A Different Approach to Quantifying Junction Modelling

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Introduction

Transport planning is a wide reaching industry, influencing how people travel and assessing how the movements of the population affect the world around us. A key role within this industry is ensuring the sustainability of new development in relation to traffic and transport. New development should ensure access for all, encourage active and sustainable forms of travel, and ensure that the local transport network continues to operate safely and without undue delay.

The National Planning Policy Framework (NPPF), which has recently been updated, sets out the Government's planning policies for England and how they are to be applied by Local Planning Authorities. In relation to transport, Paragraph 109 of the NPPF states that '*development should only be prevented or refused on highways grounds if there would be an unacceptable impact on highway safety, or if the residual cumulative impacts on the road network would be severe*'.

Given this, a primary role for transport planning consultants is to identify, assess and, if required, mitigate the impact of the development on the local highway network. Junction capacity modelling is a useful tool in quantifying and assessing the potential traffic impacts of a development on the roads which surround it.

Capacity Modelling

Where a new development is likely to have significant transport implications, a Transport Assessment (TA) should be prepared and submitted alongside an application for planning permission. A TA is a comprehensive document that sets out the transport implications of a proposed development, and, where appropriate, will identify measures to mitigate any negative impacts to improve the local transport conditions.

Transport Assessments cover a wide range of topics; however, often one of the key areas of concern to the general public is the impact a development will have on the local road network. It is common for TAs to assess this impact through the use of junction capacity modelling, which, on a localised scale includes the use of PICADY (priority junctions), ARCADY (roundabouts) and LinSig (signal junctions) models, with wider scale assessment undertaken through the use of microsimulation models such as VISSIM.

It is common practise to model three scenarios:

- **Do Nothing** – existing network traffic, generally taken from traffic count data, plus any permitted or allocated site traffic which is likely to come forward within the assessment period;
- **Do Minimum** – 'Do Nothing' plus the proposed development flows; and
- **Do Something** – 'Do Minimum' plus any proposed mitigation.

The ‘Do Nothing scenario’ will be assessed for the year of submission, as well as for an agreed future year (generally five or ten years from submission). The ‘Do Minimum’ and ‘Do Something’ scenarios will be assessed for the future year only, representing the network once the proposed development is complete.

The data for each of the above scenarios forms the basis of a capacity model, alongside junction geometry and signal timing data in the case of LinSig. The software collates all of this information to identify how the junction is currently operating, and how this is anticipated to change within each scenario. The models each provide key outputs, which, in the case of LinSig are as follows:

- **Degree of Saturation (DoS)** – the DoS is a ratio of demand to capacity for each traffic phase, with a value of 90 percent indicating that an arm is at practical capacity;
- **Practical Reserve Capacity (PRC)** – the PRC is calculated from the maximum percent DoS and is a measure of how much additional traffic could pass through the junction as a whole; and
- **Mean Maximum Queue (MMQ)** – the MMQ provides an indication of how the overall junction performance may affect adjacent junctions on the highway network.

The output reports are appended to the TA, with a summary provided within the TA outlining the key impacts of the proposals on the assessed junctions.

It is acknowledged that the primary focus of a TA in this regard is to provide a technical summary of the likely impacts of the development proposals. The report is therefore aimed at transport professionals, who have an in-depth understanding of capacity modelling and are capable of interpreting their results; it is the Highways Officer who provides a recommendation on whether the application should be granted or refused on transport grounds.

However, this approach does mean that other stakeholders and consultees are often unable to fully appreciate the technical detail presented. This often leads to claims of deception and a lack of trust between the general public and transport consultants. It is therefore considered that alternative approaches to conveying the results of Transport Assessments are required.

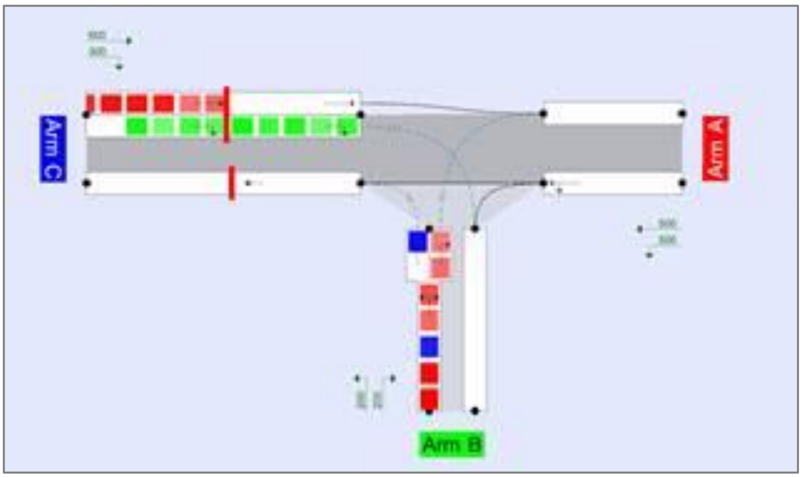
<u>Doing it Better</u>

Target Audience / Communication

As outlined above, the key audience of a TA is the Local Highway Officer. However, it is important to remember other stakeholders such as members of the public, local businesses, and members of parish and local councils. Each of these stakeholders has a right to access and understand how the impacts of a new development will affect them, and in the case of councillors, their constituents.

It is therefore considered that the information provided by capacity models should be provided in a more accessible format. People understand information best when it is presented to them in a way in which they can relate. Consequently, it is considered that outputs such as driver delay should be communicated in such a way that the majority of the general public can understand. For example, it is much easier for someone to understand that their journey time through a junction will be increased by ten seconds as opposed to being told that the Ratio of Flow to Capacity will increase by five percent.

In conjunction with this, infographics could provide a better illustration of how the local highway network will be impacted. For example ARCADY software provides a simulation of how a junction will operate, as shown in the image below:



This enables a better understanding of how the additional traffic related to a development will impact the local network.

It is noted that within Environmental Impact Assessments, a key component is a Non-Technical Summary. This is something that could be included within TAs, providing an obvious place to provide a more 'user-friendly' summary of the transport impacts of a development.

Transport Economics

Another option to improve the understanding of the transport impacts of a development is to use the results of a capacity modelling exercise to inform a cost-benefit analysis. In summary, this involves identifying how improvements to local highway infrastructure can benefit the local economy, ultimately improving the lives of local people.

The primary analysis tool used within transport economics is that of journey time savings. This represents the value that a traveller places on saved journey time, which could be re-allocated to other, possibly more productive uses. The value of travel time is typically quantified in pounds per hour, and these values are then factored up or down to reflect reliability and other aspects of the quality of the journey i.e. traffic conditions.

The Department for Transport (DfT) utilise software known as TUBA (Transport Users Benefit Appraisal) to undertake complex economic appraisals of transport schemes. However, alternate approaches are also used within the industry.

The DfT's Transport Analysis Guidance (TAG) Unit A1.3: User and Provider Impacts, provides guidance on how impacts on transport users and providers should be estimated, valued and reported in transport appraisals, assigning a monetary value to travel time savings for working and non-working time.

The value of non-working time is subjective, and dependent on each individual. The values outlined above are based on research conducted by the Institute for Transport Studies and Accent for the DfT.

Other considerations which should form part of any appraisal include:

- **Willingness to pay** – the cost an individual is willing to accept to achieve a quicker, more pleasant or more reliable journey;
- **Value of time multipliers** – i.e. people are willing to pay more to save time spent in certain conditions e.g. congestion;
- **Increases in values of time over time** – within TAG, values of time are assumed to increase with income over time with an elasticity of 1.0;
- **Values of time per vehicle** – considers vehicle occupancy rates;
- **Vehicle operating costs** – including both fuel and non-fuel operating costs;
- **Reliability** – variation in journey times that individuals are unable to predict; and
- **Impacts during construction and maintenance** – the costs to users due to construction and potential future maintenance.

As noted, when assessing journey time savings, there is an emphasis on business journeys, i.e. those trips undertaken for the purposes of work. However, non-work journey time savings can also be achieved, such as commuting and travel for social or leisure purposes. These types of journeys are much harder to quantify, and are therefore often given less weight within economic appraisals. However, it is important to include these journeys within an assessment, as arguably, these savings have a greater value to individuals.

However, caution should be given to focussing solely on non-work time savings. If values of time are based on an individual's willingness to pay which are related to income, then it is likely that investment decisions will be biased towards those measures which benefit travellers with higher incomes. This could mean that low income areas may lose out on much needed infrastructure, when arguably these locations stand to benefit the most.

Assigning a monetary value to the assessment of traffic schemes enables a better understanding of the benefits a scheme can bring. However, it is important to remember that traffic schemes can also lead to a number of other benefits (or disbenefits) which should also be considered. These include social factors such as severance and environmental factors such as noise and air quality. Within current assessment methods, these factors are often given little consideration when compared with journey time savings. However, going forward it is considered that these aspects will become more prevalent, with a growing number of users opting to travel by sustainable modes.

Case Study – Linton Crossroads, Maidstone

DHA Transport was recently tasked with providing a high-level appraisal of the economic benefits arising from proposed capacity enhancements at the A229 Linton Hill / B2163 Heath Road 'Linton Crossroads' junction, near Coxheath in Maidstone, Kent. The appraisal was based on the outputs of junction capacity modelling of the existing and proposed junction layouts, and assigns a monetary value to the travel time savings arising from the scheme. The junction in its current form is shown in Figure 1 below.

Figure 1 Linton Crossroads (Courtesy of Google Earth)

An improvement scheme for the junction was proposed by Maidstone Borough Council. However, as part of a local development application, a private land owner was able to enhance this design through the provision of additional land at the junction. An indicative plan of the improved scheme proposal is shown below, with the additional land outlined in pink.

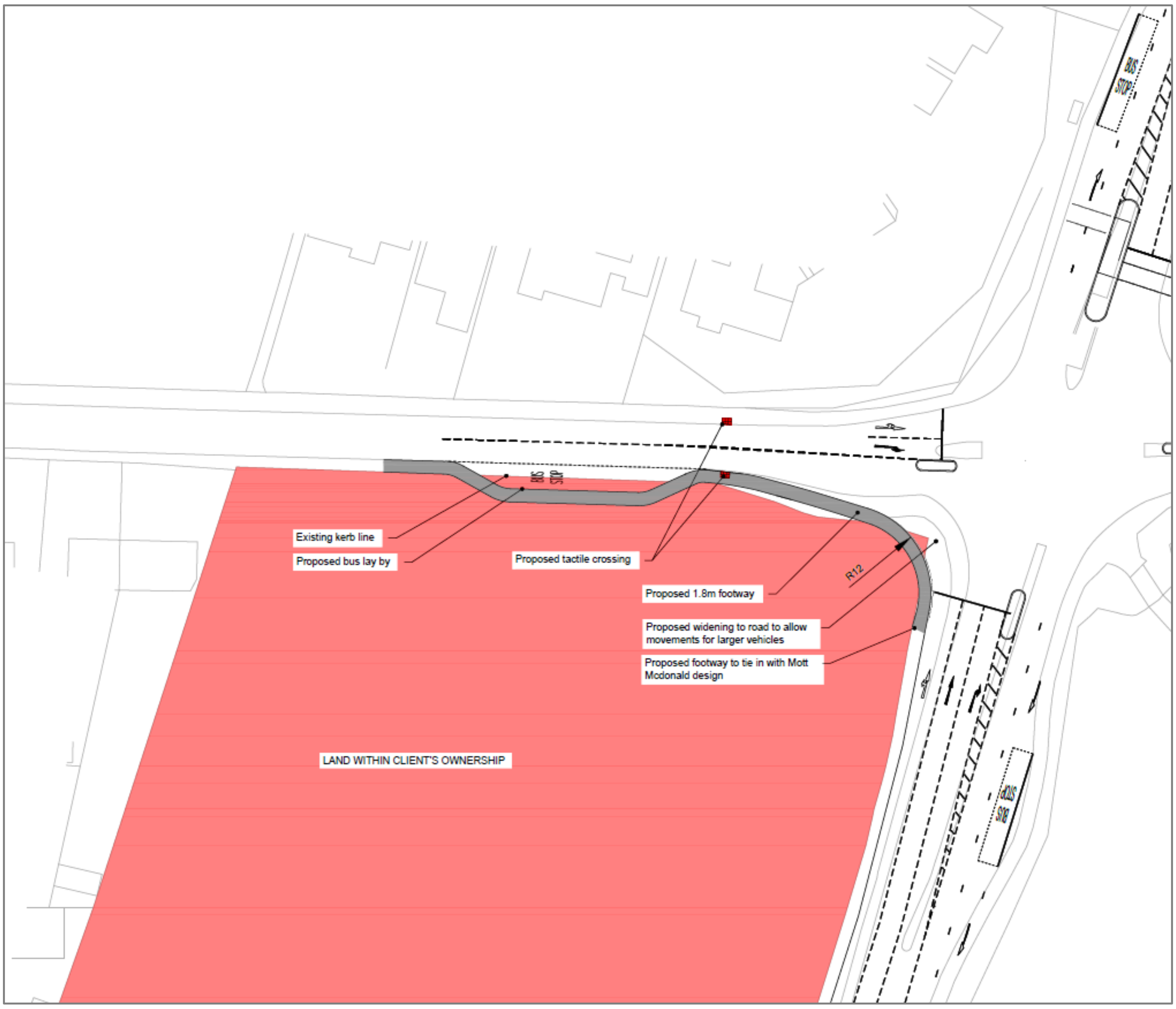


Figure 2 Linton Crossroads Improvement Scheme

The existing and proposed junction layouts were subject to capacity modelling by JCT Consultancy Ltd for the future year of 2021 and included base traffic, committed development traffic and traffic associated with the aforementioned development proposals.

Table 1 below outlines the results of this assessment for the existing junction layout in the 'Do Minimum' scenario. 'Worst DoS' represents the highest DoS in any one lane, while the MMQ figure is presented in Passenger Car Units (PCUs) which is the unit of measure for single cars.

Arm	AM Peak		PM Peak	
	Worst DoS	MMQ (pcu)	Worst DoS	MMQ (pcu)
A229 Linton Hill	102.0%	41.6	124.4%	133.8
A229 Linton Road	105.7%	65.1	92.4%	27.5
B2163 Heath Road (W)	112.0%	59.8	103.3%	42.1
B2163 Heath Road (E)	112.5%	67.9	277.8%	243.0
Cycle Time	160		160	
PRC	-25.0%		-208.6%	
Delay (pcuHr)	166.59		380.41	

Table 1 Capacity Assessment Summary - Linton Crossroads 2021 Do Minimum (Existing Layout)

The 'Do Something' scenario was subsequently considered, accounting for the proposed junction enhancement scheme outlined above. The results of this assessment are shown in Table 2 below.

Arm	AM Peak		PM Peak	
	Worst DoS	MMQ (pcu)	Worst DoS	MMQ (pcu)
A229 Linton Hill	76.1%	7.8	80.3%	10.7
A229 Linton Road	81.5%	10.1	64.3%	7.0
B2163 Heath Road (W)	82.1%	10.5	71.1%	8.5
B2163 Heath Road (E)	78.0%	14.5	79.8%	14.6
Cycle Time	90		90	
PRC	9.6%		12.0%	
Delay (pcuHr)	31.23		29.85	

Table 2 Capacity Assessment Summary - Linton Crossroads 2021 Do Something (Proposed Layout)

Significant capacity improvements were observed across all arms of the junction, with overall PRC increasing by 34.6 percent in the AM peak hour and 220.6 percent in the PM peak hour. During the AM peak hour vehicle delay reduces by 135.4 pcuHr (pcuHr representing the aggregate delay to all traffic on the route caused by queuing), with an even greater reduction experienced in the PM peak hour. It is acknowledged that models often exaggerate delay once capacity is reached, and therefore the results of this exercise need to be considered in respect of this.

Utilising the DfT's Transport Analysis Guidance (TAG) Unit A1.3: User and Provider Impacts, the monetary value of the average delay experienced by vehicles at the junction with the existing and proposed layouts in place can be quantified. The difference between the two figures equates to Total Economic Efficiency.

Table 3 below outlines the proportions of trips made in work and non-work time by percentage, based on Table A1.3.4 of the TAG methodology. For the purposes of this assessment and for ease of analysis, it was assumed that all vehicles utilising the junction were cars. This was considered appropriate given the low level of Heavy Goods Vehicles (HGVs) and Public Service Vehicles (PSVs) recorded to be routeing through the junction (6 percent and 4 percent of total movements respectively). Moreover, this provided for a robust assessment of economic impact, in that the average market price values of time per vehicle, based on distance travelled, are significantly higher for HGVs and PSVs than for cars. This is principally due to their greater work-related use compared to cars.

		7am-10am	10am-4pm	4pm-7pm	7pm-7am	Average	Weekend Average	All Week Average
Car	Work	6.8	8.3	5.5	3.6	6.5	1.7	5.0
	Commuting	40.6	11.6	32.3	26.4	25.4	9.1	20.3
	Other	52.7	80.1	62.2	70.0	68.1	89.3	74.7

Table 3 Summary of TAG Table A1.3.4 - Percentage of Vehicle Trips by Journey Purpose by Time

Table A1.3.6 of TAG assigns each journey purpose a monetary value, which is summarised in Table 4 below for the years 2010 and 2021. The 2021 figures have been used in this appraisal.

		2010		2021	
		7am-10am	4pm-7pm	7am-10am	4pm-7pm
Car	Work	31.6	30.3	36.4	35.0
	Commuting	7.8	7.7	9.0	8.8
	Other	10.1	10.7	11.4	12.2

Table 4 Summary of TAG Table A1.3.6 – Market Price Values of Time per Vehicle Based on Distance Travelled (£ per hour, 2010 prices)

Using the LinSig modelling results, the total number of vehicles routeing through the junction and the average delay per PCU has been considered. The total delay has been factored to account for journey purpose, and multiplied by the relevant monetary values in Table 4 above. These figures have then been factored by 253 to represent the annual value. This figure removes both weekends and bank holidays, as the traffic demand experienced on these days is generally lower than that experienced on a typical weekday. The resulting figures are shown in Table 5 below.

	Do Minimum	Do Something	Difference
AM Peak	£ 510,071.04	£ 95,604.50	£ 414,466.54
PM Peak	£ 1,188,321.45	£ 93,207.86	£ 1,095,113.59
Total peak saving			£ 1,509,580.13

Table 5 Travel Time Saving Benefits - Linton Crossroads

The results of the appraisal demonstrate that whilst the junction proposals have the potential to ease traffic movements through the junction, they also have the potential to achieve travel time savings worth £1,509,580.13 in the AM and PM peaks of 2021. This figure is based purely on savings relating to travel time and does not account for wider economic, social or environmental benefits.

Discussion

It is acknowledged that there are issues with the current methods used in communicating the results of capacity modelling. These primarily relate to the technical nature of reports inhibiting those with limited technical knowledge from fully appreciating the potential impacts of proposed development.

It is considered that whilst reports need to cover the technical transport issues, it is also possible to present this information in a non-technical way, to ensure that all key stakeholders are able to fully comprehend the results and understand how development may impact their day to day lives. As noted, this can be done by simply emphasising certain aspects of modelling results, such as vehicle delay. By presenting data in a way in which people can relate, the general public are more likely to engage positively in planning discussions and trust the information that is being provided. This approach will be most effective when considering existing junctions which may be impacted by proposed developments.

This method can be taken one step further when considering junction improvements schemes proposed to mitigate the impact of development. Using transport economics, a value can be assigned to journey times of vehicles routeing through a particular junction, based on a number of parameters including journey purpose and vehicle operating costs. Using the results of the junction modelling, the reduced delay resulting from a junction improvement scheme can be assigned a monetary value. This economic saving can then be communicated as benefits of the scheme, alongside any other improvements such as journey time reliability and air quality enhancements. Again, these are factors to which the general public, and local stakeholders can relate and offer key selling points of a scheme. In particular, this information could be useful to parish and local councillors, who in turn will be able to outline how these economic savings will benefit their constituents.

Whilst it is acknowledged that there are still limitations with this approach, it is considered that it offers a novel and inclusive approach which can only enhance the way in which transport planners communicate the benefits of mitigation schemes.