Trip attraction rates of mixed use developments (Summary report)

Prepared for Highways Agency

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Executive Summary

Current government policy documents such as PPG13 advocate the implementation of measures which reduce the need to travel by car. There is a broad consensus that land use policies should seek to minimise the need to travel and encourage the use of less polluting forms of transport. To support this consensus, several urban form strategies are being recommended which are considered to reduce dependency on the motor car. Mixed use development is promoted as one aspect of a sustainable urban form. PPG13 specifically suggests the intermixing of land uses by providing for 'a juxtaposition of employment and residential uses so that people have increasing opportunities to work near their homes' and 'by providing for a wide range of activities at the local neighbourhood level, the need for people to use cars to meet their every day needs will be reduced'. There is therefore a hypothetical assertion that *mixed use development reduces car dependency*, however evidence supporting this hypothesis is weak.

The objectives of the study were:

- To identify daily trends in mixed use site related traffic and to examine the effects and impacts of mixed use developments on the trunk road network.
- To consider the trip generation rates of mixed use developments compared to single use developments.
- To test the theory of mixed use development and its links with the reduction in car travel.
- To make recommendations which may increase the effectiveness of mixed use development as a tool for reducing road travel.

Any empirical work of mixed use developments on a wide and general scale is problematic given the complexities of the different development types and the difficulties in conceptualising the relationship between travel and the development. This report therefore analyses one type of mixed use development - suburban business parks. These sites are a key land use type which are relatively self-contained, providing an easily definable research area.

A criteria was defined for the selection of the suburban business parks. The criteria ensured that all the selected sites had the following characteristics:

- A mix of at least two land use types – one type must be commercial (B1 or B2 or B8) plus one or more other land use types within the site e.g. retail, leisure, residential.
- Within 3 miles of the trunk road network to enable the impacts of the business parks on the trunk road network to be estimated.

Ten mixed use business parks were selected for analysis and one single use business park used as a control site. At each site the following data collection occurred between February and April 2002 (except for one ATC which was collected in December 2002 due to technical problems):

- Two weeks of automatic traffic counts at each entry point to the business park.
- One 12 hour manual multi-modal traffic count.
- Self-completion employee questionnaires.
- Visitor surveys at each facility.

It has been found that suburban business parks generate a significant amount of traffic and therefore impact on the trunk road network. In terms of trip attraction, the mixing of land uses within the business parks has had limited benefits on reducing the number of vehicles travelling to the site each day. In general, the mixed use developments within the business parks incur additional trips rather than a reduction in trips. Some land uses can dominate the business park and operate as single uses without encouraging interaction between land uses. This is particularly evident when there are key land uses on the site such as hotels, pubs, restaurants and large retail outlets.

However, there were some sites which seemed to reduce the amount of trips made to and from the site. Business parks which had a selection of facilities and which were smaller and served only the employees rather than attracting visitors were effective in reducing lunchtime trips and did not encourage many additional trips. Therefore, the choice of land uses to locate on a business park needs to be considered carefully. Although facilities within the business parks need to be economically viable, if a key objective is to reduce trips to and from a business park they also need to be small facilities so as not to generate trips in their own right.

There was also evidence to suggest that business parks with limited on-site facilities resulted in a larger proportion of commuters travelling by car. Conversely, sites with a mixture of facilities such as food outlets attracted a higher proportion of commuter trips as car passenger, by public transport or walking and cycling. This could be due to the presence of the mixed use facilities but also could be related to the socio-economic characteristics of the employees or the availability of public transport.

The findings of the study are mixed in terms of the benefits mixed use suburban business parks have on the trunk road network. In terms of trip attraction, mixed use development appears to have a negative effect. In particular, the business parks generate a substantial amount of traffic during the peak periods contributing to congestion on the trunk road network. However, the employees of the sites are benefiting from more facilities being available within walking distance of their workplace. In turn, this appears in some cases to reduce the amount of travel off-site at lunchtime and, to a small extent, encourage the use of more sustainable modes than the private car to commute to work.

1 Introduction

The objectives of the study were:

- To identify daily trends in mixed use site related traffic and to examine the effects and impacts of mixed use developments on the trunk road network.
- To consider the trip generation rates of mixed use business parks compared to single use business parks.
- To test the theory of mixed use development and its links with the reduction in car travel.
- To make recommendations which may increase the effectiveness of mixed use development as a tool for reducing road travel.

Any empirical work of mixed use developments on a wide and general scale is problematic given the complexities of the different development types and the difficulties in conceptualising the relationship between travel and the development. This report analyses suburban business parks. These sites are a key land use type which are relatively self-contained, providing an easily definable research area and which have significant impact on the trunk road network.

The study seeks to determine the effects on travel caused by mixing land uses within business parks. For example, the study focuses on how land use mix at suburban business parks, size, site design and employment density affect the trip patterns and trip generation at those sites. Through better understanding of these factors and how they interrelate, it is possible to recognise factors which may reduce the impact of the business parks on the road network thereby improving mobility in the suburbs and maintaining the economic viability of regions.

Firstly, background to the work, including the theory and methodology behind the research is presented. Chapter 4 is an analysis of the trip attraction rates of the mixed use developments in particular, focussing on the daily trends in site related traffic. In addition, the trip attraction rates of the mixed use business parks are compared to single use sites using TRICS software. Chapter 5 discusses the use of the mixed use facilities and their impact on car travel whilst chapter 6 considers the impact of the business parks on the trunk road network.

A criteria was defined for the selection of the suburban business parks. The criteria ensured that all the selected sites had the following characteristics:

- A mix of at least two land use types – one type must be commercial (B1 or B2 or B8) plus one or more other land use types within the site e.g. retail, leisure, residential.
- Within 3 miles of the trunk road network to enable the impacts of the business parks on the trunk road network to be estimated.

In addition, one site (Frimley Business Park) was selected which was single use and had no other land uses apart from offices on the site.

Within this report the employee sites surveyed are called ‘business parks’ although, in one case the site is officially classified as a science park. In addition, the B1, B2 and B8 uses (mainly offices and distribution) are called ‘businesses’ and the other uses such as restaurants, hotels and shops are generically called ‘facilities’.

2 Theory of mixed use development

Often, the key objective of implementing a mixed use development is to reduce travel by car. However, there has been limited research to test this hypothesis. Indeed, trip generation rates for mixed use developments are difficult to measure and there is little published information or research into this issue. It is likely however that mixed use developments will generate different traffic level compositions than a single use site. This is an important factor to establish, as developers need to undertake multi-modal transport assessments for new developments and therefore require accurate trip generation rates for land uses.

Empirical evidence regarding the effectiveness of mixed use developments in achieving sustainability objectives is limited. One of the few studies which focuses specifically on mixed use found that provision of facilities, such as local shops, within a development did not significantly alter the balance of trips between walking and driving, but local facilities did help to reduce the length of car trips to these facilities. It was concluded that although car travel was reduced, car restriction measures such as taxation and parking controls are required to encourage the use of other modes when a mixed land use policy in a locality is adopted, otherwise people continue with their usual travel habits (Farthing, Winter and Coombes,1994).

These findings confirm the need for an integrated policy with a number of instruments being in place for mixed use to be an effective tool. Although mixed use developments may have a role to play, other measures such as public transport and car restriction will also be required. This is not to say that mixed use is an insignificant travel reduction instrument.

Some of the most detailed research regarding mixed use development has been undertaken in the US. In the US (as in the UK), suburban office developments have altered commuting patterns, resulting in cross-town and reverse direction movements. The dispersal of jobs has relieved some central urban areas of additional traffic and brought some jobs closer to suburban dwellers although it has seriously threatened the quality of living at the edges of urban areas due to increased congestion on suburban routes (Cervero, 1988).

The suburban developments in the US have been built at low density with ample car parking, rendering public transport unviable in some cases. The office complexes are often low rise and cover such a vast area that any other mode apart from the private car is inconvenient. Compared to their city counterparts, suburban office complexes are predominantly single-use and therefore, at lunchtime, banks, restaurants and shops are inaccessible unless employees commute by private transport (Cervero, 1988). Although similar to the UK business parks, Cervero was observing sites on a much larger scale than those found in the UK and therefore his results are not directly comparable. However, his findings are useful to this study.

Cervero (1988) examined the potential benefits of developing commercial mixed use suburban workplaces, where offices, shops, banks and restaurants are built side-by-side. Cervero found that mixed use developments could improve suburban mobility and reduce localised congestion in 4 ways:

- Reducing motorised travel by walking between facilities.
- Spreading trips out throughout the day.
- Encouraging workers to car share due to reduction in need of employees to drive off-site at lunchtime.
- Allowing shared use parking arrangements.

Other benefits can include:

- Mixed uses adding life to working environments and reducing the barreness and lack of urban amenities in current out-of-town office environments.
- Creating after-work nightlife which encourages employees to live near their workplace.

Cervero (1988) concluded that, single-use office settings seem to induce lone commuting by car whereas mixed land uses within office environments encourage car sharing, walking and cycling. Particularly important to car sharing is the availability of retail. The harmonisation of job and housing growth could encourage cycling and walking but reduce car sharing. The evidence suggested that offices, shops, banks, restaurants and housing need to be mixed but in close proximity to each other.

In the UK, stand-alone suburban office developments have been built since the 1980s, for example, high technology IT companies west of Reading and large office complexes north of Bristol at Aztec West. This suburbanisation has resulted in changes to travel patterns. In the UK, travel patterns have become more uniformly spread and less focused on city centres. Congestion is now severe at key stress areas of the trunk road network. Cervero provides an insight on how the pressure on the trunk road network from suburban employment sites may be relieved through mixed use.

3 Methodology

3.1 Study area

It was a prerequisite that all the sites studied needed to be near the trunk road network. To ensure an element of consistency between the socio-economic characteristics of the sites, business parks in the south of England were selected. As a guide, the M25, M1 (Junction 1 to Junction 10), M2, M3, M4 and M5 motorways were considered for suitable sites. Following this, other sites which were near A roads in the south of England were identified.

3.2 Site identification

Since many of the suburban business parks are only up to 10 years old, data tended to be relatively sparse. However, a range of business parks which incorporated mixed use elements were identified through the internet, by contacting local authorities for information by post and referencing business directories. Websites of developers who were known to be leading in the area of mixed use business park development were searched. Such developers included Arlington, MEPC and Akeler. Contacting both relevant local authorities and developers increased the likelihood that appropriate business parks would be identified within the study area. Following identification, TRL visited each site to confirm site details such as land use mix, business type and employee numbers. From this initial investigation 23 sites were identified. Of these 23 business parks, 11 owners gave permission for their sites to be surveyed. Figure 3.1 shows the locations of these business parks in relation to the trunk road network.

Once permission was given it was necessary to contact all occupiers on site. This included the office and distribution companies on-site and also the cafes, nurseries, hotels, pubs and other facilities. Table 3.1 shows the business parks surveyed, including their land use composition and location in relation to the trunk road network.

3.3 Data collected

Data was collected to contribute to the overall objective of assessing the trips generated by both employees and non-employees (visitors) of the business parks. The following data collection methods were used:

1 Automatic traffic counts

Automatic traffic count data was collected for approximately two weeks at each business park. The traffic counts coincided with the timing of the survey day which included other elements of the study such as employee surveys and visitor surveys. Data was collected in 15 minute time periods. The data was collected to provide a daily (24 hour) and weekly trend of travel patterns to and from the business parks.

2 Manual multi-modal traffic counts

The multi-modal counts were collected between the hours of 7am and 7pm on the survey day. Manual counters were located at the entrance and exit of each business park and the number, type and time of vehicles entering and leaving the business park were recorded. Where a business park had more than one entrance and exit, through traffic counts were recorded as well as the time, type and direction of the vehicle. The data was collected to provide details of the types of modal split each business park attracted.

3 Collecting background information

A preliminary survey was designed and completed for each site to provide an overview of each mixed use development. The survey considered general site factors such as, land use, employment, site and transport characteristics of the development. This survey was completed through reviewing literature provided by local authorities, developers and businesses through site visits.

Collection of the background data was, nevertheless, a difficult task. It was found that the business parks quickly evolve or change and a company census undertaken just

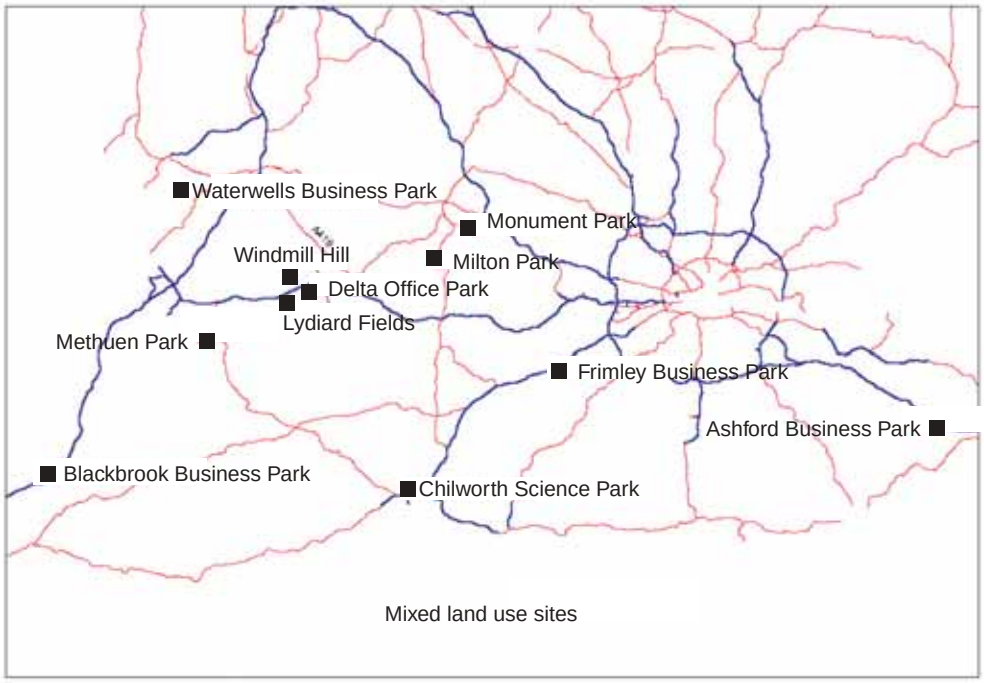


Figure 3.1 Surveyed business parks

Table 3.1 Business parks surveyed

Development	*Location*	*Description*
Frimley Business Park	M3	Offices.
Ashford Business Park	M20 Junction 10 Ashford	Retail Park and Offices, snack van.
Windmill Hill	M4 Junction 16 Swindon	High quality low-rise office buildings and nursery.
Lydiard Fields	M4 Junction 16 Swindon	Warehouse, 2 hotels (1 Hilton, 1 Travel Inn), pub/restaurant
Delta Office Park	M4 Junction 16 Swindon	Tennis Centre, Hotel, Bank, Nursery School and Convenience store.
Methuen Park	M4 Junction 17 Chippenham	Offices, Focus Store, Pub.
Waterwells Business Park	M5 Junction 12 Gloucester	Offices, Hotel (Holiday Inn Express), Pub/Restaurant.
Chilworth Science Park	M27 Junction 3 Southampton	Science park with hotel & conference facility.
Milton Park	M4 / M40 Oxford, A34	Office and distribution, convenience store x 2, hair salon, café/ restaurant, hairdressers, bank, gym.
Monument Park	M40	Offices, distribution, nursery, café.
Blackbrook Business Park	M5 Junction 25 Taunton	Offices, restaurant, hotel, cash machine.

six months ago becomes out of date as businesses and employees change locations and jobs. The employee numbers, businesses and floor space figures provided within the document are therefore approximate. Collection of this type of data was particularly difficult when surveying at a business park where the site was not owned by one owner. This was particularly apparent at Delta Business Park where the buildings were owned by a variety of different agents and occupied by tenants. There was therefore no single contact who had an overall view of the occupants within the site.

4 Employee surveys

The business parks ranged in size from 400 to 6,000 employees. For some business parks it was possible to access all the companies on the site and request that their employees completed the questionnaire. However, at the larger sites it was not possible to survey all employees. A sample size of approximately 400 employees per site was envisaged. This was achieved by randomly sampling companies and contacting these companies for permission to survey their employees. Employees at both the businesses and the facilities were surveyed.

The self-completion questionnaire surveys collected the following data:

- mode choice;
- origin/destination data;
- time of day that employees travel to and from the business park;
- public transport usage and information about trips made internally within the mixed use sites;
- details of trip chaining before/after work.

Depending on the company, the self-completion questionnaire was administered by e-mail or mail/ballot return. The data enabled an understanding of the impacts the business park was having on the trunk road network. In particular, it enabled a study of modal choice of commuters to the business park and how far employees were travelling. In addition, some conclusions could be drawn as to the effect the mix of land uses within the business park was having on travel to and from the site, particularly at lunchtimes.

5 Visitor survey

At each facility on the business park (e.g. not B1 (business), B2 (general industrial) or B8 (storage and distribution land uses), interview surveys were undertaken on the survey day between the hours of 7am and 7pm (or during the opening hours of the facility). The survey enabled the collection of data about users of these 'alternative land uses'. In particular, data was collected about their origin e.g. if they were an employee of the site or a non-employee/visitor. If the respondent was a visitor the details about their journey to the site was collected, such as mode of travel, origin and destination and journey purpose.

At some facilities this survey was difficult to administer. For example, at a children's nursery it was not possible for an interviewer to stand outside the nursery to interview parents and guardians. Instead, nursery teachers circulated self-completion questionnaires to a child's parent or guardian which asked about the child's journey to and from nursery on the survey day.

Other facilities were reluctant for interviewers to survey outside their property due to the nature of their business. Facilities which were particularly client-focussed were the least likely to give permission for customers to be interviewed as they entered or left their property. Hotels especially would not authorise surveys except in a few cases. This issue was also a factor for businesses occupying the B1, B2 and B8 uses on the site. It was requested that visitors to these businesses who may be attending a meeting or delivering goods would be interviewed. However, businesses were not prepared to allow for this element of the method. The main reason given was that businesses did not want clients bothered by surveys. Businesses did however permit voluntary self-completion questionnaires to be left at reception. Although this procedure was followed the rate of return from 'reception surveys' was very low.

4 Trip attraction rates of the business parks

4.1 Weekly and daily travel patterns

Traffic count data was supplied for two weeks coinciding with the timing of other elements of the study taking place, such as the employee and visitor surveys. In order to obtain accurate results one full week's worth of data was applied for analytical purposes whilst the remaining data was briefly examined to check the robustness of the data actually used. For those business parks with more than one entrance/exit, data was provided for each access point and subsequently added together for the purposes of the analysis. It is worth noting that Delta Business Park and Milton Business Park have a potential through flow of traffic and therefore, the manual through-flow data collected has been used in conjunction with the ATC data to calculate those trips which are specifically accessing facilities and businesses within these business parks.

Table 4.1 provides an initial indication of traffic flow levels for each of the sites. This shows that the business park with the highest number of vehicles is Milton in Oxfordshire, which is the largest business park . Waterwells Business Park near Gloucester and Monument Business Park in Oxfordshire are shown to have much lower five day average traffic flows.

Table 4.1 Traffic flows for each business park as a five day average over a twenty-four hour period

Site	*In*	*Out*
Frimley Business Park	1,707	1,777
Windmill Hill Business Park	4,380	4,413
Monument Business Park	680	686
Milton Business Park*	12,803	11,806
Blackbrook Business Park	1,752	1,557
Chilworth Business Park	1,374	1,194
Delta Business Park**	2,661	2,547
Methuen Business Park	2,678	2,800
Lydiard Fields Business Park	1,616	1,614
Waterwells Business Park	417	410
Ashford Business Park	2,627	2,651

* *Traffic flow on Thursday 14th March 2002 only (due to technical problems).*

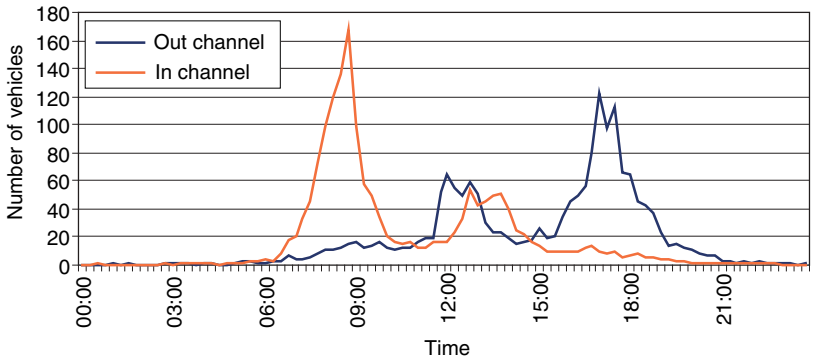
** *4-day 24-hour average (due to technical problems).*

4.1.1 Daily travel patterns

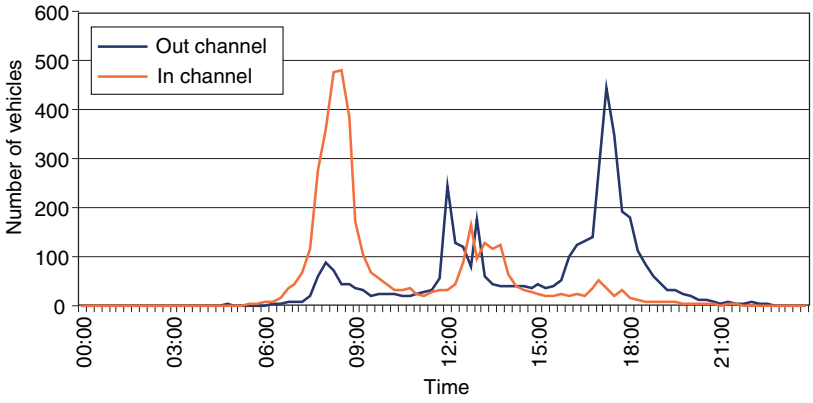
From analysing the automatic traffic count data, Figure 4.1a-k show the daily travel patterns of each business park. The graphs show that the majority of the business parks have a morning and evening peak when employees arrive and leave. There are inter-peaks at many sites indicating lunchtime trips. Traffic volumes vary between business parks due to the employee numbers and floorspace at the site. Those business parks not dominated by business uses but dominated by facilities (i.e. Lydiard Fields, Waterwells and especially Ashford) have traffic flows that do not display a clear pattern.

4.1.2 Lunchtime travel patterns

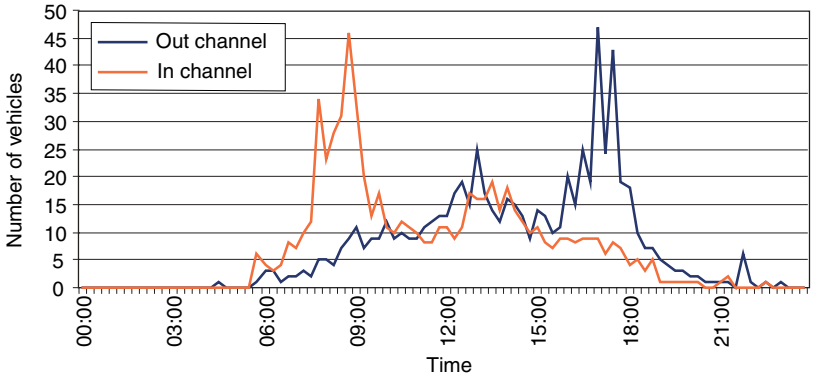
Table 4.2 shows the variation in the proportion of incoming vehicles that arrive at the site in the morning peak to the number leaving the site during the lunch-hour. The morning peak was specified to be 7-10am and the lunchtime 12-1pm for all business parks. Frimley Business Park has a comparatively high number of vehicles leaving at lunchtime possibly because there is little on the site in terms of food retailers to cater for this period of the day. Waterwells, Ashford and Methuen Business Parks also



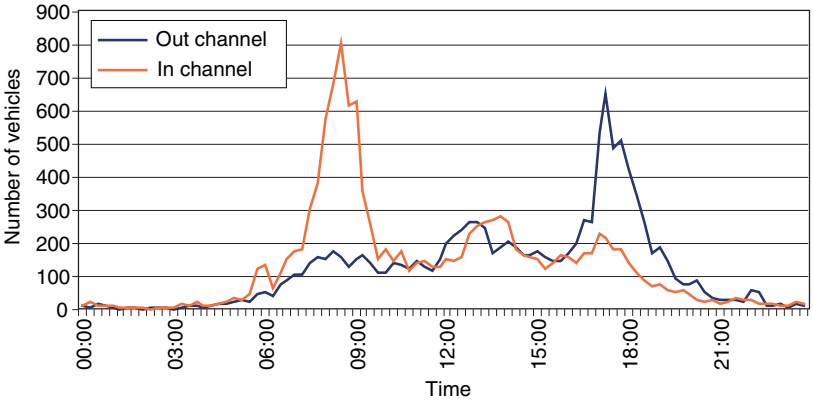
a: Frimley Business Park - ATC data for the inward and outward channel: five day average



b: Windmill Hill Business Park - ATC data for the inward and outward channel: five day average

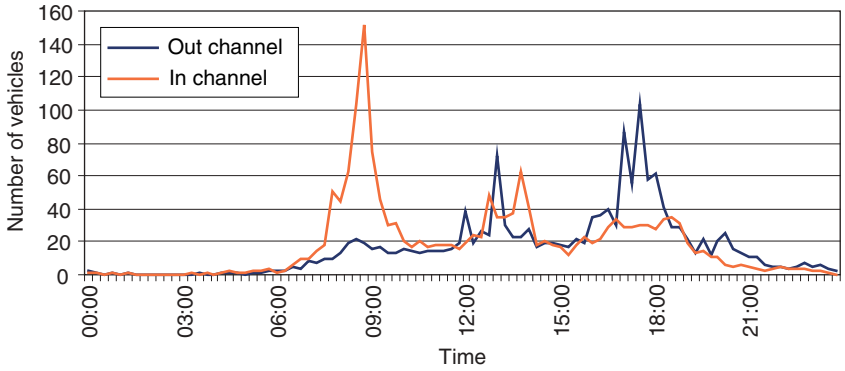


c: Monument Business Park - ATC data for the outward and inward channel: five day average

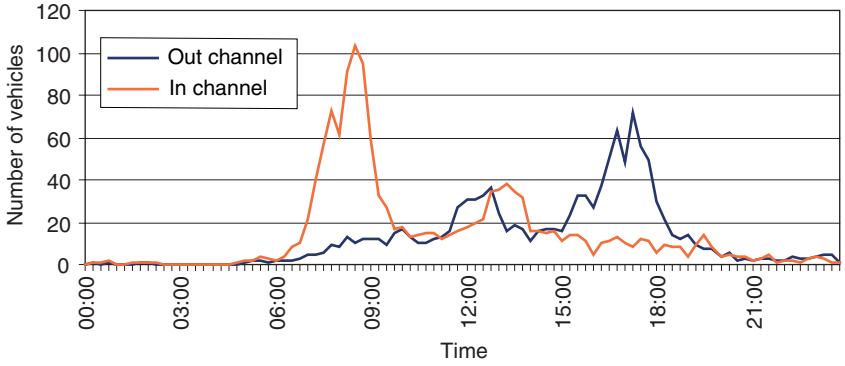


d: Milton Business Park - ATC data for the outward and inward channel, Thursday 14th March 2002

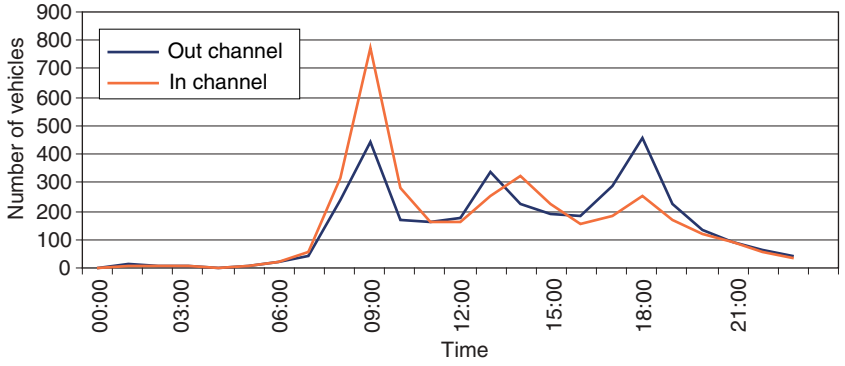
Figure 4.1 Pattern of daily traffic flows



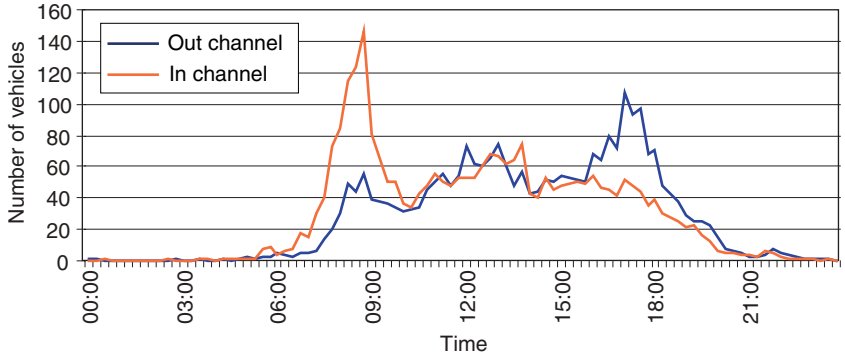
e: Blackbrook Business Park - ATC data for the inward and outward channel: five day average



f: Chilworth Business Park - ATC data for the inward and outward channel: five day average

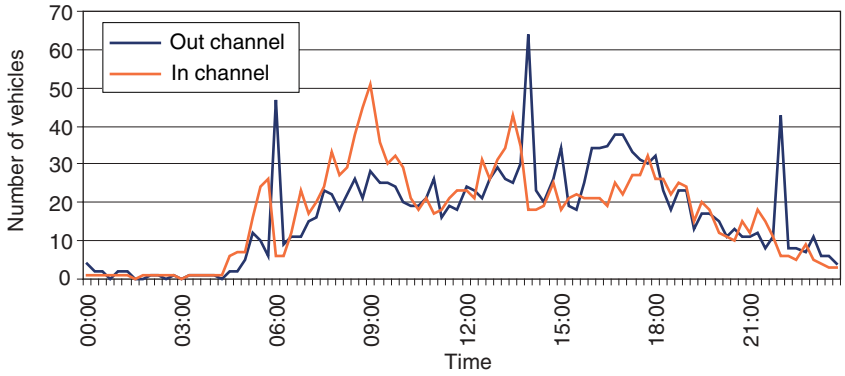


g: Delta Business Park - ATC data for the outward and inward channel, Thursday 17th December 2002

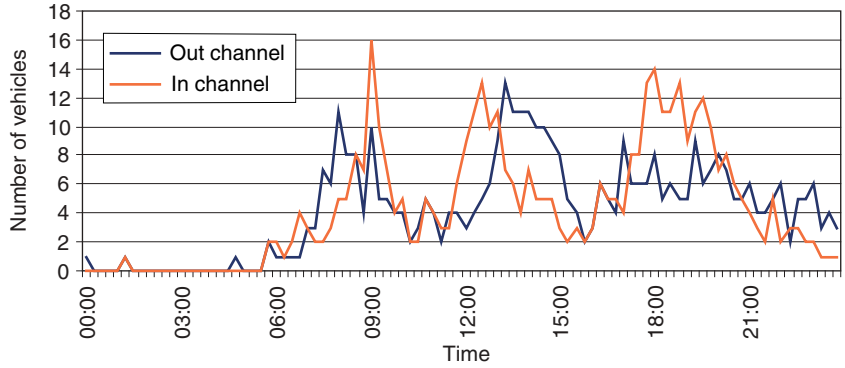


h: Methuen Business Park - ATC data for the inward and outward channel: five day average

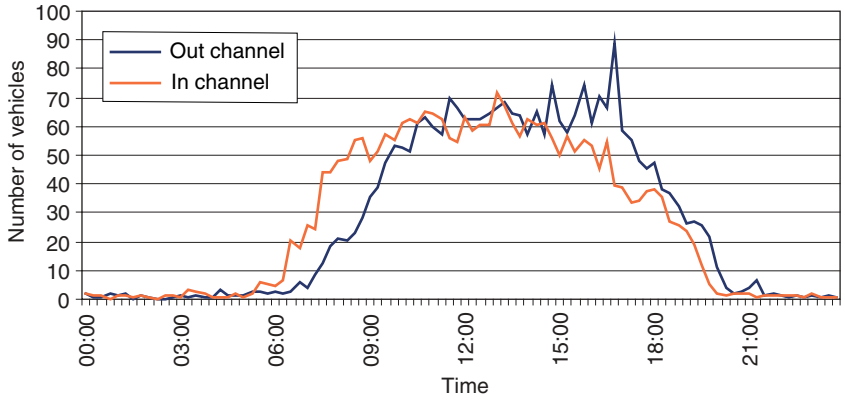
Figure 4.1 (Continued) Pattern of daily traffic flows



i: Lydiard Fields Business Park - ATC data for the inward and outward channel: five day average



j: Waterwells Business Park - ATC data for the inward and outward channel: five day average



k: Ashford Business Park - ATC data for the inward and outward channel: five day average

Figure 4.1 (Continued) Pattern of daily traffic flows

Table 4.2 Proportion of outgoing *lunchtime* trips compared with *morning peak* incoming trips

Business park	*Average weekday inflow am peak (7-10am)*	*Average lunchtime outflow (12-1pm)*	*% of lunchtime outflow to weekday inflow am peak*
Windmill Hill BP	2615	574	22.0
Waterwells BP	72	18	25.0
Monument BP	304	48	15.8
Milton BP	5206	859	16.5
Methuen BP	875	261	29.8
Lydiard Fields BP	382	94	24.6
Frimley BP	935	227	24.3
Delta BP	1367	574	24.3
Chilworth BP	677	131	19.4
Blackbrook BP	638	109	17.1
Ashford BP	557	252	45.2

exhibit high proportional outflows during the lunch-hour, most likely due to the more dominant retail/leisure elements of these sites attracting visits from traffic not related specifically to business park use. The lowest outflows are from Monument, Milton and Blackbrook. All three of these business parks have food and other facilities on-site and therefore this may reduce the number of trips made off-site at lunchtime.

4.1.3 Weekend travel patterns

Table 4.3 shows comparative flows on a weekend compared with the weekday for each business park. The single use site – Frimley – has the lowest percentage weekend to weekday inflow which supports the highly dominant business nature of the park. The business parks of Ashford, Waterwells, Methuen and Lydiard exhibit higher comparative flows on a weekend, which corresponds with the types of land uses found there which attracts trips outside of normal business hours.

Table 4.3 Proportion of incoming *weekend* trips compared with incoming *weekday* trips over a twenty four hour period

Business park	*Average weekday inflow 24 hour*	*Average weekend inflow 24 hour*	*% of weekend inflow to weekday inflow 24 hour*
Windmill Hill BP	4380	296	6.8
Waterwells BP	420	382	91.0
Monument BP	670	111	16.6
Milton BP	13773	3450	25.0
Methuen BP	2800	1808	64.6
Lydiard Fields BP	1619	822	50.8
Frimley BP	1707	102	6.0
Delta BP*	–	–	–
Chilworth BP	1374	393	28.6
Blackbrook BP	1752	596	34.0
Ashford BP	2627	1980	75.4

** Analysis not possible due to counter malfunction*

4.2 Modal analysis

Twelve hour manual multi-modal traffic counts were carried out on the survey days at each of the business parks. At the business parks where there was more than one entrance, through traffic was recorded. The manual counts were between the hours of 7am and 7pm. Although data was collected for traffic entering and leaving the business park in general, this chapter focuses on vehicles entering the business park as results were very similar for both directions.

Table 4.4 shows the modal split of vehicles entering each business park in a 12-hour period. These include both employees of the site and visitors to the site. It shows that the majority of trips to each site was made by car. The dominance of the car ranges from 73% to 93%. The second most common mode of transport is light goods vehicles. This is due to the number of deliveries made to the business parks. The remaining modes made a small contribution to the modal split. At some business parks heavy goods vehicles and bicycles made up to 4-5% of the modal split but in general the remaining modes were an insignificant proportion of the overall sum of vehicles entering the business parks.

Figure 4.2 shows the average mode split of each business park. It again shows the dominance of the car in accessing the business parks. Interestingly, it also shows the lack of use of public transport to travel to the business parks. Very few business parks are served by a bus link onto the sites. Some employees or visitors will have walked on to the business park after travelling by bus, but overall the small number suggests poor bus services to the suburban business parks.

4.3 The TRICS database

TRICS stands for Trip Rate Information Computer System. It is a computerised database and trip rate analysis package for transport planning and development control. TRICS is a database containing site and development information for some 1,600 development sites in the UK. In each of these developments traffic entering and exiting is recorded, and from this information trip rate calculations are carried out, which can be used to estimate traffic flows for a variety of development types.

The TRICS database has been used to compare modelled (TRICS) rates and flows with the actual recorded rates and flows from the business parks. The TRICS software allows for trip generation rates to be generated based on the floor area of a given site or the software can relate trip attraction rates to the number of people employed on a given site. Therefore, TRICS has been used to model expected trip rates per employee and per floorspace for each site. These trip rates were then multiplied by the number of employees on each site to generate a total daily employee traffic flow.

To ensure the compatibility of TRICS with the business parks surveyed, it is necessary to classify individual land uses according to the categories supplied by TRICS. Due to the limited range of TRICS categories, it was sometimes difficult to assign a specific land use to an appropriate

Table 4.4 Modal split for each site

	Frimley %	*Windmill* %	*Monument* %	*Milton* %	*Blackbrook* %	*Chilworth* %	*Delta* %	*Methuen* %	*Lydiard* %	*Waterwells* %	*Ashford* %
Car	93	80	76	80	86	84	90	83	79	89	73
LGV	6	7	15	7	11	10	5	7	7	5	22
HGV1	0	3	5	3	1	1	1	1	4	3	4
HGV2	0	4	0	4	0	1	0	0	6	0	1
Bus	0	1	0	1	0	1	0	0	1	0	0
Motorcycle	0	1	0	1	0	2	1	0	1	0	0
Pedal Cycle	0	2	3	2	1	2	4	1	1	1	0
Pedestrian	0	1	1	1	1	1	0	7	1	2	1
Other	0	0	0	0	0	0	0	0	0	0	0

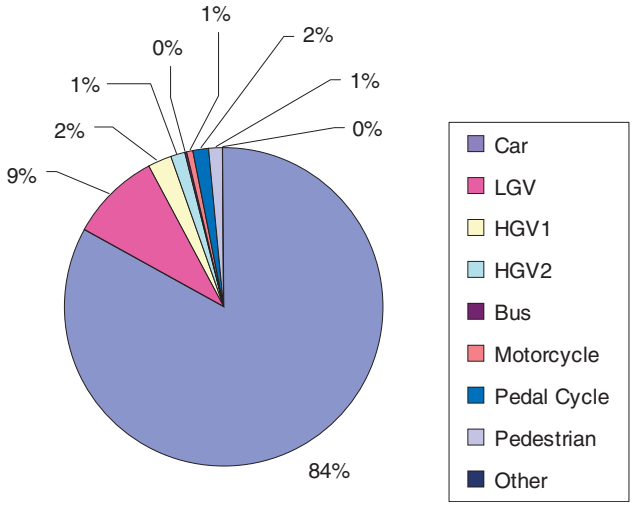


Figure 4.2 Average modal split

Table 4.5 Actual modelling trips rates by employee and floorspace

	Trip rate / Employee		*Trip rate / 100m2*	
	Modelled	*Actual*	*Modelled*	*Actual*
Waterwells	3.22	14.52	12.38	20.66
Delta	7.55	10.37	0.02	16.82
Lydiard	3.22	9.28	9.25	3.53
Ashford	7.55	7.54	9.25	9.91
Methuen	3.46	4.36	12.38	40.08
Chilworth	7.55	3.76	9.02	10.39
Blackbrook	3.46	3.48	9.02	17.37
Monument	7.55	2.78	12.38	12.57
Milton	2.63	2.65	8.38	11.39
Windmill	2.63	2.51	9.25	17.68
Frimley	2.23	2.32	9.02	16.52

TRICS category, although a best estimate has been made in each case. For example, TRICS could not supply a trip attraction rate per employee for all the categories used. Where a suitable rate could not be found, it was estimated that each employee accounted for 1.0 trips into the site and 1.0 trips out of the site, per day.

4.3.1 Trip attraction rates at the business parks

Table 4.5 shows the trip attraction rates at each business park compared to the modelled trip rate from TRICS. The modelled trip rate was calculated from the 'business parks' sub category within TRICS. Therefore, no consideration is given within the modelled figures for a mix of land uses on the site. Moreover, TRICS is limited in the number of business parks within its database from which it could model trip attraction. Therefore, when defining the floorspace or employee parameter (to ensure accuracy and comparability with the actual surveyed sites) the number of sites which can be used within TRICS is reduced and representativeness may be compromised in other ways due to the smaller sample. The modelled trip rates for business parks vary depending on the amount of floorspace and the number of employees. Therefore, for the business parks with less employees, the TRICS parameter of 'employees' was lower than for a business park with more employees. For example, the smallest business parks at Waterwells and Lydiard Fields had a corresponding modelled trip rate calculated from sites within TRICS with a range of 74-300 employees. In contrast, larger business parks such as Milton Park and Windmill Hill had a trip attraction rate modelled from sites with 3,000-3,780 employees.

The table shows the actual and modelled trip rates by employee and floor space in descending order of actual trip rate per employee. The modelled trip rates were calculated by selecting the 'land use' as 'employment' and the 'sub land use' as 'business park'. As suggested above when considering the number of employees at each business park, TRICS can draw from a range of sites with a minimum of 74 employees and a maximum of 3,780 employees. If this full range of employees is used with the 'employment' and 'business park' categories then the trip rate per employee is 3.99. If a more precise range is used (to represent the number of employees working on a specific business park) then the trip rate changes. This approach also applied to floorspace. The floor areas of the TRICS sites ranged from 2,120 square metres to 118,448 square metres, however, if a range was selected which fitted more accurately with a specific business park then the trip rate changed. So, ranges were set according to each business park's characteristics and this affected the modelled trip rates. The range selection was also affected by the stock range of surveys that was available through TRICS.

To calculate the 'actual' figures the more accurate manual 12-hour counts were used. The table shows that

Waterwells has the highest trip rate per employee. The business parks with high trip rates per employee after Waterwells are Delta, Lydiard and Ashford. This is interesting as they are the same business parks which highlighted abnormal vehicle patterns in Figures 4.1. These business parks have high flows as they have land uses which dominate over the B1, B2 and B8 land uses on site. The lowest trips rates per employee are Monument, Frimley and Windmill. This may be due to these sites having a higher proportion of B1, B2 and B8 land uses within the site compared to other uses.

Figure 4.3 represents the land use composition of each business park. It shows that the sites with the lowest trip rate per employee (Windmill and Frimley) are dominated by office and distribution land uses. The graphs have been divided into 'employment', 'retail' and 'other'. 'Employment' applies to office and distribution land uses e.g. B1, B2 or B8, 'retail' applies to shops and retail warehouses on-site and 'other' applies to the other land uses such as hotels, pubs and nurseries.

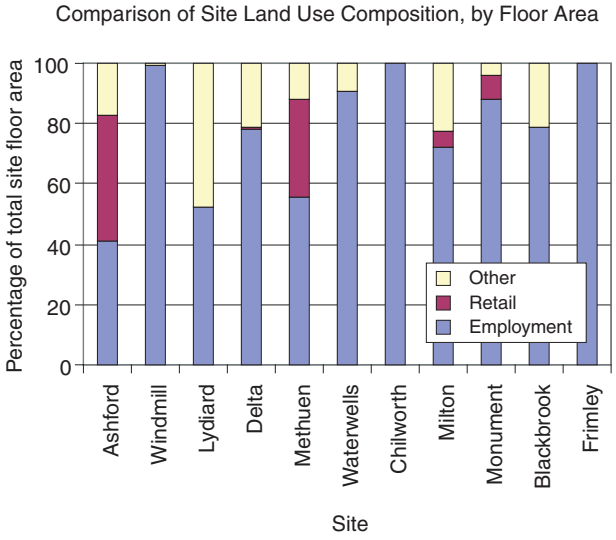


Figure 4.3 Land use composition

Figure 4.4 represents the differences found between the modelled and the actual rates based on employee numbers. Employee numbers have been chosen rather than floorspace as the employment figures provided by the business park owners and occupiers are more accurate than the floorspace figures given. The modelled figure is based on a similar size (in terms of employee numbers) single use business park. It shows that trip rates are much higher at Lydiard and Waterwells than would be expected. This is likely to be because of the dominance of other facilities such as hotels, pubs and retail outlets which attract their own trips. Most business parks show a slightly higher than modelled trip rate, possibly due to the mix of uses generating some traffic in addition to the businesses on the park. Monument and Chilworth however have lower trip attraction rates per employee than TRICS would expect. This may be because the additional facilities at Chilworth

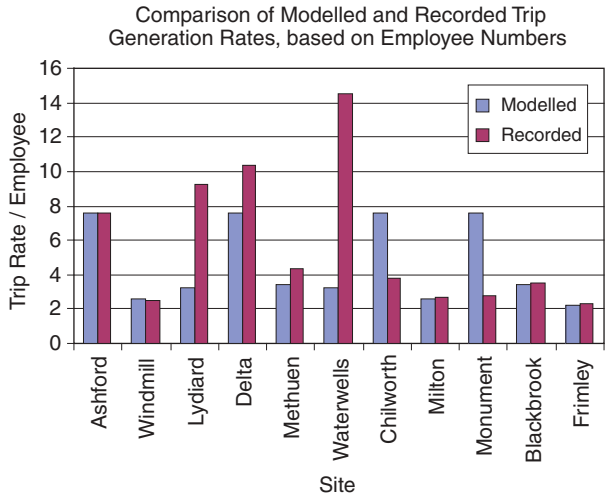


Figure 4.4 Comparison of modelled and recorded trip rates

and Monument do not generate many additional trips and reduce the number of additional trips made by employees during the working day.

4.3.2 Allocation of trips per land use

Self-completion questionnaire were completed by a sample of employees at each site. The number of employees that classified themselves as 'car drivers' to each site was recorded and then factored to represent the estimated total daily number of trips made by employees to and from the site by car. However, the factoring used for this total allows for only one entry and one exit from the site per car driver. The total does not take into account any trips that may be made during the day, for example, an employee may leave and return to the site during their lunchtime, creating two more trips that are not included in this estimated total. Therefore, to allow for this, the trip rate per employee at Frimley Business Park was used (2.32 trips per employee). Frimley Business Park is single use and therefore employees, rather than visitors to other land uses, will broadly make the number of trips on and off the site. However, the total does not take into account employees that drove a van or motorcycle to or from the site.

Nevertheless, from the employee questionnaires it was possible to calculate the trip purpose by car driver for the employees. In addition, the visitor surveys were used to estimate the number of cars entering the site to use the facilities. As very few reception surveys were carried out, the number of LGVs and HGVs entering the site was used to approximate the number of deliveries and visitors to businesses being made to the site. However, there may be some inaccuracy with the numbers of visitors to the businesses particularly those trips for deliveries as these trips were particularly difficult to record. From these calculations it was possible to allocate approximate trips per land use.

The series of graphs (Figure 4.5a-k) shows the percentage breakdown for the estimated trip numbers. These graphs show that employees largely account for the majority of trips to the sites, particularly at Frimley,

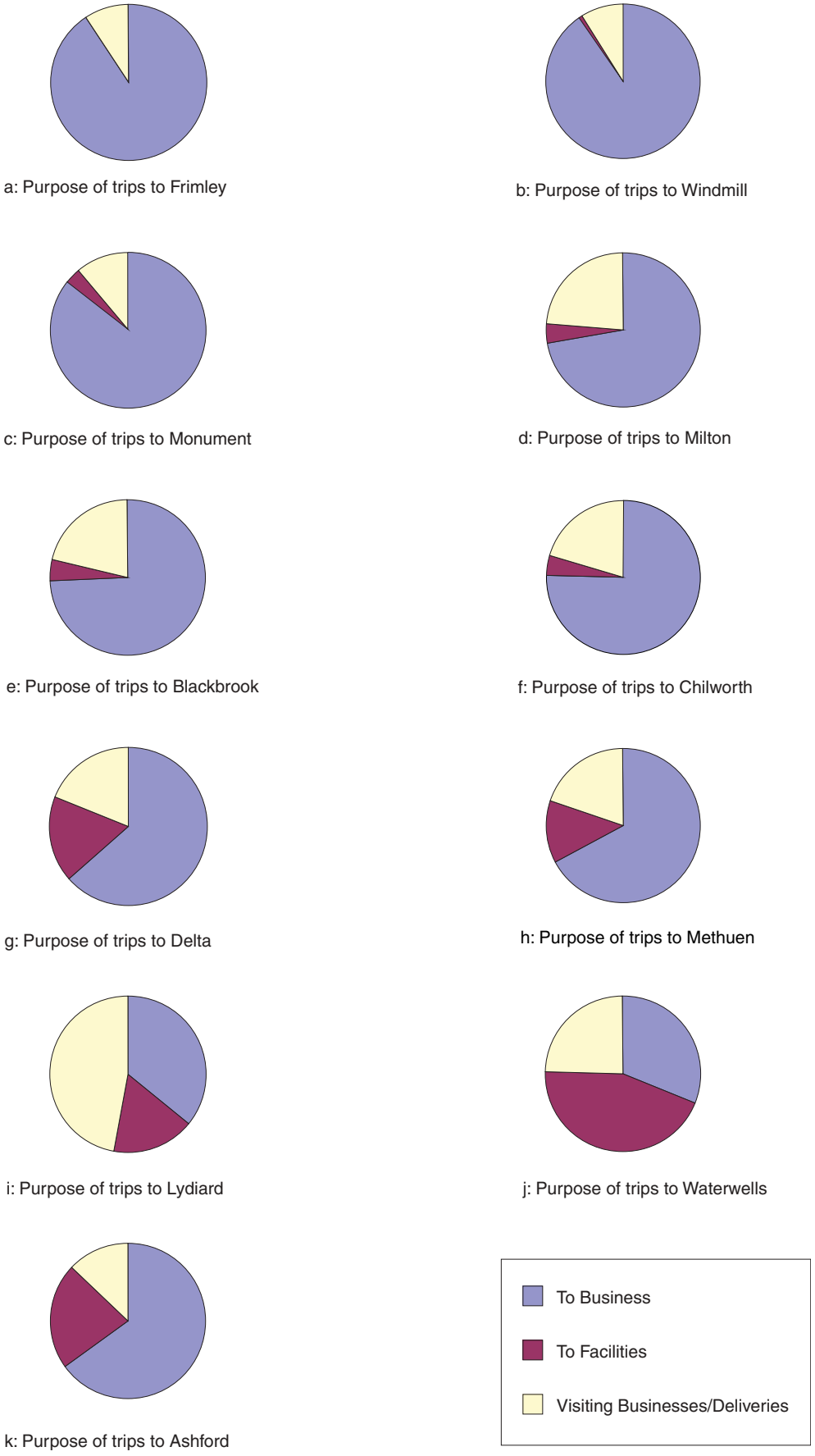


Figure 4.5 Journey purpose to the business parks

Windmill and Monument. This is because there were no or only a small number of facilities on these sites. Milton, Blackbrook, Chilworth, Delta, Methuen and Waterwells have similar proportion of trip purpose to each site. In particular, approximate 10-15% of trips to these sites are for visiting businesses, either for a meeting or for a delivery. Lydiard, Waterwells and Ashford show the least typical proportions of all the business parks. Lydiard has a large component of visitors to businesses and this is due to the presence of a distribution centre on site attracting a large number of HGVs. Waterwells is dominated by a hotel and pub and therefore the majority of trips to this site are due to these land uses. Ashford also attracts a lot of visitors to its facilities due to its large retail component.

4.4 Summary of trip attraction rates of the business parks

Actual daily traffic flows vary widely from business park to business park. Reasons for this include the employee numbers at the site and the floorspace of businesses present. However, the majority of the business parks have a morning and an evening peak period when employees at the site are arriving and leaving their places of employment. There are also inter-peaks at most of the sites indicating vehicles leaving and returning during lunchtime. The majority of the sites have a high weekday trip generation and a much lower weekend flow rate. The business parks with a dominant mix of facilities do not conform to this pattern (i.e. Lydiard Fields, Waterwells and especially Ashford) and instead have traffic flows that fluctuate throughout the day without a clear pattern and a high trip attraction rates at the weekend. Comparatively high weekend traffic flows can be explained by particular facilities on-site such as a hotel, retail, warehousing and a restaurant or public house.

5 Use of the facilities and their impact on travel

5.1 Use of the facilities

Figure 5.1 shows the users of the facilities and the percentage that are employees against the percentage that are visitors to the site. The graph shows that in only three cases are over half the users employees. This would suggest that only Milton, Monument and Delta are providing the types of facilities that are required by employees to encourage trip chaining whereas the remainder are only partly providing facilities needed by the employees. In addition, the remaining seven mixed use sites are also providing facilities which are attracting visitors to the site, thereby generating new trips. In particular, the large retail and leisure developments within Ashford, Lydiard and Methuen are attracting very few users who are employees. In general, the business parks generating the highest trip rates per employee (e.g. Waterwells, Lydiard, Ashford) are the sites which attract a high proportion of visitors to the facilities rather than employees of the business park.

5.2 Impact on travel of the facilities

Within the self-completion questionnaire each employee was asked how he or she travelled to work. Figure 5.2 provides an overview of the mode choices made by the employees at each business park. As with the manual multi-modal count, the dominance of the car driver is clearly apparent, however some attention should be drawn to sites such as Lydiard Fields and Milton Park where car passengers and public bus users are also notable. Ashford, Delta and Lydiard all have observable numbers of walkers, whilst there is a notable proportion of cyclists at Chilworth. Sites such as Delta and Lydiard Fields have, although minimal, a varied base of other mode users.

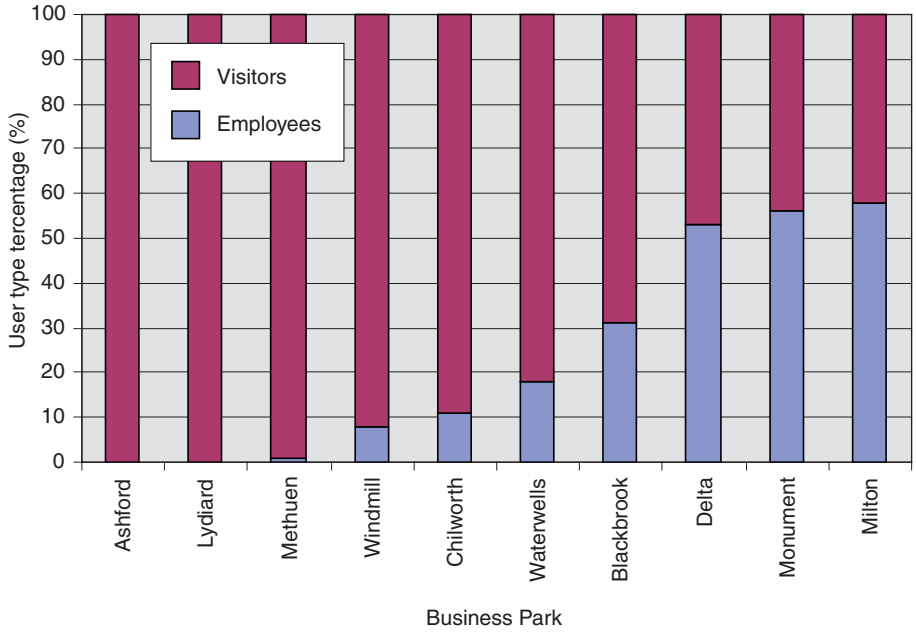


Figure 5.1 Proportion of visitors and employees using the facilities

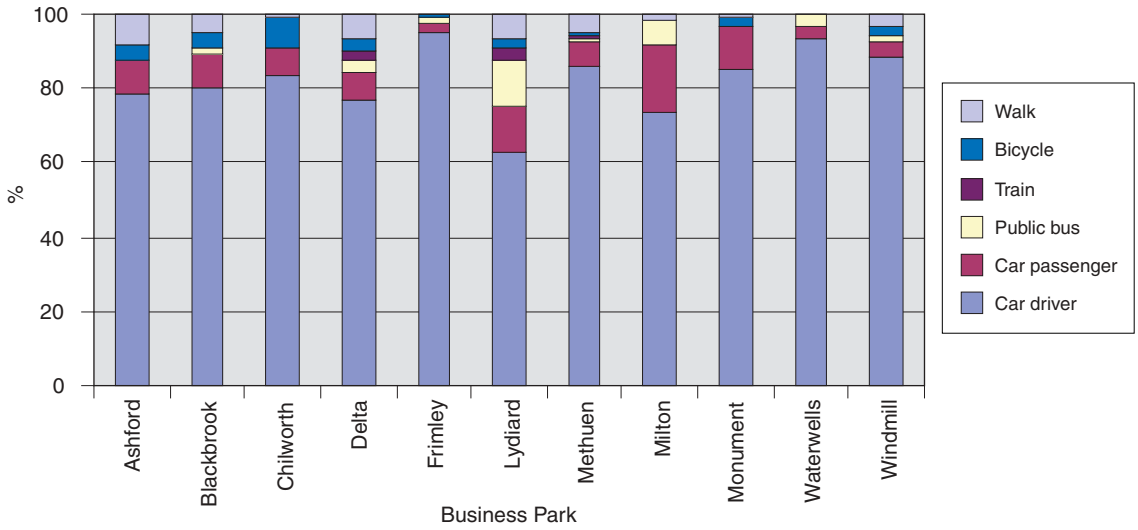


Figure 5.2 Overview of mode choice on survey day for all sites

Figure 5.2 suggests that business parks with limited on-site facilities resulted in a larger proportion of commuters travelling by car (Frimley, Windmill). Conversely, sites with a mixture of facilities such as food outlets attracted a higher proportion of trips as car passenger, by public transport or walking and cycling (Lydiard, Milton, Delta). This could be due to the presence of the mixed use facilities as Figure 5.1 has shown that a significant proportion of employees do use the facilities at Delta and Milton. However, it could also be related to the socio-economic characteristics of the employees or the availability of public transport. These findings are similar to those found by Cervero (1986).

5.3 Summary of facility use and its impact on car travel

The survey has shown that employees are using some of the on-site facilities. The more diverse the facilities on-site the more use were made of them by employees. For example, the business parks at Milton and Delta had a variety of different facilities and employees used these facilities. This would suggest that the type, scale and mix of uses at these sites were having a beneficial effect on the number of trips being made to these facilities during the day.

A key issue to consider when planning mixed use is the types of facilities which will be available. Suburban business parks are generally highly accessible by car and the types of land uses need to be chosen carefully to ensure extra trips are not generated. Retail outlets with a diverse range of goods may attract a large numbers of visitors and a limited amount of interaction between employees at the businesses and use of the facilities. Therefore, business parks like Methuen and Ashford Business Parks generate a large number of trips in addition to the employee trips.

The findings of the study are mixed in terms of the benefits of mixed use in suburban business parks. The business parks attract a substantial amount of car traffic. However, the employees of the sites are benefiting from more facilities being available within walking distance of their workplace. In turn, this appears to reduce the amount of travel off-site at lunchtime and encourages linked trips and, to a small extent, encourages the use of more sustainable modes than the private car to commute to work.

6 The impact of the trips on the trunk road network

Previous chapters have studied the trips generated at the local level. This chapter outlines the extent of the impact of the business park on the trunk road network by analysing commuting times. The eleven business parks are located in Southern England. They are situated within a distance of 180 miles from London. All of them, except Ashford, are located west and south west of London. The business parks are within easy access of the trunk road network. The parks attract many trips and most people (as discussed in previous sections) drive to and from the sites by car.

6.1 Comparison of commuting times

Figure 6.1 shows the proportion of employees and their journey times from home to work. The graph shows that of all the business parks surveyed, between 50% and 80% of employees do not travel longer than 30 minutes to work. The graph also shows that each business park has a different pattern and this is likely to be due to the socio-economic and land use profile of the site.

The business parks with a high proportion of employees travelling for longer than thirty minutes include Frimley, Windmill, Delta and Methuen. These business parks are predominantly composed of office based service sector companies. In contrast, the business parks with a large proportion of employees travelling for short commuting times include Monument, Milton, Delta, Lydiard, Waterwells and Ashford. There could be a number of reasons for this characteristic. The business parks of Lydiard, Waterwells and Ashford are not densely populated with office development. Many of the businesses on these sites are retail or leisure uses. The

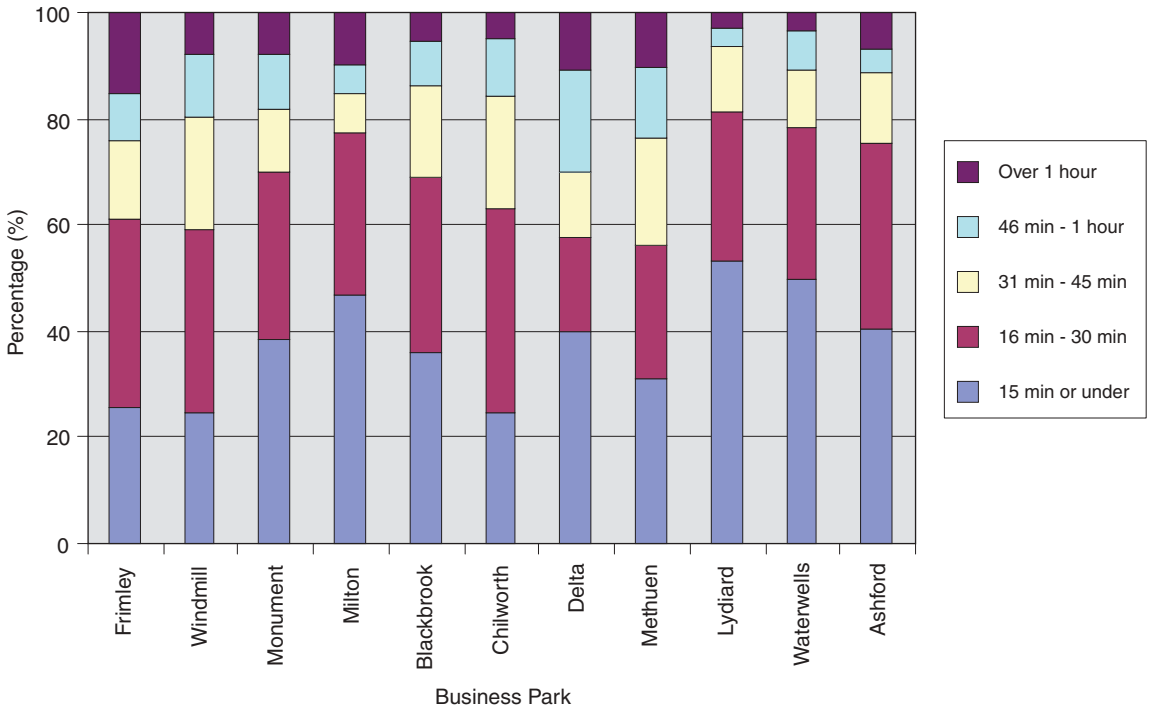


Figure 6.1 Proportion of commuters travelling within a time band by business park (all modes)

employees travelling to these businesses may not need to travel far to work in these industries. Although Milton Business Park has a large amount of office space, the site has a high proportion of distribution companies compared to other sites. Thus, the business profile at Milton may be affecting the commuting times. Monument also has a large number of short distance commuting trips. Monument is composed of a large number of small businesses which aims to serve the local community. Therefore, Monument is successfully attracting employees from within a 30 minute catchment of the business park.

Figure 6.2 shows the time taken for car commuters to travel to work. Similar trends are observed for the car-only commuters, compared to the all mode graph of Figure 6.1.

Due to the location of the business parks near the trunk road network it can be reasonably assumed that many of

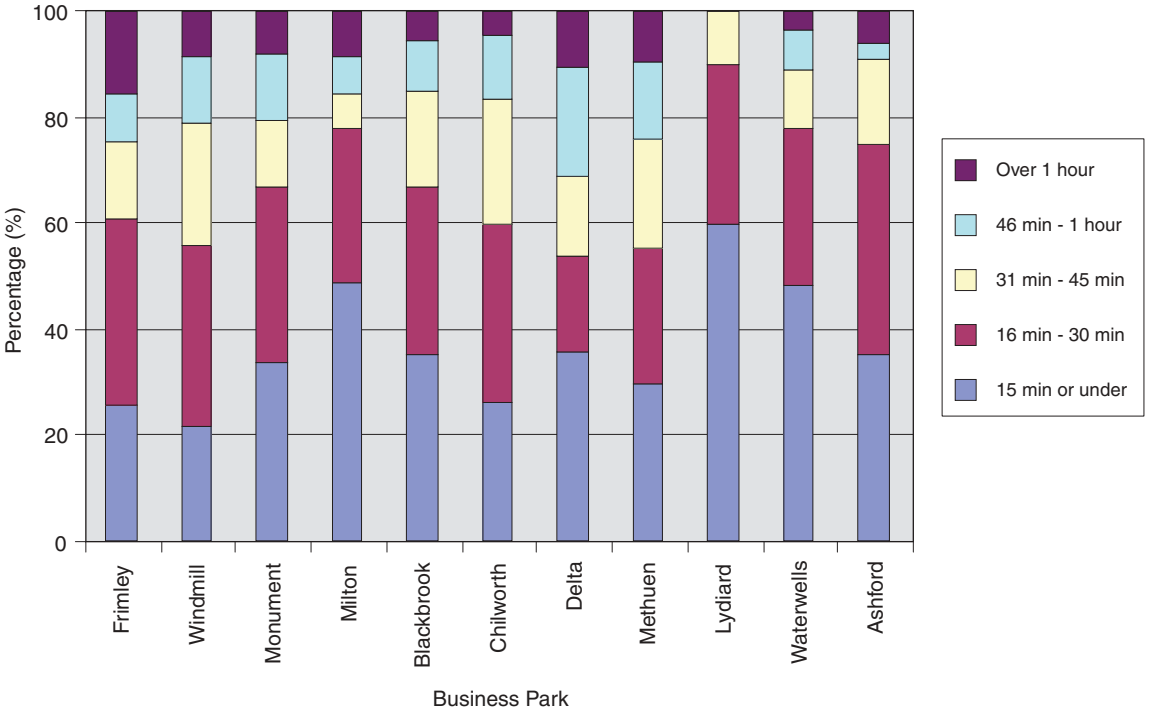


Figure 6.2 Proportion of car commuters travelling within a time band by business park

those commuters travelling for over thirty minutes are likely to be travelling on the trunk road network. According to this assumption and to the Figures 6.1 and 6.2 which don't take in account the additional traffic generated by more local employees and visitors to the site, approximately 20% to 50% of the employees will contribute to the trunk road's traffic volume. This may be useful to note when planning any type of business land use near a trunk road

6.2 Postcode analysis and summary

In addition to the commuting times analysis, the employee questionnaires collected information concerning employees' home postcodes. A simple mapping exercise was carried out in order to get a better understanding of the impact employee journeys have on the trunk road network. The distribution of employees by postcode districts gave a very rough representation of the impact on the trunk road network. The analysis showed that a relationship exists between the road network and residential location as often employees are located near to the trunk road network to access their workplaces. Distance to work also plays a role as densities of employees within each postcode area fall with distance. In addition as mentioned in section 6.1, the types of industries within the business parks has an impact on the distance travelled by employees.

For all sites the impact of the trips generated by the employees depends on the local network features:

- The number of routes possible to get to the park.
- The capacity of the roads.
- The proportion of people commuting at the same time.

It is evident that due to the location of the sites (adjacent to the trunk road network) that if employees do not contribute to the daily flow on the trunk roads they are likely to impact at the junctions. Therefore, although some sites generate predominantly local traffic, this local traffic will join with long distance traffic at key interchanges and junctions contributing to congestion, resulting in a knock-on effect to the trunk road.

7 Conclusions and recommendations

This section aims to provide an overview of the travel patterns generated by the business parks. The section is broadly divided by the objectives of the project:

- To identify daily trends in mixed use site related traffic and to examine the effects and impacts of mixed use developments on the trunk road network.
- To consider the trip attraction rates of mixed use business parks compared to single use business parks.
- To test the theory of mixed use development and its links with the reduction in car travel.
- To make recommendations which may increase the effectiveness of mixed use development as a tool for reducing road travel.

7.1 Daily trends in business park traffic and the effect on the trunk road metwork

Of the sites surveyed, eight showed typical commuter pattern flows, with morning and evening peaks in vehicle flow as vehicles entered the site and left the site and a smaller peak at lunchtime. Three of the sites displayed daily trends which would not have been expected for commuter related traffic. Waterwells and Lydiard showed a trend of peaks of vehicle activity throughout a twenty-four hour period. This relates to traffic arriving and leaving the hotel and pub/restaurant facilities at certain times of the day. Ashford Business Park shows high flows of traffic throughout the day and it is assumed that this is due to the large amount of retail occupancy.

Business parks with the highest vehicle flows have the most impact on the trunk road network. Nevertheless, due to the location of the business parks, adjacent to the trunk road network, it is likely that all the parks impact on the trunk road network to a degree. The eight sites which display typical commuter travel patterns are more likely to have a significant effect on the trunk roads at peak times as this is when they generate more trips. The three remaining sites tend to have peaks outside the 7am-9am morning peak and the 4.30pm-6pm evening peak. It could therefore be argued that these three sites have less of an impact on the trunk road network in terms of congestion. However, all sites generate a significant amount of traffic either during the peaks or throughout the day. Most sites attract a limited number of vehicles at the weekend and therefore do not affect the trunk roads at these times. However, sites with large facilities such as hotels, pub/restaurants and retail also generate large volumes of traffic at the weekend and significant congestion can be caused because of these leisure uses during normally expected off-peak periods. Sites which could potentially be causing an impact in the off-peak periods include Lydiard, Waterwells, Methuen and Ashford.

7.2 The trip attraction rates of mixed use business parks

The eleven sites have shown a variation in trip attraction rates. Table 7.1 shows the variation by employee numbers. The business parks are ordered with the highest trip attraction rate per employee, highest in the list. These figures suggest that Windmill Hill, Frimley, Milton and Monument have the lowest trip attraction rates per employee and that Delta, Waterwells and Lydiard have the highest trip attraction rates per employee. This therefore suggests that

Table 7.1 Trip rates of each business park

Business park	*Trip rate / Employee*
Waterwells	14.52
Delta	10.37
Lydiard	9.28
Ashford	7.54
Methuen	4.36
Chilworth	3.76
Blackbrook	3.48
Monument	2.78
Milton	2.65
Windmill	2.51
Frimley	2.32

the business parks dominated by business uses have the lowest trip attraction rates. The sites with a significant amount of facilities attractive to visitors generate the highest number of trips per employee as additional non-business park related trips are made to the site.

This raises the issue of the extent to which mixed use developments benefit the rate of trip attraction. Table 7.1 suggests that mixed use is having a negative effect in terms of reducing trips, particularly as Frimley Business Park (a single use site) has a low trip rate in relation to the other sites. In general, the business parks generating the highest trip rates are the sites that attract the most visitors to the facilities rather than employees of the business park to those facilities (see Figure 5.1).

7.3 Mixed use development linked with the reduction in car travel

The finding that mixed use developments are not necessarily reducing the amount of car travel, goes against some of the assumptions concerning mixed use development. However, although there is evidence that it does not reduce the number of trips to the site, there is some evidence that sites with less mixed use such as Frimley and Windmill attract more commuter trips as car drivers (Figure 7.1). Therefore, the presence of mixed use may be making the journey to work more sustainable.

Figure 5.1 showed that some of the on-site facilities were being used by employees and that generally, the more diverse the facilities on-site the more use were made of them by employees. For example, the business parks at Milton and Delta had a variety of different facilities and more employees than visitors used these sites. This would suggest that the type, scale and mix of uses at these sites were having a beneficial effect on the number of trips being made to these sites during the day. This was partly confirmed in Table 4.2 which showed the percentage of lunchtime outflow from the business parks, taking the outflow between 12:00 and 13:00 hours as a percentage of the inflow between 07:00 and 10:00 hours. This was only an approximate indication as the outflow figure will also include vehicles not leaving the site due to a lunchbreak. Also, it was assumed that people were only leaving for lunch between 12:00 and 13:00 hours. However, there is an indication that Milton has a particularly low proportion of vehicles leaving the site at lunchtime suggesting the use of on-site facilities. Monument also shows low levels of lunchtime outflow. This could be because of the presence of a small café on-site. What appears to be important is the presence of on-site facilities which are attracting a larger proportion of employees to visitors. This reduces the amount of outflow generated by the business park as employees remain on-site. Sites like Ashford and Methuen have high proportions of lunchtime outflow because of visitors continuously leaving the retail outlets in addition to employees travelling off-site at lunchtime.

These findings highlights the need to consider the types of facilities developed on a suburban business park. Suburban business parks are generally highly accessible by car and therefore the types of land uses need to be chosen carefully to ensure extra trips are not generated. The business parks which generated the least number of visitor trips were those with small facilities such as Monument or with a diverse number of smaller facilities (Delta and Milton). Retail outlets with a diverse range of goods attracted large numbers of visitors and a limited amount of interaction between employees at the businesses and use of the facilities. Therefore, Methuen and Ashford Business Parks generated a large number of trips in addition to the employee trips. This was particularly confirmed when the automatic traffic count figures showed a high number of trips being made to these business parks at the weekend.

7.4 Summary

It has been found that suburban business parks generate a significant amount of traffic and therefore impact on the trunk road network. In terms of trip attraction, the mixing of land uses within the business parks has had limited benefits on reducing the number of vehicles travelling to

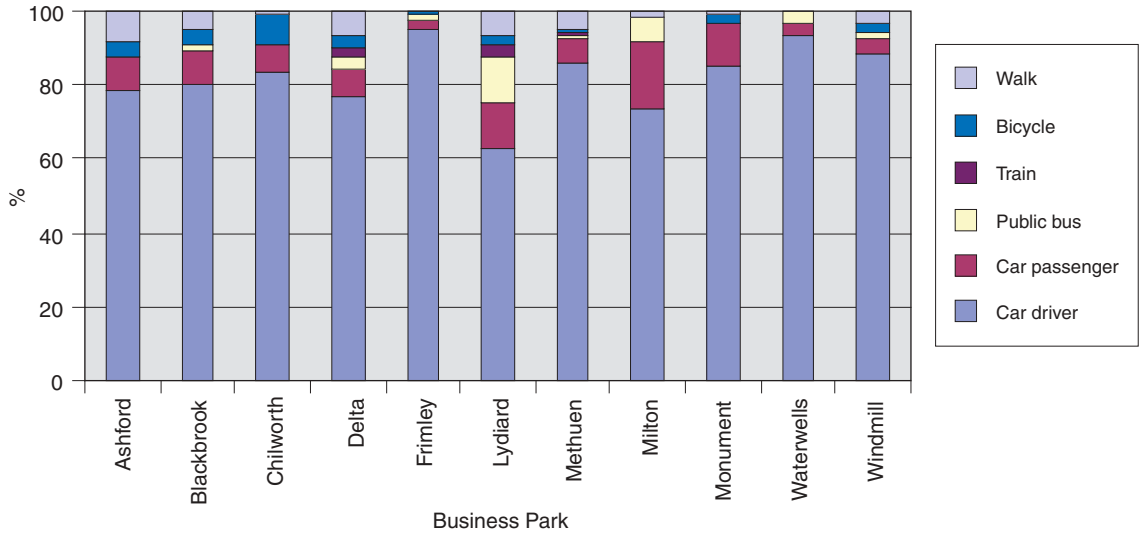


Figure 7.1 Employee mode choice

the site each day. In general, the mixed use developments within the business parks incur additional trips rather than a reduction in trips. Some land uses can dominate the business park and operate as single uses without encouraging interaction between land uses, particularly if large retail outlets were a component of a business park. Instead, each land use generates its own set of trips. This is particularly evident when there are key land uses on the site. For example, sites with hotels, pubs, restaurants and large retail outlets dominated or were equivalent to the business on the site in terms of generating traffic.

However, there were some sites which seemed to reduce the amount of trips made to and from the site. Business parks which had a selection of facilities and which were smaller and served only the employees rather than attracting visitors were effective in reducing lunchtime trips and did not encourage many additional trips. Therefore, the choice of land uses to locate on a business park needs to be considered carefully. Although facilities within the business parks need to be economically viable, if a key objective is to reduce trips to and from a business park they also need to be small facilities so as not to generate trips in their own right.

There was also evidence to suggest that business parks with limited on-site facilities resulted in a larger proportion of commuters travelling by car. Conversely, sites with a mixture of facilities such as food outlets attracted a higher proportion of trips as car passenger, by public transport or walking and cycling. This could be due to the presence of the mixed use facilities but also could be related to the socio-economic characteristics of the employees or the availability of public transport.

The findings of the study are mixed in terms of the benefits mixed use suburban business parks have on the trunk road network. In terms of trip attraction, most sites have a negative effect. In particular, the business parks generate a substantial amount of traffic during the peak periods contributing to congestion on the trunk road network. However, the employees of the sites are benefiting from more facilities being available within walking distance of their workplace. In turn, this appears to reduce the amount of travel off-site at lunchtime and, to a small extent, encourage the use of more sustainable modes than the private car to commute to work.

8 Acknowledgements

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Abstract

This research report, commissined by the Highways Agency, considers the trip attraction rates of mixed use developments. The research has provided greater understanding of the impacts of mixed use on car travel. Initially, a literature review highlighted existing knowledge of the effects of mixed use. Subsequently, in 2002, empirical research was carried out to collect primary evidence. Eleven suburban business parks were selected in the south of England to study employee and visitor trip patterns to each site. Data collection methods included automatic traffic counts, manual multi-modal counts, employee and visitor questionnaires and developer interviews.

Related publications

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