XT Junction-
The next junction on the road to net zero?

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Submission Date: 31/03/2023

Publication Date:

Keywords:
XT junction, Displaced Right Turn (DRT), Continuous Flow Intersection (CFI), Alternative Junction Design.

Abstract: Taking inspiration from a range of alternative junction designs commonly used in the United States, there have only been a few tentative steps of introducing 'alternative design' junctions to resolve congestion problems at T junctions in the UK. Among these, two 'Displaced Right Turn' (DRT) T-junctions have been built. Alternatively called a 'Continuous Flow Intersection' (CFI), they work on the principle of 'swapping over' the opposing streams of traffic on the minor road arm to enable unopposed right turns to be made at the main junction. This enables a simplification of the traffic signals staging, delivering improvements in capacity and reducing delays. In undertaking this study, a range of hypothetical XT junction layouts varying in size and configuration have been developed and modelled. The results of the modelling exercise suggest that depending on the layout tested, traffic volume and the degree of active travel facilities provided, the adoption of an XT junction is likely to result in an additional spare capacity up to 33% in comparison to a standard T junction. This spare capacity could either be used to benefit traffic capacity, congestion, and delays or to improve crossing time and clearance allowance for active travel modes – all without a detrimental effect on traffic and potentially at a lower cost, without resorting to more expensive infrastructure. In addition, the results show up to 100% traffic signal cycle time savings based on the level of active travel provision. Furthermore, the most significant environmental benefit is the scope to reduce the operational carbon dioxide CO_2 emissions, potentially by up to 35%.

While additional testing and/or practical trials are required to definitively establish the safety credentials of the design, the research outcomes from this study demonstrate that the XT junction has the potential to be highly effective in delivering a range of holistic improvements and improving social outcomes at congested T junctions, and can make a viable contribution towards meeting the objectives of the modern transport agenda and the UK target of net zero carbon emissions by 2050.

Introduction

Junction delays and congestion are issues that engineers have been trying to solve ever since the motor vehicle became the dominant mode of transport. A priority T-junction - where a minor road joins a major road and the dominant flow arms have priority, is the most basic type of road junction. They tend to work well in low and medium volumes of traffic, but when levels increase beyond what the junction can handle, alternative means of control or alternative infrastructure solutions must be considered.

The starting point for improving any delays and congestion at traffic junctions is by firstly changing road markings or priority rules, and if that proves ineffective, optimising the traffic flows using traffic signals to apportion time more equitably between the arms. When none of these are successful, highway authorities often need to invest in significant physical upgrades to the junction. For example, building a flyover, bridge, grade-separated junction, multi-lane interchanges, etc. All these can help improve traffic flows, but they can be very costly, require a lot of space, take a long time to construct, and can be very harmful to the environment. Besides, in many cases, options are limited by cost, space constraints or environmental factors.

Several different alternative junction types have been invented to deal with rising traffic levels without resorting to more expensive infrastructure and civil works. The United States has been at the forefront of such innovations. The Diverging Diamond Interchange (DDI) is probably the most well-known of the established vehicle 'crossover'-type junctions, in which the two directions of traffic on the minor road cross to the opposite side of the road for a short section before being transferred back to the correct sides of the carriageway either side of the junction. The arrangement permits access to the major road on and off-ramps under partial free-flow conditions and results in a reduced number of conflict points. The DDI has been shown to improve traffic flow and reduce congestion, as well as increase safety by reducing the number of conflict points between vehicles. As of July 2022, it is estimated that more than 135 DDIs are operational worldwide and many under construction.

The Continuous Flow Interchange (CFI) (also called the "Displaced Left Turn" (DLT) in right-hand drive countries, or "Displaced Right Turn" (DRT) in left hand drive countries works on the same principle of 'swapping over' the opposing streams of traffic on the minor road arm to enable unopposed right turns to be made at the main junction. This enables a

simplification of the traffic signals staging, delivering improvements in capacity and reducing delays.

The re-focussing of transportation policy in the last 20 years towards a more sustainable 'decide and provide' approach, creates an opportunity to explore whether a re-purposed, and re-branded DRT junction, can make a viable contribution towards meeting the objectives of the modern transport agenda and UK target of net zero carbon emissions by 2050. Our research team have therefore developed the 'XT junction', a DRT variant which aims to not only deliver junction capacity improvements and reduced delays for motor vehicles, but also better conditions for active travel modes, reduced environmental impacts and improved social outcomes. And all at a cost which is likely to be cheaper than many conventional solutions.

History of the Crossover Design

The efficacy of the crossover feature was first established with the construction of the first DDI in France in the 1970s, Chlewicki (2003).[1] However, some studies claim that the crossover design principle may go back as far as the 1950s, Simmon and Chick (2003).[2] The first DDI built in the US was in 2009 in Springfield, Missouri, the concept being put forward by Chlewicki (2003).[1],[3] The reconfigured intersection has been widely regarded as a relatively low-cost solution that improves traffic operations and safety (Christopher et al., 2021).[8] The concept was further explored by the Federal Highway Administration report (Hughes et al., 2010)[9], dedicating a chapter to the DDI design, that offered "substantial advantages over conventional at-grade intersections and grade-separated diamond interchanges".

In 2016, the New Mexico Department of Transportation implemented the first DDI in New Mexico.[4] In November 2016, the Delaware Department of Transportation completed the conversion of an overpass at DE-1 and DE-72 (Wrangle Hill Road) west of Delaware City into a DDI.[5]

The DDI design gained popularity in the United States and was adopted by other countries as well. In Canada, the first DDI opened in August 2017 at Macleod Trail and 162 Avenue South in Calgary, Alberta, followed by another one in Regina, Saskatchewan.[6] In Australia, the Department of Transport and Main Roads of Queensland was the first to implement a DDI in 2019 at Caloundra, Bruce Highway.[7] Nowadays, the DDI design has become a popular and effective solution for improving traffic flow and safety at intersections and interchanges around the world.

The first Continuous Flow Intersection (CFI) was built in the U.S. 1995 at a T-junction on the William Floyd Parkway in the town of Shirley, New York. Other examples can be found in Maryland, Louisiana, Utah, and New Mexico.[9]

Displaced Right Turn (DRT)

Goldblatt et al., (1994),[12] reported that a CFI configuration reduces delays, fuel consumption and CO_2 emissions compared to conventional intersections and that a CFI can handle up to 50% more traffic than conventional intersections. They also acknowledged some limitations and challenges of CFI adoption, such as relatively higher construction costs, increased right-of-way (ROW) requirements, potential driver confusion and safety concerns due to possible wrong-way manoeuvres.

Chick and Simmonite (2003)[2] proposed that although there is a slight increase in cost associated with the DRT concept, these additional costs are generally more than offset by the benefits in terms of increased capacity, reduced travel times and reduced congestion in comparison to traditional junction layouts. They also concluded through studies and tests, that the DRT footprint is likely to be similar to that of an equivalent conventional roundabout footprint. They also stated that pedestrians and cyclists could easily be accommodated at a DRT junction without compromising the capacity of the intersection using "Walk with Traffic" facilities. The pedestrian and cycle provision also benefits from the short cycle times inherent in a DRT arrangement in comparison to a standard T junction layout, keeping pedestrian/cyclist delays to a minimum.

Pitaksringkarn (2005)[10] established through VISSIM modelling of the proposed Gude Drive/Frederick Road intersection in Maryland, United States, that the overall delay and queue lengths measured during the peak PM hour decreased from those of a conventional intersection significantly by 64% and 61%, respectively.

The United States Department of Transport confirmed in their report, Alternative Intersections/Interchanges (2010),[11] that a DRT intersection can improve traffic operations and safety by reducing delay, queue length, number of conflict points, and number of signal phases at the main intersection.

As of the time of writing this paper, in the UK, only two prototype DRT junctions are known to have been built – one completed in 2002 at the junction of A4198 Thamesdown Drive/A4311 Cricklade Road near Swindon in Wiltshire, and the other completed in 2015 at the A380 Hamelin Way/A380 South Devon Expressway, east of Torquay, Devon. Other than these two examples, there has been no other known DRTs/CFIs as a solution to congested T junctions in the UK.

XT Junction

While earlier CFI intersections have been introduced predominantly with the aim of mitigating any vehicular traffic congestion and delay, the goal of the XT junction is to deliver a more holistic and equitable range of improvements across all road user groups. To this end, an XT junction is likely to be more suited to urban, or semi urban locations – like the Swindon junction, rather than rural or semi-rural locations, such as the Torquay example.

Like the DRT, the XT concept uses the principle of switching minor road traffic to the opposite sides of the carriageway prior to the main junction – see Figure 1. This gives the advantage of combining both movements to and from the minor road into a

single phase. As a result, the junction requires only two traffic signal phases instead of three for a standard signalised T junction. The most notable feature is the right-turn crossover on the minor arm (the 'X'), which allows drivers to make an unobstructed right turn at the main junction.

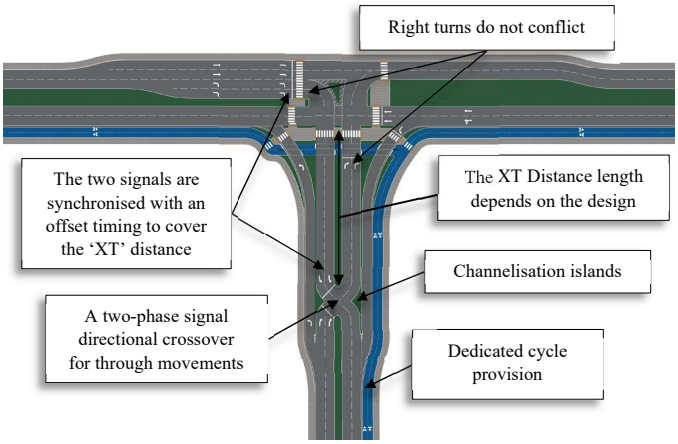

Figure 1: Key characteristics of an XT junction.

Motor Vehicles: The movements required to traverse an XT junction as a motor vehicle driver are as follows:

Right turn from major arm to minor arm: At the main XT junction signals, the signalised right turn is made into the minor arm side of the carriageway which normally carries the traffic entering the junction. Under an XT arrangement, this arm is instead dedicated to carrying the traffic away from the junction and into the minor arm, transitioning back to the correct side of the road at the X part further into the minor arm. The XT arrangement provides for a seamless transition through the main junction and crossover, meaning that in general, most right-turning drivers who wait at the main junction signals would not need to stop at the second signal at the X crossover because both sets of traffic lights are synchronised.

Right turn from minor arm to major arm: On the approach to the main junction, vehicles turning right will position themselves in the appropriately signed traffic lane just like a normal junction, only it's a little further back – at the X part of the junction. At the X crossover, drivers transition across opposing traffic under signal control to approach the main traffic signals on the opposite side of the road. The right turn is then made into the correct side of the main arm. The XT arrangement also provides for a seamless transition through the crossover and main junction. However, if more green time is given to the through movements, then this will leave redundant time at the crossover. As a result, drivers might occasionally need to stop twice.

Left turns into and out of the minor arm are made in the same way as filtered left turns at a conventional T junction.
In general, the relatively small area required to install the 'X' crossover means that the conversion from T to XT could be accommodated within the current footprint in most circumstances, reducing construction time and inconvenience. These are only small changes, but they have the potential for making a significant difference in terms of junction performance and user experience for all users.

XT Multimodal Opportunities

The XT junction is intended to cater for pedestrians and cycle users in a safe manner. This is achieved through a combination of having sufficient physical space for the facilities required and using the spare capacity provided by the continuous right-turn arrangement to allow sufficient crossing and/or junction clearance time for active travel modes.

Pedestrians: Pedestrians are provided with signal-controlled crossing points and full crossing is achieved in a three-stage operation, as opposed to a four-stage operation in an equivalent conventional T junction arrangement. In circumstances where pedestrian and cycle paths are segregated, pedestrians will be provided with uncontrolled crossing points across the cycle paths, via lowered kerbs.

With a centrally located crossing design, as per the DRT at Thamesdown Drive in Swindon as shown in

Figure 2, the pedestrian crossing to the centre of the junction on the major arm is unusual compared to a typical T junction design where separate crossings are usually located on the approach and exit arms. Depending on the design vehicle and XT speed, the pedestrian refuge island separating the right turn movements can be quite large and pedestrians need clear guidance and information on where to walk and where to cross.

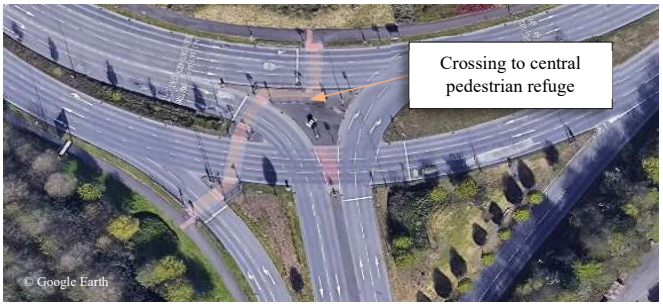

Figure 2: Pedestrian facilities at a DRT in Swindon, Wiltshire, UK.

Another consideration for the XT design is that pedestrians may not be aware of which direction the traffic is coming from as they traverse the splitter and refuge islands. In Swindon for example, the highway authority has provided pedestrian directional road markings and provided tracts of pedestrian guard railing to channel pedestrians in the desired direction. While there is a general move away from guardrail in recent years in pursuit of an uncluttered urban environment, the decision to include or exclude of guard railing should be guided by the findings and recommendations of a Road Safety Audit.

Cyclists: Cycle-friendly design should aim to minimise cycle-vehicle conflicts, provide appropriate lateral clearance between vehicles, cycles and pedestrians, minimise speed differentials between different modes, and manage potential conflicts. The XT junction must therefore provide clear and visible lane markings and signage, provide for fully segregated cycling

facilities wherever possible, and consider the comfort of cyclists by providing a smooth riding surface, avoiding steep gradients, and minimising conflicts with turning vehicles.

At the XT junction, there are a few basic design options to accommodate cycling. These options include the provision of:

- **Segregated cycle path on the outside of the carriageway**: this could be a two-way or a one-way bicycle network as shown in Figure 3. While the former is preferable, the latter design can be used when there is not enough space to accommodate two-way operation.

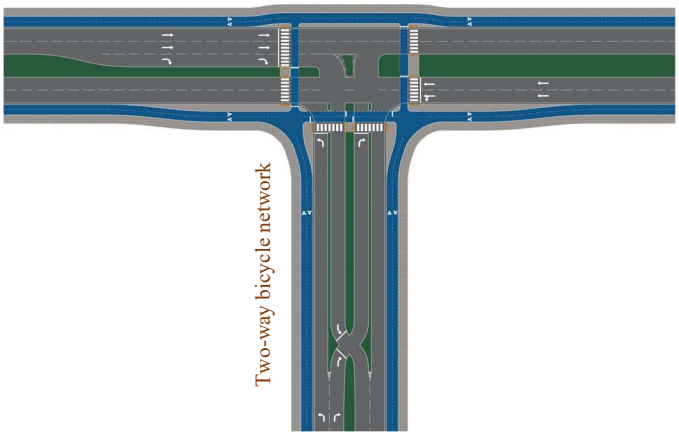

Figure 3: Dedicated cycle lanes on the outside of the carriageway.

- **Segregated cycle path on one side of the carriageway:** This design is suitable when available space is limited or in response to a uni-directional nature of cycling destinations and desire-lines as shown in Figure 1.

- **On-carriageway cycle lanes:** Suitable when the traffic volumes and vehicle speeds are low. Cyclists would follow the vehicular signals at the crossover and the main junction. The introduction of advanced stop lines to improve conditions for cyclists can also be considered. However, this option is not recommended for both typical T junctions and the XT junction if traffic volumes are high.

XT Analysis

To evaluate the capacity and cycle time benefits of the XT junction, two different layouts namely "large" and "small" junction configurations have been tested as shown in

Figure 4 and Figure 5.

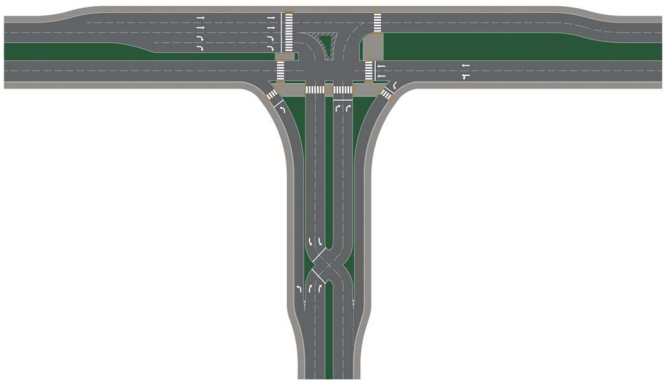

Figure 4: Large junction design.

Figure 5: Small junction design.

To benchmark the capacity savings and signal cycle time optimisation, it was proposed to test multiple scenarios as outlined in Table 1. Four options with varying degrees of active travel provision on a standard T Junction and XT Junction were tested for a like-to-like comparison. An additional test with a straight pedestrian crossing option on the small layout was also carried out.

Table 1: XT junction tested design features.

	Large Junction Layout	Small Junction Layout
Op 1	Advance cycle stop line (ASL) + Toucan crossing	ASL + Toucan crossing
Op 2	Toucan crossing only	Toucan crossing only
Op 3	Partial crossing (one side of a major road)	Partial crossing (one side of a major road)
Op 4	No crossings	No crossings
Op 5		Straight crossings

LinSig models for the standard T junction and XT junction were developed for each of the scenarios listed in Table 1. Signal time optimisation for Practical Reserve Capacity (PRC)

Table 2: Delay and PRC results of the junction models at 144s cycle time.

		Traditional T Junction		XT Junction		
	Option	PRC	Delay (sec)	PRC	Delay (sec)	Spare Capacity
Large Junction	Op1	-2%	57	11%	42	13%
	Op2	-1%	50	17%	39	18%
	Op3	-1%	49	24%	36	25%
	Op4	3%	41	37%	32	33%
Small Junction	Op1	-3%	43	23%	31	26%
	Op2	-1%	40	24%	29	26%
	Op3	-1%	39	27%	27	28%
	Op4	2%	34	32%	24	30%
	Op5	-3%	42	20%	31	23%

was carried out at 144 sec cycle time for both the standard T junction and XT junction to realise the delay and PRC savings.

Further cycle time optimisation was carried out on the XT junction to realise the cycle time savings with a targeted traffic flow of 3,900 PCU/h for the large junction layout and 2,800 PCU/h for the small junction layouts. These volumes typically represent the situation where the Standard T Junction would start to operate at full capacity. The staging and phasing of the standard T junction and the XT junction were replicated as close as possible to enable a like for like comparison. The XT junction has an additional signal stream with two phases to switch the traffic over on the minor arm.

As shown in Table 2. the modelled XT junction results in a spare capacity of between 13% to 33% in comparison to a standard T junction - depending on the layout tested and the degree of active travel facilities provided at the junction. This spare capacity could either directly benefit capacity, congestion, and delays at the junction, but conversely could be used to improve crossing time and clearance allowance for active travel modes, or, depending on local site characteristics and priorities, a combination of the two.

"The XT junction increases capacity by up to 30% compared to a typical T Junction."

Further signal cycle time optimisation has been carried out on the XT junction to understand the cycle time savings. Figure 6 and Figure 7 show the cycle time savings on the XT junction. It can be observed that the XT junction results show a minimum of just under 20% cycle time saving and a maximum of 100% cycle time saving based on the active travel provision provided at the junction.

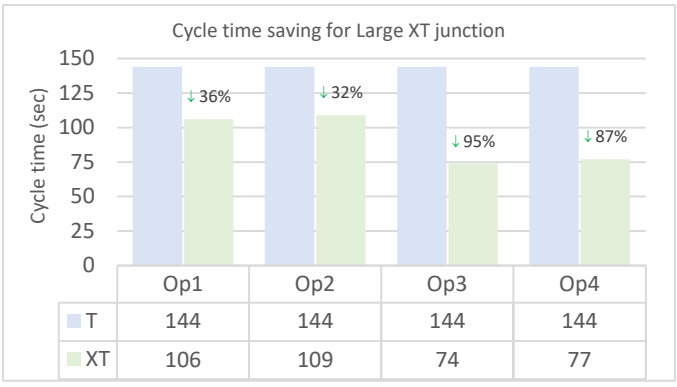

Figure 6, Cycle time saving for XT junction.

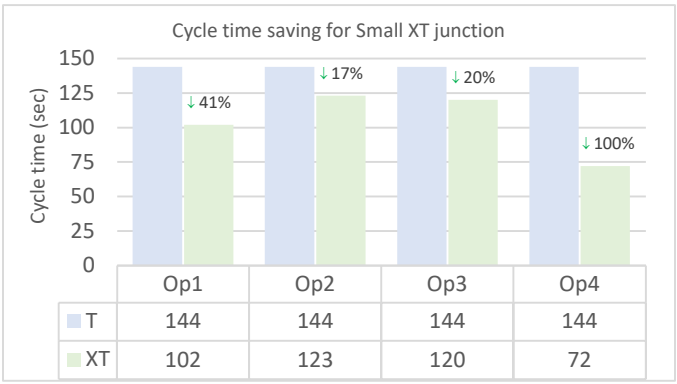

Figure 7, Cycle time saving for XT junction.

Further modelling forecasts that the XT junction would reduce CO_2 emissions by 10% for non-congested existing T junctions and by more than 35% for congested T junctions.

Figure 8 shows the results of modelling using traffic analysis software which compares the average CO_2 levels resulting from traditional T-junctions compared with the predicted average CO_2 emissions from the XT junction design. The graph shows that CO_2 levels are predicted to be lower with the new design.

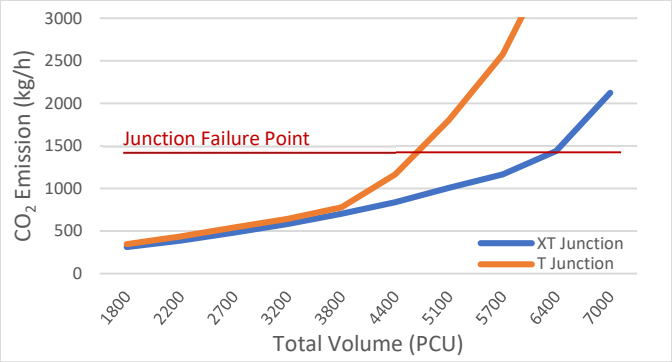

Figure 8: CO_2 comparison graph.

Safety

While the accident statistics for the two existing DRT junctions suggest broadly that accident rates have improved at these locations since their implementation, it is clear that UK currently has insufficient real-life examples from which to deduce any reliable safety correlations in terms of having a robust statistical sample size. Chick and Simmonite's 12 hours post-opening observations of conflict points at the Swindon DRT and a nearby standard T junction concluded that the greater incidence of conflicts observed at the DRT were likely to be a result of insufficient road markings and signage, which, once mitigated, should mean that number of conflict incidents at the DRT should be equivalent to that of a traditional highly trafficked intersection. Indeed, it should be expected that the reduction in conflict points inherent in the XT design is likely to result in a safety improvement correlation. Of course, local factors will play an important part in determining the extent to how his can be achieved. To achieve optimal performance in terms of both operation and safety, there will always be factors related to aspects such as sight lines and visibility splays, topography, design speed, speed limits, numbers of active travel users, signing and lining, and signals layouts and timings that may need to be adjusted from the design stage right through to post-implementation.

When considering issues of overall safety in the context of proposals to introduce an XT junction solution, a particular emphasis will be placed on how the two 'unconventional' features of the traffic crossover ('X') and the unopposed right turns at the main junction will operate, and how these features will be 'read' by vehicle drivers and those using active travel modes. Clear signage, traffic signals and road markings will play an important part in ensuring that the approach and transit through the junction is a seamless experience for all users. However, to the extent that attendant signs, road markings are required for the XT junction, the aim should be for these to only act in confirming the priorities and rights of way to users who have already been safely and seamlessly guided through the junction by virtue of a self-reading geometrical design and a well-designed traffic signals layout.

XT Distance

The position of the XT crossover is highly dependent upon the spacing and location of the adjacent junction. Queue storage demand must also be addressed in determining the XT distance. There is flexibility in placing crossovers when there is sufficient space available. However, the XT distance between the crossover and main junction is influenced by queue storage requirements, crossover curve design, skew angle, and other constraints.

The XT distance is crucial and plays an important part in the coordination between the signal nodes, Despite the attempt by Chick and Simmonite to develop an equation to show the flexibility of in-cycle time and displacement of the crossover node, there are no equations or guidelines to calculate the minimum/maximum design distance between the crossover and the main junction and further research is required to explore this area in depth. Federal Highway Administration, AIIR (2010)[9] recommended that the upstream crossover distance to the main intersection for a CFI/DLT should be between 300 and 400 feet (91m-122m).

Pitaksringkarn et al. (2011) [11], studied the CFI by using traffic microsimulation to determine the optimum distance for a four-leg intersection. They stated that an increase in traffic volume entering the intersection resulted in longer delays. To mitigate this, they recommended that the CFI right-turn crossover position be located further from the main intersection. In addition, they suggested a minimum distance of 60m for a volume of 2,500 PCU/h and 150m for a volume of 3,500 PCU/h when there is no length limitation.

Qi et al. (2017) [13], conducted an assessment to evaluate the operational impacts of the DLT crossover distance in their study concerning the use of innovative intersection designs to improve mobility and reduce congestion. Their simulation results showed that as the crossover distance increased, the average delay at the intersection decreased. Furthermore, when the left turn crossover distance was increased to 400ft (122m) or more, there was a slight decrease in delay as the distance continued to increase. Qi et al. recommended a crossover distance of around 400ft subject to construction cost and available space'.

Both Pitaksringkarn et al. and Yi Qi et al. emphasised the importance of the crossover position and its influence on the capacity and efficiency of the CFI traffic operation and acknowledged the lack of comprehensive design guidelines and that more research is needed to support the existing materials.

Challenges in Implementing an XT Design

Designing and implementing an alternative intersection such as an XT junction can be complex and challenging. Some of the challenges include:

- **Public acceptance** can be a challenge because an XT design is likely to be a new concept to the public.
- **Design configuration** can present challenges such as ensuring proper sight lines for drivers. ROW and property acquisition may be required and can be a complex process.
- **Coordination with agencies and organisations** is necessary to obtain permits and approvals.
- **Multimodal design,** integrating all transport modes into an XT design can also be challenging.
- **Proximity junctions** can impact the ability of an XT junction to process traffic efficiently because of queue tailbacks from the nearby junctions.
- **Funding** for a project can also be a major challenge.

SOCIAL OUTCOMES

The purpose of this Social Impact (SI) Analysis is to present the findings of the assessment of possible social impacts of implementing the XT Junction design in place of more traditional three-arm T junctions. The XT junction is a rare design and has only been implemented in two known locations in the UK. The analysis is based on theoretical case studies only the social impacts that have been considered as the basis to this analysis are: accidents, health, severance, journey quality and accessibility, which are summarised below:

Accidents

Potential reduction in road accidents:
- Reduced conflict points.
- Reduced speed through X curvature.

Potential reduction in pedestrian and cyclist accidents:
- Segregated cycle lanes.
- Signalised crossings.

Physical Activity

Reduction in non-communicable diseases:
- Increased physical activity.
- Reduction in CO_2.

Severance

Slight decrease:
- Only if active travel is incorporated.

Journey quality

Initial increase in user stress:
- Seemingly complex design.
- New layout.

Decreased journey times:
- Reduced congestion.
- Increased capacity.

Accessibility

Decreased accessibility:
- If active travel not incorporated, non-motorised users would struggle more.
- Greater cognitive load for those with learning difficulties.

Increased accessibility:
- Less congestion eases sense of isolation.
- Active travel includes everyone.

In summary, it is expected that the XT Junction design will have beneficial social outcomes, when compared with a traditional T junction. This is due to the crossover (X) feature leading to reduced conflict points and potentially increasing road safety and reducing accidents, whilst reducing operational CO_2 emissions, and creating potential for cumulative health benefits within local communities. The estimated average capacity increase of 30% should also improve journey quality by slightly decreasing congestion and journey times. In addition to this, a reduction in congestion could slightly increase accessibility, helping to tackle feelings of loneliness and social isolation in the community. Ultimately, however, the above benefits would only be slight, if not at all, based upon the use of only one XT junction in a locality due its triviality relative to the wider highway network. XT junctions would have to be rolled out on a much larger scale to replace T junctions throughout a locality or geography for a tangible beneficial social impact to be realised.

Furthermore, the additional benefits listed above are in part or wholly reliant on the inclusion of active travel and pedestrian infrastructure. Therefore, if these features are not included in the implementation of an XT junction, social impacts would be greatly reduced.

As the XT junction is currently in the early stages of research and development, and the existing UK continuous flow intersections are mainly predicated on the principle of improving vehicular traffic flows, it would be appropriate to re-assess the social outcomes if it were to progress to implementation within a project or scheme. With a location-based study area for the XT junction, a more extensive assessment could look further into the equality and distributional impacts on different characteristic groups within the locality that are protected under the Equality Act.

CONCLUSION

This report has investigated the potential benefits and disbenefits of The XT junction concept - a new Displaced Right Turn junction design, reimagined and re-engineered to meet a modern transport agenda and in support of the UK's aspiration of net zero carbon emissions by 2050.

While additional work and/or testing and practical trials are required to definitively establish the safety credentials of the XT design, this study has determined that it may be possible to better use the capacity benefits inherent in the DRT concept to deliver benefits to both active travel users and vehicular drivers in a more equitable and holistic way.

The principal advantages over an equivalently sized conventional T junction are:

- Reduced congestion and delay – up to 33% capacity improvement.
- Up to 100% traffic signal cycle time savings.

- Reduced conflict points – which should lead to improved safety.
- Improved conditions for active travel modes.
- Reduced severance due to improvements to pedestrian crossing facilities.
- CO2 emissions cut by 10% for non-congested T junctions and 30% for congested T junctions.
- Also delivers similar congestion relief benefits as bridges/flyovers or tunnels for much less cost.

Some potential disadvantages:

- Confusion – especially among vulnerable user groups.
- Potential for greater land requirement.
- May be more costly than conventional means of improving standard T junctions.
- Limited UK evidence around safety available.
- Greater uptake required for delivering tangible social outcomes.

Like all traffic engineering solutions, the viability of a fully configured XT junction that caters for all modes will be highly dependent upon location specifics such as available land, local priorities and policies, pedestrian and cycling demand, safety record and economic evaluation/business case. The extent as to how much this will be achieved is also highly dependent upon the land available. The land requirement can be even greater when there is a need for active travel infrastructure such as pedestrian crossings and cycle lanes/paths. However, an XT/DRT – type junction solution can often only require about as much land as that required for a large roundabout.

In this respect, there are likely to be numerous additional locations in the UK which currently suffer congestion, severance, poor active travel provision, and safety issues that could benefit from the introduction of an XT junction solution.

ACKNOWLEDGMENT

We would like to express our sincere gratitude to the Future Transport Vision Group and the Rees Jeffreys Road Fund for their generous support and funding of our project. Their contributions have been invaluable in helping us achieve our goals and we are deeply grateful for their assistance.

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