crossing in order to improve safety? *

☐ Yes

☐ No

☐ Not sure

If yes, what changes would you like to see in order to improve safety (mandatory if yes):

10. Did you know about trials related to this crossing before completing the survey today? *

- ☐ Yes
- ☐ No [skip q11]

11. If yes, where did you hear about the trials? *

- ☐ Welsh Government website
- ☐ Living streets publication
- ☐ Local News
- ☐ Facebook
- ☐ Twitter
- ☐ Others (please state): _____

Participant information

12. Which of the following applies to you? *

- ☐ Male
- ☐ Female
- ☐ Non-binary
- ☐ Prefer not to say
- ☐ Prefer to self-describe: _____

13. Which of the following age groups do you fall into? *

- ☐ 18-24 years
- ☐ 25-34 years
- ☐ 35-44 years
- ☐ 45-54 years
- ☐ 55-64 years
- ☐ 65-74 years
- ☐ 75 years or older

14. Do you have any long term physical or mental disabilities or health conditions which affect your mobility? *

Please tick all that apply

- ○ None
- ○ Mental health condition
- ○ Mobility impairment
- ○ Age-related mobility difficulties

- Visual impairment
- Respiratory problems
- Hearing impairment
- Learning disability
- Serious long-term illness
- Prefer not to say
- Other (please specify):

Please describe how your mobility is affected (optional):

Prize draw entry

Before we end the survey, and as thank you for taking part in this survey, you may choose to be entered into a prize draw for a chance to win £200. SRI will arrange the distribution of the prize draw and no contact information will be passed on to TRL or Welsh Government. You will need to provide your contact details to be entered into the prize draw. Would you like to be entered into a prize draw to win £200? *

- ☐ Yes [ask q15]
- ☐ No [skip q15]

15. Please provide your below details*:

Full Name: _____

Email address: _____

Telephone number (if email not available): _____

Thank you page

That's the end of the survey. Thank you for your help.

As research for this project is ongoing, please do not discuss what you have done with other people, or post anything about it on social media.

Thank and close.

Appendix C Driver trials

C.1 Recruitment form

Begin

Hoffech chi lenwi'r ffurflen hon yn Saesneg neu Gymraeg? Would you like to complete this form in English or Welsh?

- ☐ English / Saesneg [Use English version]
- ☐ Cymraeg / Welsh [Use Welsh version]

Introduction

What is it all about?

Strategic Research and Insight have been commissioned by Transport Research Lab (TRL), an independent transport consultancy, to carry out a study of a trial road layout on behalf of the Welsh Government.

As a thank you for taking part, we will give selected participants £50 upon completing the task and survey.

What will I be required to do?

You will be asked to drive your own car on a designated route on a public road in Whitchurch, Cardiff. If you meet all the requirements of the study, and are still interested, a researcher will contact you by phone to discuss the next steps.

On the day of the drive, you will be invited to meet the researcher at the starting point of the route. The researcher will confirm your identity, brief you on the instructions of the drive, and obtain your consent to participate in the study. Then following the drive, after you have returned to the starting point and parked your car, you will be asked to complete a short face-to-face survey with the researcher about your experience on the drive.

Please note: As the route is part of the public road, private vehicle insurance may be sufficient to cover any incidents. However, **we strongly encourage you to check this with your insurance providers in advance of the drive.** You are responsible for determining whether your insurance is adequate.

Due to the nature of the study, participants need to be:

- 18 years old or above
- Have a valid UK driving licence
- Have a valid MOT and insurance policy
- Have a car that you drive regularly
- Be very familiar and comfortable using Google Maps as their navigation system
- Have a mobile device that you can access the Google Maps app on
- Have an appropriate device holder to safely mount the above device so that it does not obstruct your view

Participants will be recruited on a first-come first-served basis so we cannot guarantee that everyone expressing an interest will be able to take part.

The drive may take around 20-30 minutes – this will vary depending on the traffic at the time of the day. The face-to-face survey is expected to take about 10 minutes.

If selected, you will be allocated a suitable time slot. Sessions will take place between 7am and 6pm between Monday 13 December and 15 December in Whitchurch, Cardiff.

Following the drive and completed face-to-face survey, we will provide you with £50 cash payment to cover your time and travel expenses.

What happens now?

If you are interested in taking part, please complete the following questions about yourself and your availability. This should only take a few minutes to complete. We will then be in touch with a date and time for you to attend if you are chosen to take part.

Contact and further information

If you have any queries, please contact Mrs Saadiah Hood, Senior Research Consultant at saadiah@strategic-research.co.uk

The only personal data we will collect from you are your name, email address, and contact number but you can also view SRI's privacy policy here, as well as TRL's privacy policy here: Privacy Notice.

1. Are you interested in taking part in this research?
   - ☐ Yes
   - ☐ No [disqualify participant]

If no – this message pops up: We need your consent to participate in this research, and for us to use your data in the way described above. If you want to change your mind, then tick 'yes' above.

Requirement questions

2. Please indicate your age group*
   - ☐ 17 years or younger [disqualify participant]
   - ☐ 18-24 years
   - ☐ 25-34 years
   - ☐ 35-44 years
   - ☐ 45-54 years
   - ☐ 55-64 years
   - ☐ 65-74 years
   - ☐ 75 years or older

3. Do you currently hold a valid UK driving licence?
   - ☐ Yes
   - ☐ No [disqualify participant]

4. I understand and agree that TRL, Strategic Research, or the Welsh Government will not be liable for any damages, injuries or damage to property sustained while I am participating in this study.
   - ☐ Yes
   - ☐ No [disqualify participant]

5. Do you have a valid MOT and insurance policy.
   - ☐ Yes
   - ☐ No [disqualify participant]

6. Do you use a smartphone app for satnav while driving?
   - ☐ Yes
   - ☐ No [disqualify participant]

7. If yes, select which are you most familiar with?
   - ☐ Google Maps
   - ☐ Komoot
   - ☐ Apple maps
   - ☐ Waze
   - ☐ Others:_____

   Q7 - Disqualify participant if they select any other than Google maps.

8. Do you have an appropriate device holder to safely mount your smartphone so that it does not obstruct your view?
   - ☐ Yes
   - ☐ No [disqualify participant]

9. Are you a resident in the Cardiff area?
   - ☐ Yes
   - ☐ No [disqualify participant]

Present Q10 onwards only to participants who have not been disqualified up till this point.

Further information on participant

10. How many years have you held a driving licence?
    - ☐ <2
    - ☐ 3-5
    - ☐ 6-9
    - ☐ 10+

11. How frequently do you drive? (Please tick whichever option most closely matches how often you drive)

    ☐ More than once a week

    ☐ Once a week

    ☐ 2 or 3 times a month

    ☐ Once a month

    ☐ Less than once a month

12. Which of the following applies to you? *

    ☐ Male

    ☐ Female

    ☐ Non-binary

    ☐ Prefer not to say

    ☐ Prefer to self-describe: _____

13. Please provide your name and contact details for the researcher to contact you*

    Full Name: _____

    Phone number: _____

    Email address: _____

    Best time of day to call: _____

14. Please indicate which session(s) you will be able to attend. The drive may take around 20-30 minutes – this will vary depending on the traffic at the time of the day. Face-to-face surveys are expected to take about 5-10 minutes. *

    If you are able to attend any session on a date, please tick 'any time slot', otherwise indicate the sessions you are able to attend.

    Each participant will only be able to attend one session.

	ANY TIME SLOT	7-8am	8-9am	9-10am	10-11am	12-1pm	1-2pm	2-3pm	3-4pm	4-5pm	5-6pm
Tuesday 13th December											
Wednesday 14th December											

Thursday 15th December											
Another date – please state											

If you have a strong preference for which session you would like to attend, please indicate this in the box below.

-

_____

__

Thank you page

If completed survey

Thank you for your interest in the study! A member of the research team at SRI will be in touch with you soon to arrange the driving session.

If disqualified

Thank you for your interest in the study. Sorry you do not qualify to take part. You are seeing this page either because

1. You indicated you are not interested to take part in the study
2. OR you do not have a valid UK driving licence. You need to be able to drive to take part in the study.
3. OR you do not have a valid MOT and insurance policy. We need participants to have these documents in order to participate in the study.
4. OR you do not use the navigation tool (Google Maps) that we are using during the study. We want to ensure the safety of our participants.
5. OR you are under the age of 18. You need to be 18 years or older to take part in this survey.

Thank you for your interest in this research.

Post drive survey

Q1 and 2 to be filled by researcher before handing over to participant.

1. Please enter the Unique Participant ID: _____
2. Please indicate the route assigned to the participant
   - ☐ A
   - ☐ B
   - ☐ C
   - ☐ D
3. Please indicate when this took place during peak or off-peak hours

☐ Peak hours (7am – 9:30am, 12pm – 2pm, 4pm-6:30pm)

☐ Off-peak hours

New Page

4. How would you like to complete this survey?
   ☐ English [Use English version]

   ☐ Welsh [Use Welsh version]

INTRODUCTION

Hello and welcome to this survey on understanding drivers' perceptions of a new road layout that the Welsh Government is trialling in Cardiff. We will first ask you for some details to confirm your eligibility to participate in this trial, and then we will give you details of a short route around the neighbourhood that we would like you to drive. We will meet you back here at the end of the drive and ask you some questions about your experience.

As mentioned in the recruitment form, this is a reminder that as the route is part of the public road, private vehicle insurance may be sufficient to cover any incidents. We had strongly encouraged you to check this with your insurance providers in advance before you participate in the study**. You are responsible for determining whether your insurance is adequate.** TRL, Strategic Research, or the Welsh Government will not be liable for any damages, injuries or damage to property sustained while you participate in this study.

Due to the nature of the study, we require that participants

1. Are very familiar and comfortable using Google Maps as their navigation system
2. Have a device that you can access the Google Maps app on
3. Have an appropriate device holder to safely mount the above device so that it does not obstruct your view

The researcher can disqualify your participation in the study if you do not have appropriate device and device holder.

All responses are anonymous and will be used to understand views from across the community. You can stop participation at any time without giving a reason by closing the web browser. If you do this, we will not save or use any of the data that you have provided up to that point. If you have any questions or would like to know more information regarding this project, please contact Bharti Gupta (Project Lead at TRL) at bgupta@trl.co.uk.

Thank you for taking part.

PRIVACY STATEMENT

You are not required to provide your name, email address, date of birth or any other identifiable personal data in order to complete this survey. If you wish to view our privacy policy, please click here: Privacy Notice

Please press the next/forward arrow button to start the survey.

[Select one answer per row. If response 'No' to any of the following statements -> disqualify participant]

5. Please answer the following questions*

	Yes	No
I am 18 years old or above		

I have read and understood the information above and have had the opportunity to ask the researcher questions.		
I understand and agree that TRL, Strategic Research, or the Welsh Government will not be liable for any damages, injuries or damage to property sustained while I am participating in this study.		
I have a valid MOT and insurance policy.		
I understand that my participation is voluntary and that I am free to withdraw at any time without giving a reason.		
I give my consent to participate in this trial and survey		

Thank you for confirming your participation in the study.

The researcher will now provide you a URL link that will redirect you to a specified route on your Google Maps. You should not make any detours or other stops on the way. Please complete the drive and return to the meeting point to complete the rest of the survey. The drive may take around 15-25 minutes – this will vary depending on the traffic at the time of the day.

If at any point during the research, you are lost, please return to the meeting point immediately and inform the researcher.

You may contact the researcher at xxxxxx if you are lost or need help.

The researcher will now follow you to your car to ensure you have the appropriate device and device holder mounted correctly to ensure your participation in the study is done safely.

☐ Ok OR next button

- Blank screen – Participant on drive

☐ I have completed the drive and can proceed to the survey. [Next]

☐ I was unable to complete the drive [end survey, still pay incentive]

Please explain why the drive could not be complete*:

_____

6. This was one of the crossings you would have come across on your drive. Did you recognise it as a pedestrian crossing? *

☐ Yes

☐ No

☐ Not sure / don't remember

Please explain the reasons for your answer (optional):

_____

7. Did you notice anything different about this crossing? *
   ☐ Yes
   ☐ No
   ☐ Not sure / don't remember

   If yes, please describe what was different about the crossing (optional):

   _____

8. How would you rate the visibility of this crossing? *
   ☐ Not very visible – very difficult to identify when approaching in a vehicle
   ☐ Somewhat visible – difficult to identify when approaching in a vehicle
   ☐ Not sure
   ☐ Somewhat visible – easy to identify when approaching in a vehicle
   ☐ Very visible – very easy to identify when approaching in a vehicle

9. How easy or difficult was it to identify it as a pedestrian crossing? *

1	2	3	4	5
Very easy	Easy	Neither easy nor difficult	Difficult	Very difficult

Please explain the reasons for your answer (optional):

_____

NEW Page - Ensure participant can't go back to change response –

Standard zebra crossing	Trial zebra crossing
• Has a series of alternate black and white stripes on the carriageway. • a yellow globe is positioned at each end of the crossing (commonly referred to as a Belisha beacon); • give ways lines and zigzag markings set-back from the mouth of a side road	• removes all standard features on the left • the crossing markings will be located at the mouth of the road junction at the dropped curbs

10. When you approached the side road with the trial zebra crossing, did you notice any pedestrians on the crossing or about to approach the crossing? *

    ☐ Yes, at all crossings

    ☐ Yes, at some of the crossings

    ☐ No, the road was clear at all the crossings

11. When you approached the side road with the trial zebra crossing, how easy or difficult did you find it to decide whether to give way to pedestrians crossing the road? *

1	2	3	4	5
Very easy	Easy	Neither easy nor difficult	Difficult	Very difficult

    Please explain the reasons for your answer (optional):

    _____

12. When you approached a side road without any pedestrian crossing, how easy or difficult did you find it to decide whether to give way to pedestrians crossing the road? *

1	2	3	4	5
Very easy	Easy	Neither easy nor difficult	Difficult	Very difficult

    Please explain the reasons for your answer (optional):

    _____

13. How safe or unsafe did you feel using when making the following turns at the side road with the trial zebra crossing? *

[choice matrix; select 1 per row]	Very unsafe	Quite unsafe	Neither safe nor unsafe	Quite safe	Very safe	Not sure

Turning into the side road						
Turning out of the side road						

Please explain the reasons for your answer (optional):

_____

14. Would you like to see any changes to the design of this crossing in order to improve safety? *
    - ☐ Yes
    - ☐ No
    - ☐ Not sure

    If yes, please describe the changes you would like to see in order to improve safety (mandatory if yes):

    _____
    _

15. Before we end the survey, did you know about trials related to this crossing before completing the survey today? *
    - ☐ Yes
    - ☐ No [skip q16]

16. If yes, where did you hear about the trials? *
    - ☐ Welsh Government website
    - ☐ Living streets publication
    - ☐ Local News
    - ☐ Facebook
    - ☐ Twitter
    - ☐ Others (please state): _____

If completed survey

That's the end of the survey. Thank you for your help. You will shortly receive the £50 cash/voucher promised for your participation in the study.

As research for this project is ongoing, we would be grateful if you could avoid discussing this on social media until the trials are complete in 4 weeks' time.

If you have any further questions, please contact the project's Technical Lead:

Bharti Gupta: bgupta@trl.co.uk
Subject matter: 'Welsh side-road zebra survey'

If disqualified

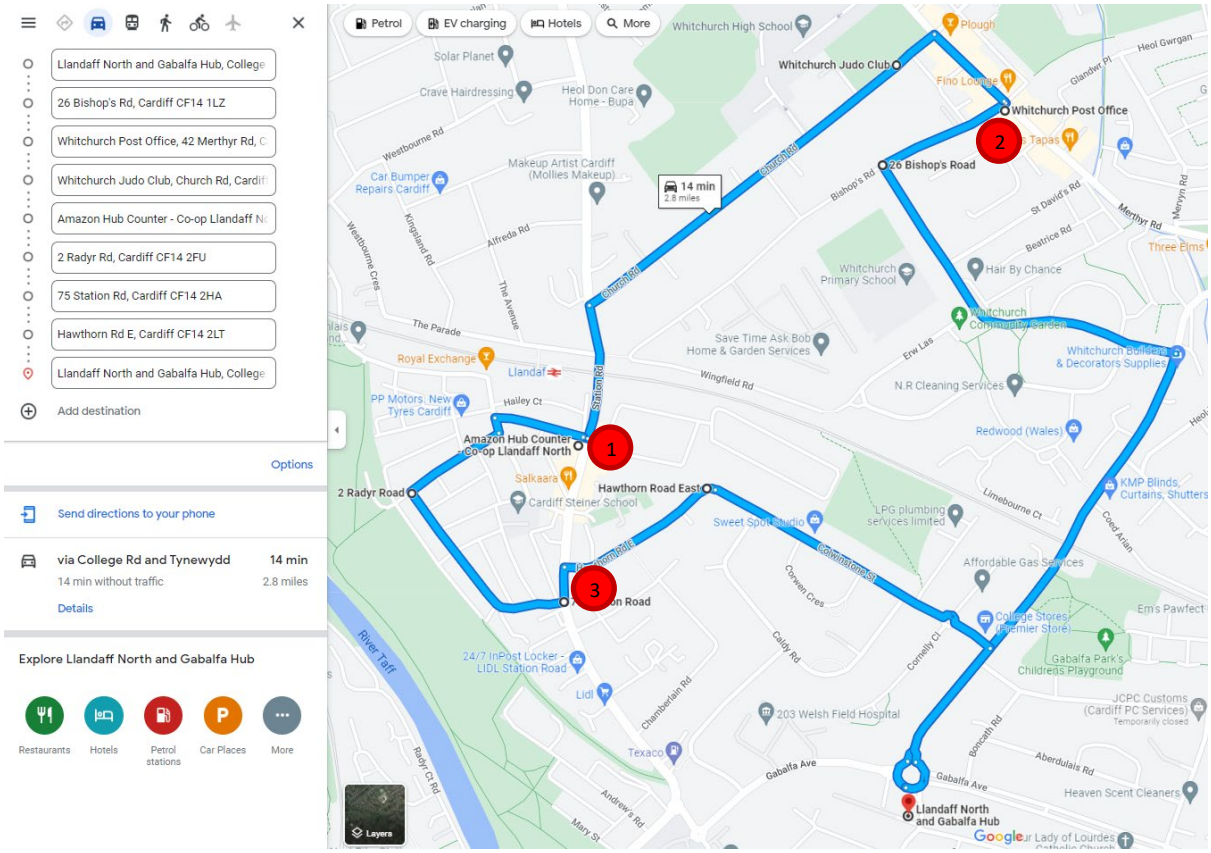
Thank you for your interest in the study. Sorry you do not qualify to take part. You are seeing this page either because

6. You are under the age of 18. You need to be 18 years or older to take part in this survey.
7. OR you do not have a valid UK driving licence. You need to be able to drive to take part in the study.
8. OR you do not have a valid MOT and insurance policy. TRL, Strategic Research, or the Welsh Government will not be liable for any damages, injuries or damage to property sustained while participating in this study.
9. OR you do not have appropriate navigation device and/or holder to take part in the study.
10. OR you did not give consent to participate in the study.

Driving routes

- All routes start and end at Llandaff North and Gabalfa Hub
- Route A & B is the same route, in opposite directions. Route A is **anti-clockwise**, and Route B is **clockwise**
- Route C & D is the same route, in opposite directions. Route C is **anti-clockwise**, and Route D is **clockwise**

Route A – link

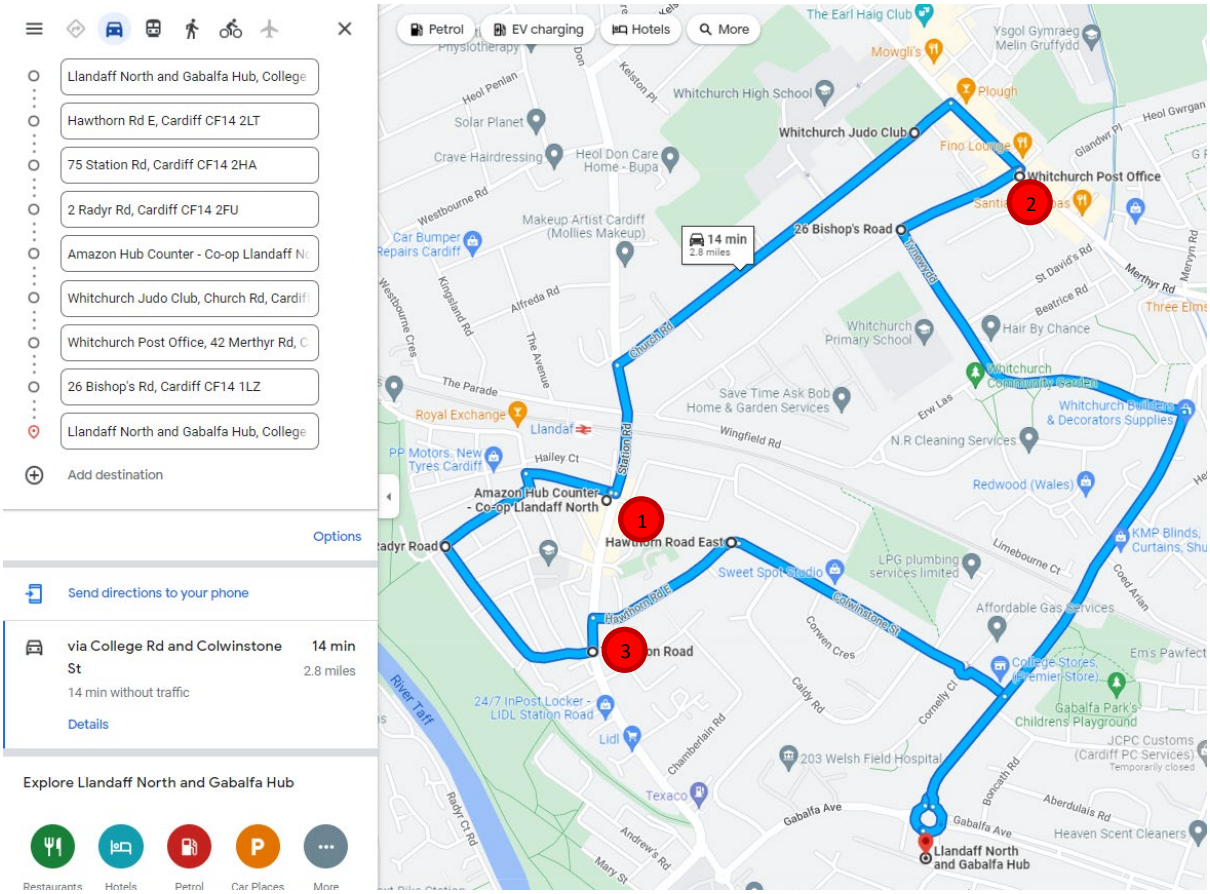


Route A

- Location 2 - Out of side road (left)
- Location 1 - Into side road (right)

- Location 3 - Into side road (right)

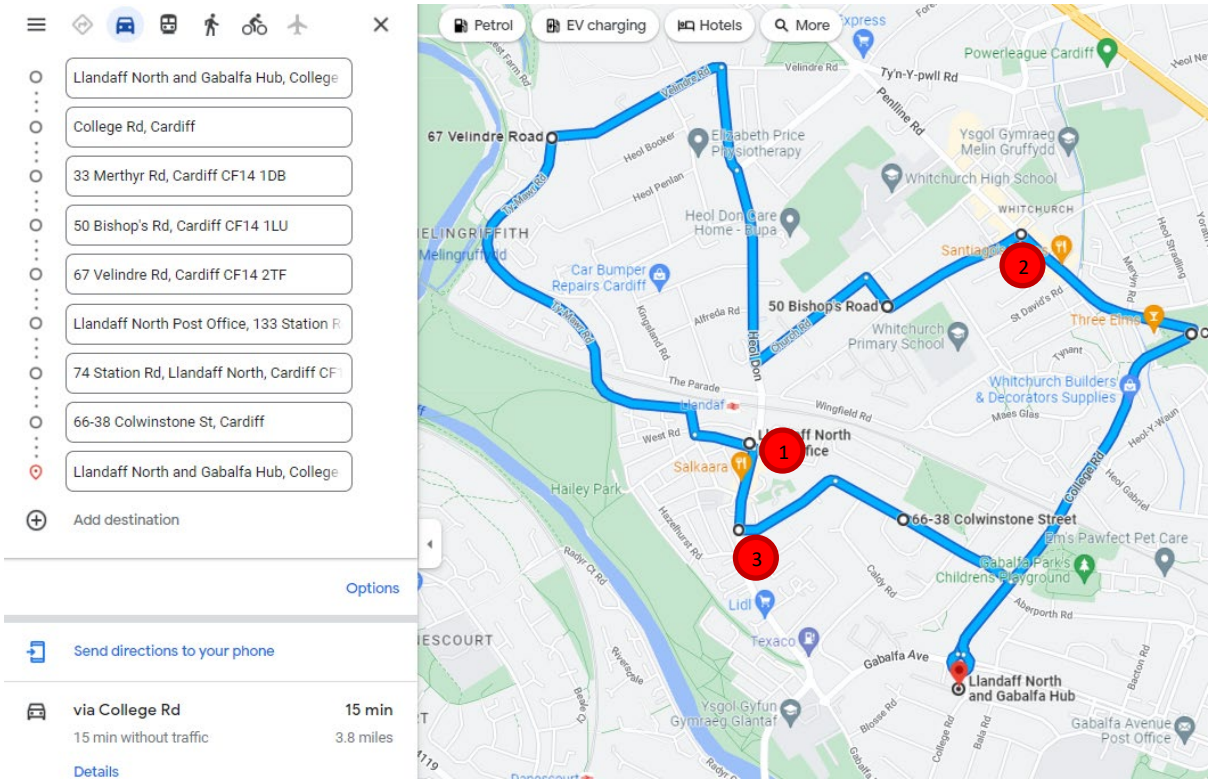
Route B – link



Route B

- Location 3 - Out of side road (left)
- Location 1 - Out of side road (left)
- Location 2 - Into side road (right)

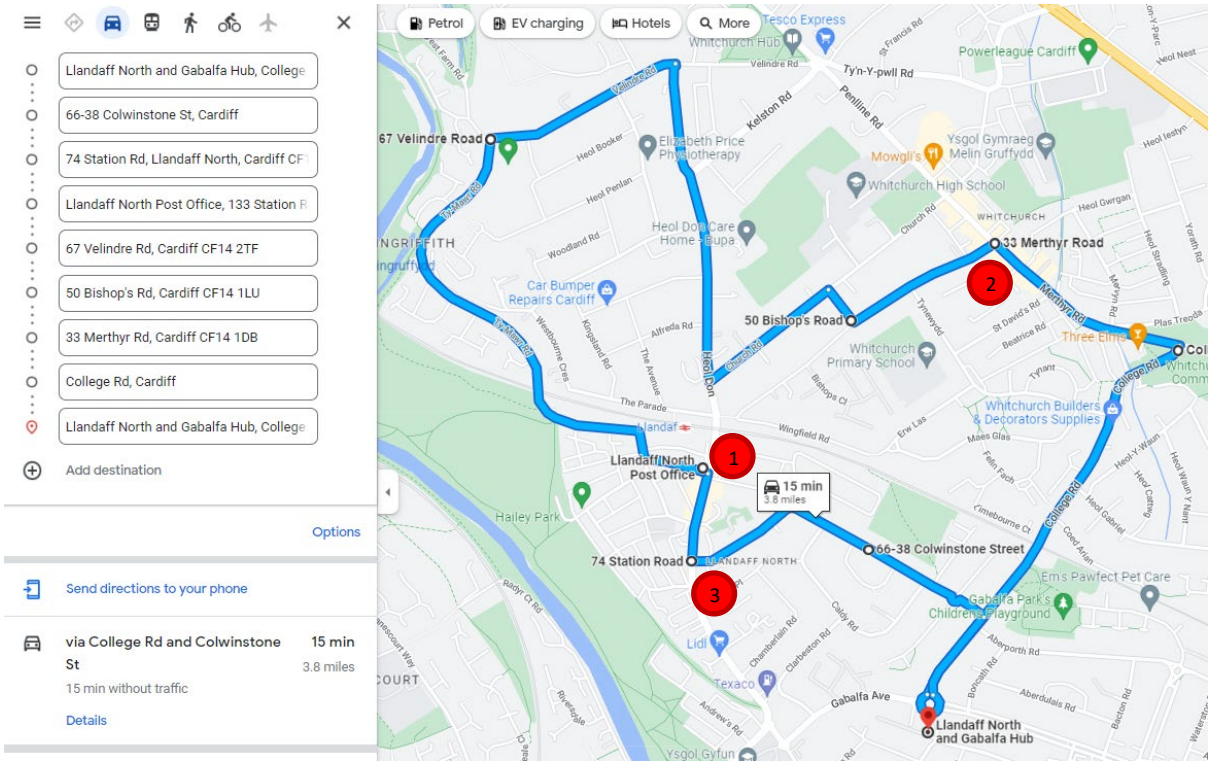
Route C – link



Route C

- Location 2 - Into side road (left)
- Location 1 - Out of side road (right)
- Location 3 - Into side road (left)

Route D – link



Route D

- Location 3 - Out of side road (right)
- Location 1 - Into side road (left)
- Location 2 - Out of side road (right)

Appendix D Disability group topic guide

There were four parts to the discussion and following questions were used to lead the conversation.

1. Perceived safety of the crossing
    i. Did you notice any aspects of the crossing that might be a safety hazard for some people?
    ii. Did you notice any aspects of the crossing that might be seen as a safety hazard by some people?
    iii. To what extent do you think that some people might avoid using the crossing?
2. Right of way
    i. Do you think that people will understand the 'right of way' rules in relation to the crossing?
    ii. If not, then what might the consequences be of this lack of understanding or confusion?
    iii. Can you think of any ways in which right of way rules in relation to the crossing might be made clearer?
3. Convenience
    i. Do you think there are any aspects of the crossing that might make it less than convenient for some people to use?
    ii. If so, then what might the consequences be of this lack of convenience?
    iii. Can you think of any ways in which the crossing can be made more convenient to use?
4. Likelihood
    i. If you were to approach a similar junction at a side road *with no pedestrian crossing*, what is their likelihood of crossing the road at the mouth of the junction?
    ii. If you were to approach a similar junction at a side road *with a pedestrian crossing*, what is their likelihood of crossing the road at the mouth of the junction?

5. The convenience of the crossing
    i. Do you think there are any aspects of the crossing that might make it less than convenient for some people to use?
    ii. If so, then what might the consequences be of this lack of convenience?
    iii. Can you think of any ways in which the crossing can be made more convenient to use?

Welsh side road Zebra crossings Road user behaviour and perceptions

Welsh Government commissioned TRL to undertake the trial of non-prescribed zebra crossing markings, located at the mouth of the junction, on side roads in Cardiff. The study involved monitoring the impact of the trial crossing on road user behaviour employing an innovative AI-based optical sensor system to produce a digital interpretation of road user movements and positions before and after the implementation of the trial crossing; and survey of user perceptions through questionnaires and workshops.

After the trial markings were applied, the observations from the optical sensors showed that there was a substantial and statistically significant drop in the number of cases where the pedestrian went second, providing strong evidence that there was a significant increase in propensity to give way. Additionally, significantly more pedestrians were also clearing the crossing area before the vehicle reached it.

The presence of the trial crossing was recognised by a majority of all user groups as a crossing, and there was a clear acknowledgement that the pedestrian had the right of way; although some users raised concerns that other road users may not be aware of the priority.

Other titles from this subject area

PPR1003	Non-prescribed zebra crossings at side roads. Final Report. Jones M., Matyas M. and Jenkins D. 2021
PPR1010	Non-prescribed zebra crossing at side roads. Technical Annex 7: Observations of conflict and givingway during on street trials. Greenshields S., Ognissanto F., Lee R. and Macgregor E. 2021
PPR1007	Non-prescribed zebra crossing at side roads. Technical Annex 4: Road user perceptions and understanding. Blunden A., Gupta B., Matyas M., Mazzeo F., Wallbank C. and Wardle A. 2021
PPR1008	Non-prescribed zebra crossing at side roads. Technical Annex 5: Implications for people with disability. Blunden A., Gupta B., Verwey L., Butler, R. and Wallbank C. 2021