Active Travel Oriented Development: Assessing the suitability of sites for new homes

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Abstract: The location of new housing developments, and the provision of safe space for walking and cycling to key destinations around them, have major and long lasting impacts on travel behaviour, health, and environmental outcomes. Transit Oriented Development (TOD) is a well-recognised concept in urban planning, but systemic evidence is often lacking on the likely ‘active travel performance’ of new developments, making it hard for the planning process to support sustainable transport objectives. This paper articulates the concept of ‘Active Travel Oriented Development’ (ATOD) and describes methods for operationalising it. We demonstrate the use of a set of simple metrics to assess the active travel performance of new and proposed development sites. ATOD has the benefits of building on the established concept of TOD and being easy to assess. We conclude that ATOD, and tools for measuring it, are needed to ensure that transport and development policies work in harmony.

1 Introduction

The transport sector now represents the largest single source of carbon emissions in the UK (Department for Transport 2021b), and since 1990, countries across Europe have converged towards high levels of road transport emissions (Marrero et al. 2021). Paris Protocol signatories have agreed to restrict anthropogenic climate change to 2°C above pre-industrial levels (UNFCCC 2015), requiring action across all sectors of the economy. This means stronger action is now required to reduce transport emissions (Axsen, Plötz, and Wolinetz 2020; Brand et al. 2020).

Travel behaviour varies greatly at local and regional scales, with car dominance often being greater in rural areas (Gray et al. 2001). This underlines the importance of place in influencing our travel patterns and behaviours. One of the most fundamental ways in which we shape places is through the construction of new homes and residential neighbourhoods.

1.1 Residential development and active travel

The need for residential development has risen up the political agenda in countries such as the UK, and raising housebuilding rates is a cornerstone of UK government policy (MHCLG

2017a; 2017b). Current Planning Practice Guidance on Local Housing Need (MHCLG 2020a) sets out a housing need in England of around 300,000 new homes per year, a 68% increase on the 178,000 homes completed in 2019 (MHCLG 2021).

These new homes will shape the communities of the future. Decisions surrounding their location and design will have long-lasting impacts on our ability to meet policy objectives such as the UK government commitment to becoming zero carbon by 2050 (BEIS 2020). They will influence the lifestyles and choices available to future residents, including whether they are able to walk, cycle or wheel within their local neighbourhoods and on journeys to key trip attractors such as shops, schools, workplaces and public transport hubs.

In the UK, as in many countries, planning and transport policies have tended to be developed in isolation from one another, despite the clear linkages between them. The UK Government has recently published a transport decarbonisation plan which includes the aim for 50% of all journeys in towns and cities to be walked or cycled by 2030 (Department for Transport 2021a). New cycle infrastructure design and policy guidance will help enable these changes (Department for Transport 2020a; 2020b). However, there is little recognition of the role that planning policies might have in helping or hindering those objectives (MHCLG 2020b).

The National Planning Policy Framework emphasises the need to put new homes in locations that allow for "limiting the need to travel" (MHCLG 2019a), and National Planning Policy Guidance states that proximity to public transport and services can be recorded as part of assessing sites in the allocation process (MHCLG 2019b), but no set methodology nor distances are recommended. As a result, consideration of proximity in allocating sites for new homes, particularly of walkable distances, has taken a piecemeal approach across England (Streb, pers. comm.). Without careful consideration of the location and design of new residential developments, this risks exacerbating urban sprawl and the distances travelled, particularly by private car (Oueslati, Albanides, and Garrod 2015). This could result in increasing transport emissions at a time when they need to fall rapidly.

The construction of homes in places with poor provision for active travel and public transport risks deepening inequality and transport poverty for social groups such as those on low incomes (Gates et al. 2019) and people with disabilities (Schreuer et al. 2019). It also impacts those in precarious housing or employment situations, who may have limited choice over their home and work locations. This can force into car ownership people who would otherwise be expected to find it unaffordable (Mullen, Marsden, and Philips 2020).

For most people, acceptable journey distances for active travel are relatively low. In the UK, analysis of adults living in suburbs and satellite towns showed a steep drop in walking rates beyond 800m (Barton, Horswell, and Millar 2012). Although there are some differences across countries, the picture is largely similar. In the Netherlands, 85% of older people walked less than 2 km for grocery shopping trips (Prins et al. 2014). For daily shopping trips in Spain, 55% would walk over 15 minutes, but only 25% would walk more than 20 minutes (Arranz-López et al. 2019). When journeys are short, the vast majority of people will walk (Department for Transport 2018).

In addition to location, the design of residential developments also has important implications for active travel. Within a residential development, the connectivity, or lack thereof, can add considerable distances, particularly to short walking journeys. Within a site, low circuitry of cycling and walking routes suggests well-connected, legible street patterns that are easy to navigate (Randall and Baetz 2001). The comparative directness of routes by foot, by bicycle

and by car can also be used as an index of filtered permeability (Melia 2008). Links across site boundaries are important because new developments are often poorly connected with their immediate surroundings, which can harm prospects for active travel.

1.2 The concept of Transit Oriented Development

Attempts at the integration of planning and transport have a long history. Land-use transport models (LUTMs) and the thinking underlying them date back to at least the 1960s (Ford et al. 2018; Holz-Rau and Scheiner 2019; Moeckel et al. 2018). While Transit Oriented Development (TOD) as a concept was coined in the early 1990s (Calthorpe 1993), in practice the first examples were associated with the growth of railways and trams in the mid nineteenth century (Knowles, Ferbrache, and Nikitas 2020). In the mid-twentieth century there was in many places a move towards private car-focused transport, but at the same time a new era of planned TOD also began with Copenhagen's 1947 'Finger Plan' (Knowles 2012). We are now in a third era of TOD, which has seen a range of transit technologies, as well as cycling and bike-sharing, used to support urban regeneration and urban expansion (Knowles, Ferbrache, and Nikitas 2020).

When Calthorpe first outlined the concept of Transit Oriented Development (TOD), he identified the presence of a walkable environment as *"perhaps the key aspect of the concept... More walkable, integrated communities can help relieve our dependence on the auto in many ways other than just transit. Reducing trip lengths, combining destinations, carpooling, walking, and biking are all enhanced by TODs. A healthy walking environment can succeed without transit, but a transit system cannot exist without the pedestrian."* (Calthorpe 1993). As the quote makes clear, mixed land use and the proximity of community facilities to one another and to people's homes, is a vital part of creating a walkable environment, and the built environment also has a strong impact on cycling levels (Zhao 2014).

Public transport remains a core component of integrated transport planning, but with the impact of Covid-19, there has recently been greater recognition of the importance of local neighbourhoods and the need to support active travel (Nurse and Dunning 2020; Considine 2020). The "15 minute neighbourhood" concept, in which key community services such as schools, shops and parks are available within a 15 minute walk or cycle of people's homes (Sallis et al. 2009; Sastry, Pebley, and Zonta 2004), has emerged as a means of improving the liveability of communities. In a French context this is known as *"Ville du quart d'heure,"* as proposed by Carlos Moreno in 2016 and applied in cities such as Paris (Moreno et al. 2021). The benefits of this go far beyond reducing carbon emissions, and extend to improving health and wellbeing, safety and social inclusion (Pozoukidou and Chatziyiannaki 2021; Qin et al. 2021).

1.3 Active Travel Oriented Development

In the planning and design of new residential developments, if we apply the principle that housing should be located near to people's everyday needs and in an environment that supports walking and cycling, this can enable the creation of places that are conducive to the healthy lifestyles and climate benefits which active travel confers. We term this Active Travel Oriented Development.

Just as Renne & Wells (2005) and Evans et al. (2007) identified the need for indices defining TOD, there is also a need for a systematic evidence base to enable the integration of transport and planning and support ATOD. Valuable indices developed so far include the spatial multi

criteria assessment approach of Singh et al. (2014), and the walkability indicators of Schlossberg & Brown (2004). However, neither of these focus specifically on the active travel provision and potential of new residential developments, or on walking and cycling routes from new developments to key destinations.

Tools have been developed to assess current and future levels of active travel potential, but these tend to be based on existing travel networks and are thus of limited use when designing interventions to enable walking and cycling in and around new development sites (Larsen, Patterson, and El-Geneidy 2013; Lovelace et al. 2017; Natera Orozco et al. 2020).

Our aim is to develop widely applicable methods that can be used to assess levels of active travel around new residential developments and their potential for improvement. These include a prototype tool and an actionable index that can be used directly to assess walkability and cycleability. Although the case study development sites are all from the UK, the methods are applicable internationally.

1.4 Policy relevance

The research and methods presented here are particularly timely in relation to the UK policy context. Substantial reforms to English planning policy have been proposed by the Ministry of Housing Communities and Local Government (MHCLG 2020b). These could involve, among other measures, a zoning system in which outline planning consent for new homes is granted by default in areas designated as ‘growth’ zones, making it even more important to ensure that the locations of these zones are chosen wisely. This is also an important time in terms of climate change mitigation policies as UK political leaders prepare to host COP26 in Glasgow in November 2021.

We anticipate that scalable methods to systematically assess the walking and cycling potential of new residential developments will be of interest to a wide range of stakeholders working at local, regional and national levels, including researchers, developers and transport and planning officers working in local government.

1.5 The importance of intervening early in the planning process

For analysis of active travel potential to have genuine impact on both site location and design, it must occur at the earliest possible stage of the planning process. In an English context this means feeding into the selection of sites to be taken forward in the Local Plan. It is thus important that tools and methods for assessing active travel can be applied to any location, including sites that have not yet been built and locations where a planning application has not yet been made.

The provision of quality infrastructure or services to support active travel must also happen at an early stage in site construction. For individuals, travel behaviours are most likely to change at the onset of major life events such as moving house or starting a new job (Clark, Chatterjee, and Melia 2016). Therefore, it is important that the capacity for sustainable travel is built into new residential developments from the date the first homes are occupied, rather than being added on several years later. If new developments do not support walking, cycling and public transport from the outset, this risks ‘locking in’ car dependency.

However, it is also beneficial for methods to be applicable to existing sites. This can reveal how close active travel levels at a site are to their theoretical potential, and where there may

be specific barriers or opportunities to improve walking and cycling access. The methods could be used longitudinally to assess changing conditions pre- and post-construction.

1.6 Objectives

Our objectives are to:

- 1) assess walking and cycling provision in the vicinity of planned or proposed residential developments, and highlight barriers that could be overcome;
- 2) assess walking and cycling potential associated with planned or proposed developments, with regard to distance from likely destinations; and
- 3) where possible, to assess the suitability for active travel of the internal layout of a site and its direct connectivity to surrounding neighbourhoods.

2 Methods

In the context of the research and policy landscape presented above, we set out to produce an evidence base that could enable planners to better account for, and support, active travel by intervening in the planning process in favour of developments that will likely boost local walking and cycling levels while preventing car dependency. Recognising that the problem is widespread and international, our aim was to develop methods that could be scaled nationally and deployed in new contexts. Building on research in the field of planning support systems (Pelzer 2017) we aimed to produce measures that are easy to visualise, understand and act on. We have provided a demonstration of these methods in the form of an open source web tool.¹

2.1 Selection of case study sites

As case studies, we selected a sample of 38 large residential development sites. Our selection criteria was that the sites should be large, well known to the researchers (to ensure the results matched with our understanding from site visits and published documents) and diverse, representing both urban and rural sites across the whole of England. All chosen sites had >500 new homes, 84% having >1000 new homes. They represent a diverse range of development types including urban extensions, urban regeneration schemes and new settlements such as proposed Garden Villages. Most of the sites have been profiled as part of two Transport for New Homes reports (Transport for New Homes 2018; 2020), providing a wide range of background information. In most sites, construction remained in progress as of early 2021, while three were completed prior to 2021, and 12 had not yet reached the construction phase. Their locations are shown in Figure 1, reflecting the preponderance of house building in large greenfield sites beyond the Metropolitan Green Belt that surrounds London.

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¹ <https://actdev.cyipt.bike/>

Figure 1: Map showing the geographic distribution of case study sites across England, with symbol size proportional to the number of dwellings when complete and colour showing the proportion of existing commuter journeys made by active travel in the area surrounding each site.

2.2 Planning data

UK PlanIt² is a national database of planning applications based on scraping and aggregating data from the websites of more than 400 planning authorities. The UK has no centralised government dataset of planning applications; the PlanIt dataset enables the methods presented in this paper to be deployed nationwide. Planning applications relate to a wide range of activity and there is no official standardised indication of the type or size of development which is being planned. We used the 38 case study sites to improve the classification of planning application size within PlanIt.

2.3 Demographic and travel data

In the UK, the best available travel data at high geographic resolution are the 2011 Census travel to work origin-destination (OD) data, which formed a foundation of the analysis. We used data aggregated to Middle Layer Super Output Area (MSOA) zones; these have a mean population of around 7800.³ Converting the OD data to desire lines, we used their Euclidean distances and flow data to demarcate a study area around each site, incorporating all desire lines with length ≤ 20 km where the number of journeys by foot, bicycle and car/van drivers met a threshold value. The threshold value was set as $t = d/250$, where t is the threshold value and d is the number of dwellings the site will contain at completion. The cut-off distance was set at 20 km to allow us to capture the vast majority of cycleable journeys.

2.4 Journey routing and road characteristics

² <https://www.planit.org.uk> PlanIt provides an open API, but use beyond the rate limit requires registration, potentially involving a commercial arrangement.

³ <https://data.gov.uk/dataset/2cflf346-2f74-4c06-bd4b-30d7e4df5ae7/middle-layer-super-output-area-msoa-boundaries>

For all desire lines within the study area, we generated cycle and walking routes for journeys to work. We also generated cycle routes for journeys from each site to the nearest town centre, using the English Town Centres 2004 dataset published by MHCLG.⁴ Walking routes were generated as long as the town centre was within 6 km of the site.

All journeys originate from the centre of the site polygon. For journeys to work, the destination is the population-weighted centroid of the appropriate MSOA. Journeys on foot were routed using the Open Source Routing Machine⁵ (OSRM) routing engine. For cycle journeys, we used the CycleStreets.net ‘fastest route’ algorithm, which aims to emulate a likely route option a knowledgeable cyclist might take, by minimising journey time.

The generation of these cycle routes involves estimating the cycleability of route segments. This is determined by factors including road type, cycle path width and surface quality, barriers and obstructions, signage and route legibility, and is lowest on routes with a high degree of traffic stress.⁶ We also calculated the circuitry of the walking and cycling routes as the ratio of total route distance to Euclidean distance from origin to destination.

2.5 Mode shift scenarios

For each site, we generated two scenarios, as illustrated in Figure 2. The 2011 Census data represent baseline conditions. For the Baseline scenario, we recalibrated these data to represent the estimated population, at completion, of the chosen residential development site, rather than the population of the MSOA(s) that the site lies within. For any given OD pair and mode:

$$T_b = \frac{T \square_m * d * hs}{P_m}$$

where T_b is the number of trips in the baseline scenario; $T \square_m$ is the number of trips from the MSOA(s) the site lies within, according to the 2011 Census; P_m is the total population in 2011 of the MSOA(s) the site lies within; d is the number of dwellings the site will contain at completion; and hs is the mean UK household size.

The Go Active scenario represents the potential for increased uptake of walking and cycling, in the presence of high quality infrastructure and sustained investment. We calculated this uptake purely as a switch from car/van driving to walking or cycling. Other modes of travel were kept constant, and no change was made to journeys that already took place by foot or bicycle. We assumed that the journey destinations and total volume of travel remain identical to the Baseline scenario.

⁴ <https://data.gov.uk/dataset/ed07b21f-0a33-49e2-9578-83ccbc6a20db/english-town-centres-2004>

⁵ <http://project-osrm.org/>

⁶ <https://www.cyclestreets.net/api/v1/journey/>

Figure 2: Commute mode shares by distance for the Baseline and Go Active scenarios, showing the uplift in walking and cycling and reduction in car/van driving in the Go Active scenario.

To generate the increased cycle uptake in Go Active, we used the 'Go Dutch' cycling uptake function from the Propensity to Cycle Tool⁷ (Goodman et al. 2019; Lovelace et al. 2017). This represents the proportion of journeys that would be undertaken by bicycle if cycle mode share corresponded with average cycling levels in the Netherlands, controlling for route length and hilliness.

To generate the increased walking uptake in Go Active, we used a set of simple estimations to approximate a distance decay curve. For journeys ≤ 2.0 km in length we assumed a 30% increase in walking mode share; for journeys of 2.0 - 2.5 km length, walking mode share was increased by 20%; for 2.5 - 3.0 km by 10%; and for 3.0 - 6.0 km by 5%.

2.6 Within-site metrics

For sites that were at least partially occupied (and therefore contained internal road networks in OSM), we assessed mean in-site circuitry of walking, cycle and driving routes by creating 20 pairs of random origin and destination points within each site. We generated driving routes for journeys between each pair of points, then reset the point locations based on these results, constraining the points to be directly on the road network. We then generated walking and cycle routes between each pair of points. For comparability, all journeys were routed using OSRM. To assess links that cross site boundaries, we calculated the number of unique locations where cycle routes for travel to work or the town centre crossed the boundary of each site.

3 Results

We are able to assess the suitability of sites for Active Travel Oriented Development, through a set of simple metrics that provide data on existing travel patterns and the future potential for active travel within the vicinity of the site, as well as (where data on internal road networks are available) provision for active travel within the site itself. Our case study sites are listed in Supplementary Information Table S1, while Table 1 shows the chosen metrics with a

⁷ <https://www.pct.bike/>

summary of the site level results. These results are also visualised on a site-by-site basis in our prototype web tool.

Metrics			Min	First quartile	Median	Third quartile	Max
Existing active travel provision in vicinity of site	Existing commute modes (%)	Active	4	9	13	24.25	47
		Walk	3	5.25	10	15	39
		Cycle	1	2	3	5	31
		Drive car/van	27	53	67.5	73.75	83
	Quality of walk and cycle routes	Circuitry of cycle routes	1.13	1.3	1.36	1.54	1.86
		Circuitry of walking routes	1.16	1.27	1.32	1.47	1.98
		Cycleability of cycle routes	1.46	2.67	3.69	4.24	6.38
Potential for active travel in vicinity of site	Distances to destinations (km)	Median commute	1.7	3.83	6.75	9.75	16
		Town centre	1	2.2	2.95	4.75	11.9
	Potential commute modes (%)	Active	10	25	31.5	45.5	64
		Walk	0	6.5	12	18.75	50
		Cycle	2	12.5	18.5	24	40
		Drive car/van	19	27.5	49	57.75	79
Within-site active travel provision	Quality of routes within and across border of the site	Circuitry of walking routes	1.28	1.39	1.48	1.73	2.79
		Circuitry of cycle routes	1.31	1.45	1.62	1.83	3.02
		Circuitry of driving routes	1.44	1.72	2.38	3.09	4.93
		Crossing points	2	3	4	5	10

Table 1: Metrics of Active Travel Oriented Development. The within-site metrics were calculated only for the 26 sites at which construction had begun as of early 2021. The other metrics were calculated for all sites, except circuitry of walking routes, which could not be assessed at Wynyard and Long Marston since no walking routes <6km in length were identified here. Results that suggest good active travel provision/potential are highlighted in green, these bad are highlighted in red.

3.1 Existing active travel provision in the vicinity of the sites

To assess existing active travel provision, we have chosen metrics representing existing commute mode shares as a percentage of total commute journeys, and the quality of walking and cycling routes in the vicinity of the sites. These both relate to the wider vicinity of the site, rather than solely the site itself, giving the benefit that they can be applied to sites which do not yet exist, or are not yet occupied.

Baseline travel patterns are derived using 2011 Census commuting data. Although some of our case study sites were partially complete by that date, the census data are best seen as an indication of travel patterns in the local area surrounding a site, rather than a reflection of the site itself, because we used data aggregated at the MSOA level. Therefore, even for sites which were partially occupied in 2011, this baseline data is derived from a wider zone which stretches beyond the site boundaries.

Unsurprisingly, existing commuting patterns in the vicinity of these sites vary greatly. Baseline walking mode share as a percentage of all commuter journeys varies from 3% at Upton, Newborough Road (both urban fringe sites) and Dickens Heath (a satellite town) to 39% at Bath Western Riverside (an urban core redevelopment scheme), with a median of 10%. Cycling mode share is as low as 1% at eight, mainly rural, sites, though this group also includes Northwick Park Hospital in Brent, London.

At five sites driving mode share is > 80%, and four of these (Dickens Heath, Chapelford, Wynyard and Upton) are sites in which some of the homes are known to have been occupied prior to 2011. Only at eight sites is driving mode share < 50%. These are all urban sites; three of them are in London.

Provision of safe, direct, high quality active travel infrastructure is a key determinant of people's travel behaviour. To quantify this, we assessed the circuitry of walking and cycling routes and the cycleability of the cycle routes. Cycleability and circuitry varied greatly, even between sites that had similar levels of walking/cycling potential based on proximity to key destinations. This is illustrated in Figure 3, which shows walking and cycling routes to workplaces (aggregated by MSOA) and to the nearest town centre.

Figure 3: Web tool screenshots showing route networks for walking routes (top) and cycling routes (bottom) in [Great Kneighton](#) (left) and [Chapelford](#) (right). For the cycle routes, note the predominance of blue (meaning high cycleability) route segments at Great Kneighton compared with the predominance of red (low cycleability) segments at Chapelford, indicating the relatively busy, and potentially unsafe, nature of routes to key destinations surrounding Chapelford.

Circuitry must be interpreted in combination with the commute distances, since it typically falls with greater journey distance (Cubukcu 2021). Cycle route circuitry was highest in isolated sites such as Wynyard and Dunton Hills, where there are very few cycleable links between the site and surrounding areas, and is lowest in Cricklewood in North London. Circuitry of walking routes shows similar results, being lowest in well-connected sites.

Low scores are best in the metric used for cycleability. Unsurprisingly, the results are lowest in the two Cambridge sites; a city with the highest quality cycle infrastructure in England. Results are highest where cycle routes tend to follow major roads, such as Priors Hall, separated from Corby by a large industrial estate, or Halsnead Garden Village, the site of which lies adjacent to the M62 / M57 motorway interchange.

3.2 Potential to increase active travel in the vicinity of the sites

The potential to increase active travel is assessed using metrics representing median distances to key destinations and the potential future commute mode shares under a scenario of high active travel uptake.

For the vicinity of each site, we used the 2011 Census data to calculate the median commute distance. This ranges from 1.7 km at Taunton Firepool to 16.0 km at Culm Garden Village, with a median of 6.75 km. By comparison, the median distance from a site to the nearest town centre is 2.95 km.

Combining the commute modes and distances, and using a standardised set of distance bands, we further interrogated the travel to work data, as seen in Figure 4 below, to investigate the relationship between the distance travelled to work and existing mode of travel. We can see that walking and cycling mostly occurs in the shorter distance bands. At Chapelford the median commute distance is higher than at Great Kneighton, and active modes also comprise a smaller proportion of the short journeys. We could have further broken down the first distance band into journeys of 0-1 km and 1-3 km, but since these represent distances to MSOA centroids, many sites had very few journeys in the 0-1 km band.

Figure 4: Baseline scenario commute modes and distances at Great Kneighton (left) and Chapelford (right).

Assuming workplace locations remain unchanged, the Go Active scenario uses commute distances and gradients to provide an estimate of the proportion of these journeys that could theoretically switch from car/van driving to walking or cycling. This allows us to understand the potential usership of new walking and cycling infrastructure during the AM peak, if sustained investment is made in high quality active travel provision. Journeys to school, which also occur during the morning peak, are not yet included in this, so the overall impact

could be greater.⁸ We can also see which sites continue to have low levels of active travel, even in the Go Active scenario, suggesting that typical journey distances are so long that switching mode from driving to walking or cycling is not feasible. Conversely, if existing walking and cycling levels around a site are far below their estimated Go Active scenario potential, this suggests there may be particular barriers in the local area that need further investigation. We do not model changes in other modes of travel.

The proportion of commutes by foot under our Go Active scenario ranges from 0% to 50%, median 12%. At Wynyard and Long Marston the proportion is 0% because in these places there were no journeys less than 6 km in length in the input data on commuting, 6 km being our maximum threshold distance for walking. These are isolated rural or semi-rural sites where new settlements have been proposed or constructed. In contrast, five dense urban sites - Bath Western Riverside, Exeter Red Cow Village, Taunton Firepool, Leeds Climate Innovation District and Poundbury - see at least 40% of commutes by foot in this scenario.

Uptake of cycle commuting in the Go Active scenario is low in some urban sites with short median commute distances because there are relatively few existing commuters who drive, and the majority of these journeys have been assumed to be walked instead, with walking being chosen in preference to cycling in the uptake model. Low uptake of cycle commuting is also found in the more remote rural sites with long median commute distances. Total active travel uptake (measuring walking and cycling combined) is highest at Poundbury and in centrally located urban redevelopment sites in smaller cities or large towns. The proportion of commutes by car/van drivers is typically lower in Go Active than in the Baseline scenario, ranging from 19% at Kidbrooke Village to 79% at Wynyard and Long Marston.

Studying the differences between the Baseline and Go Active scenarios, we can see where shorter distances to employment sites create potential for substantially increased uptake of walking and cycling, given the right circumstances. Of the 38 sites, the greatest proportional increase in walking from the Baseline to the Go Active scenario is at Chapelford, where walking mode share increases 150%, from 4% to 10%. This suggests that in 2011, the proportion of people walking at Chapelford was considerably below potential. Proportional increases in cycling to work are much greater than for walking. At Dickens Heath, cycling mode share increases 1900%, from 1% to 20% (Figure 5). By contrast, the proportional increase in cycling is just 29% at Great Kneighton in Cambridge, where cycling is already close to Dutch levels.

Figure 5: Baseline (left) and Go Active (right) scenarios for Dickens Heath.

⁸ <https://www.gov.uk/government/statistical-data-sets/nts04-purpose-of-trips>

3.4 Travel in and around the sites themselves

Where data are available on the actual or proposed internal layout of a development site, it is beneficial to include this in assessments of active travel potential. We have selected as metrics the circuitry of the walking, cycling and driving routes within a site, and the number of unique locations at which cycle routes from the site cross the site boundary.

For all sites that are at least partially occupied, we find median within-site circuitry of 1.48 for walking networks (meaning walking routes are on average 59% longer than the direct Euclidean distance), 1.62 for cycling networks, and 2.38 for driving networks. When comparing different modes for the same site, the mean ratio of walking to driving route circuitry is 0.71 and the mean ratio of cycling to driving route circuitry is 0.78. By comparison, Costa, Marques & Moura (2021) found median circuitry for trips in Lisbon of 0-2km of around 1.3-1.5 for walking, 1.5-1.9 for cycling, and 1.6-2.2 for driving. Conventional post-war North American suburbs, with curvilinear street patterns and cul-de-sacs, typically have circuitry values of around 1.6 - 1.9 (Randall and Baetz 2001). At sites where construction remains in progress, the circuitry of routes will be subject to change as new links are created within the site.

At sites where circuitry is relatively high for all three modes, such as Clackers Brook, Melksham, this suggests unintuitive, winding street patterns, often dominated by cul-de-sacs, which make it difficult to reach local services and encourage car dependency. Where circuitry is high for driving but lower for walking and cycling, this suggests a degree of filtered permeability which may benefit active travel, as long as the walking and cycling routes are of sufficiently high quality, and are not, for example, poorly lit/surfaced alleys and cut-throughs that some residents do not feel safe when using. For example Wichelstowe has a walking:driving circuitry ratio of 0.32 and a cycling:driving circuitry ratio of 0.35. Here, the road that passes through the centre of the East Wichel development contains a bus gate, preventing through traffic in the residential area.

At sites where circuitry is low for all three modes, this suggests intuitive street patterns and layouts that are easy to get around, as long as the streets are designed in a way that puts the needs of non-motorised modes first. A good example is Poundbury (Figure 6), with within-site circuitry of 1.30 for walking, 1.37 for cycling, and 1.49 for driving. Finally at Wynyard the site contains two distinct zones between which there are no safe walking or cycling routes. It is simply not possible to cross the dual carriageway that separates these two zones, so for many residents there is no viable way to reach local shops and services on foot or by bicycle.

Figure 6: Web tool screenshot showing the internal walking route network at Poundbury; routes are shown between 20 randomly selected OD pairs within the site.

The number of locations in which cycle routes cross the site boundary ranges from two to ten, with a median of four. Apart from the urban site of Taunton Firepool, the next highest site has six crossing points.

4 Discussion

To support Active Travel Oriented Development, it is clear from previous research that location, the provision of infrastructure leading to key destinations, and site design are key. This paper proposes an approach to making this knowledge actionable, by rating developments (existing and proposed) in terms of current and potential levels of walking and cycling.

We have chosen a set of metrics relating to well-understood factors influencing active travel, which make use of widely available data and can thus be used in the greatest possible range of circumstances. For example, people walk more when they have easy access to destinations, especially workplaces (Cerin et al. 2013). High density neighbourhoods with a mix of land uses, and where distances to non-residential destinations are low, are known to be conducive to active travel (Hooper et al. 2015; Saelens and Handy 2008; Stevens 2017).

The metrics we have identified can be used as an index of ATOD, supporting assessment of new developments from an active travel perspective. They highlight three key factors influencing walking and cycling provision and potential: quality of surrounding walking and cycling routes, proximity to trip attractors, and provision for active travel within the site. Commute mode shares and distances in our Baseline scenario approximate existing conditions in the local area, while the Go Active scenario represents the potential for greater walking and cycling given high quality infrastructure and investment. The difference between these two scenarios highlights the extent to which new infrastructure could lead to more walking and cycling. In-site circuitry metrics for people on foot, cycling and driving provide an indication of the connectivity of the internal street layout and the existence of filtered permeability measures.

It must be emphasised that high mode shares for walking and cycling under the Go Active scenario do not necessarily indicate that a site has good accessibility for active modes. They

instead suggest there is potential for high levels of active travel, but this potential can only be realised with a very high quality of support for active travel. Since this scenario was created based on cycling levels in the Netherlands, we expect this would include a Dutch-style standard of infrastructure.

The prototype web tool which we have developed allows these methods to be used by interested parties such as planners, policy-makers and researchers. The tool is open source and free to use, with a user-friendly interface. It has already received interest from stakeholders involved in the development planning process.

The approach presented in this paper is not without limitations. The focus on only 38 sites means that the evidence is only available for a fraction of proposed housing developments in the UK and beyond, something we hope to address in future work. The reliance on 2011 Census data impacts on how closely the results correspond to current conditions.

Many MSOAs cover a large area, and a given development site may have considerably different characteristics to the localities that contain the majority of the population of the MSOA(s) that it sits within. This means that residents of some development sites may be expected to exhibit different travel behaviour to the average resident within the same MSOA. This is especially pertinent for greenfield sites that are relatively far from existing homes, and must be taken into account when interpreting the results for existing and potential commute mode shares. This effect could be ameliorated by using Lower Super Output Area (LSOA) data rather than MSOA data, with the drawback that the smaller average population size of LSOAs would result in a smaller set of modelled commute destinations.

Travel to work accounted for around 20% of total UK travel by distance before the Covid-19 pandemic. The average commuting trip distance is longer than most other trip purposes,⁹ suggesting it is a useful proxy when considering maximum distances people will walk or cycle. During the pandemic, working from home levels increased from around 5% to 30% of the workforce.¹⁰ The lasting impact of this on travel behaviour is still unknown, but people working from home continue to make journeys for other purposes (Elldér 2020). New data representing trips to other destinations, such as schools, shops and public transport nodes such as rail stations could address this limitation.

We used a simple uptake model to represent ambitious scenarios of increased active travel, illustrated in Figure 2. A limitation of this is that the model only represents modal shift from driving to walking and cycling. To overcome this, alternative multi-modal uptake models could be developed, for example based on data from areas that have seen substantial increases in walking and cycling.

Travel behaviour in existing journeys can provide a valuable depiction of the quality of existing active travel provision, but our focus on a limited set of quantitative measures will undoubtedly miss some aspects relating to active travel provision and potential, such as the more qualitative aspects. Additional assessment metrics could be added to broaden the scope of the analysis. This could include more measures that directly relate to the residential development sites themselves. For example, a common problem with residential development sites is a lack of connectivity between the site and surrounding streets and neighbourhoods. Often, there are relatively few links that cross the ‘red line’ of the site boundary, causing isolation even when the geographic distance to neighbouring suburbs and community

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⁹ <https://www.gov.uk/government/statistical-data-sets/nts04-purpose-of-trips>

¹⁰ <https://www.ons.gov.uk/peoplepopulationandcommunity/healthandsocialcare/conditionsanddiseases/bulletins/coronavirustheukconomyandsocietyfasterindicators/22april2021>

facilities is small. Our metric of the number of unique points at which routes to work cross the site boundary addresses this, but it could be supplemented by additional measures.

As the above limitations make clear, the metrics presented in this paper cannot provide a definitive account of a residential development's active travel provision and potential. However, they provide a standardised and easily usable index, able to fill a gap in the planning process which is often overlooked (Chang et al. 2019). Further work can lead to improvements in particular metrics with the ability to support the principle of Active Travel Oriented Development.

5 Conclusion

Active Travel Oriented Development is suggested as a means of creating liveable communities in which jobs and services are within easy reach of people's homes, and residents do not need to rely on private vehicles to go about their daily lives. This can help to alleviate the many problems associated with high levels of motor traffic, such as carbon emissions, air pollution, noise pollution and lack of physical activity. Transit Oriented Development also addresses many of these issues, but we believe it can be complemented by perspectives that focus directly on active travel within local communities.

The methods presented in this paper have great potential to support ATOD. Specifically, they can generate the actionable evidence that is needed for planners to decide between sites from the perspectives of sustainable and active travel. Climate change and health objectives are increasingly included in Local Plans, but often the planning processes to achieve these are overlooked. Results generated by the methods we have presented can influence two main types of decision in the planning process:

1. Early in the planning process, the decision of whether or not to approve potential development sites, based on consideration of the feasibility of future residents walking and cycling to key destinations, including town centres and workplaces.
2. For sites that are taken forward, the results can inform planners about potential site layouts, road space reallocation options, and opportunities to bridge gaps in walking and cycling networks to increase walkability and cycleability, revealing ways in which planning gains associated with the development could be invested to improve sustainability.

In tandem, these changes have great potential to ensure that new housing developments meet not only the needs of the future residents, but also steer society away from car-dependency and towards the zero carbon and physically active society that is necessary for a sustainable, healthy and liveable future.

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