The role of bus-based Park and Ride in the UK: A temporal and evaluative review

STUART MEEK, STEPHEN ISON* and MARCUS ENOCH

Transport Studies Group
Department of Civil and Building Engineering, Loughborough University
Loughborough, Leicestershire, LE11 3TU, UK.

*Corresponding author. Tel.: +44 (0)1509 222605; fax: +44 (0)1509 223981. Email address: s.g.ison@lboro.ac.uk

Abstract

The number of bus-based Park and Ride schemes in the UK has grown substantially over the past 40 years as a result of its encouragement by the Government as a tool to deal with increasing traffic congestion and traffic-related pollution. The aim of this paper is to analyse the degree to which Park and Ride is effective in the contemporary policy context. The authors identify phases of development of Park and Ride since its emergence as a local solution to transport capacity constraints in historic towns. Policy goals are identified against which a review of literature is used to highlight its effectiveness. It is concluded that Park and Ride may increase the distance travelled by its users due to low load factors on dedicated buses, public transport abstraction and trip generation, although it is highlighted that there are areas in which further research is required to clarify its impacts.

1 Introduction

'Park and Ride' (P&R) is the name given to the form of intermodal transport that specifically involves the interchange between private and public modes to perform a complete trip, through the provision of a parking facility with direct access to a public transport service (Spillar, 1997). While the private mode used is generally the car, cycle storage facilities are also common, either alongside car parking or exclusively with 'bike and ride' schemes. Various modes of public transport are used for the 'ride' component of the trip. P&R sites are found adjoining light and heavy rail networks and may be added to an existing bus network, or as is more common, dedicated bus services. P&R is also used as an interchange facility for ridesharing.

P&R is a tool that has been used internationally, although varying degrees of success have been experienced. It has become particularly popular in the US for instance, where most urban areas have introduced schemes to support existing public transport networks, reduce congestion or provide a ridesharing facility (US EPA, 1992). The design of P&R schemes also differs according to the contexts in which it is used and the reasons for its use but there are three main formats adopted (AASHTO, 1992; Spillar, 1997): *remote P&R services* offer a long-distance connection (typically 40-80 miles) from satellite or rural settlements to major employment or retail centres using express services; *local service P&R* tends to be located on traditional public transport networks and operates informally and on a much smaller scale; *peripheral P&R* schemes are those located on the edge of urban areas and are used to intercept motorists travelling into the centre.

In Europe, the popularity of P&R has been mixed. In the Netherlands for example, a general lack of success with P&R has been attributed to insufficient excess demand for CBD parking and a lack of sustained political support (Bos and van der Heijden, 2005). P&R has been more successful in other parts of Europe however. Germany is one such example and in Munich alone there are over 26,000 users of P&R every day, the spaces for whom are provided adjoining stations on the S-Bahn (commuter rail) and U-Bahn (metro) networks (Haller, 2006). Other successful P&R policies have been seen in other European cities such as in France, Spain and Scandinavia (CfIT, 2001).

In the UK, heavy rail-based P&R has been very common and although this has usually been practiced informally from station car parks, but there are instances where parking is branded as a P&R service. There has been renewed interest in light-rail in

the UK over the past 30 years or so and resultantly P&R sites are used on most of these networks. It is bus-based P&R however, operating from the edge of towns and cities, that has become significantly popular with over 100 currently operating throughout the UK (TAS Partnership, 2007) and is indeed the subject of this paper. Although some shared-use sites have been used, on racecourse and supermarket car parks for instance, these are exceptions and schemes usually operate from purpose-built sites located 2-6km from the urban core (Parkhurst and Richardson, 2002). Sites are served by dedicated high-frequency bus links which have few egress points. Buses are generally modern and of high quality to convey an image appealing to motorists that would not otherwise use public transport. The price of the service is usually combined, with payment been made either on-site or on-bus for both the parking and bus (return trip) elements.

The development of P&R in the UK however, has occurred in light of philosophical shifts towards transport policy which have brought with them changing policy goals for P&R despite the concept itself remaining relatively unchanged. The aim of this paper is to trace the development of bus-based P&R schemes in the UK and consider the degree to which they are effective in the contemporary policy setting by means of a detailed review of literature. As such, the following section charts the phases of P&R development within the UK in terms of the political context from which it has emerged. From this, the broad strands of policy goals are elucidated, namely those that are associated with transport, the environment and the economy. This framework is then used to evaluate the effectiveness of P&R in the subsequent section. This is followed by conclusions regarding the overall role of P&R within the UK and recommendations for future research.

2 The development of Park and Ride in the UK

Although there are currently over 100 bus-based P&R schemes operating in a wide range of settings across the UK, this proliferation has only occurred relatively recently. P&R has grown from its success being initially confined to small- and medium-sized historic towns (Parkhurst and Richardson, 2002). In order to highlight the development of P&R the authors have identified four distinct phases which characterise both the reasons for P&R's growth in popularity and the changing policy goals for which it has been used: *the emergence phase*, in which P&R was originally championed by local authorities as a solution to local infrastructure constraints primarily in historic centres; in *the national awareness phase* the profile of P&R was raised through its recognition by Central Government, albeit within a limited role; *the promotion phase*, wherein the Government then increased support through policy and funding; and in *the cautionary development phase* there has been a retreat in political support as a result of uncertainty over the effects of P&R, although it continues to be adopted by local authorities.

2.1 Emergence phase

Bus-based P&R services were first established in the UK during the 1960s in various centres such as Leeds, Nottingham and Leicester. They were initiated by local authorities as a result of concerns over the effects of rising car ownership on their centres and the need for expansion of road and car parking infrastructure within the urban core (LCPD, 1964; Bixby, 1988). Such development would have been at the detriment of both local urban identity and valuable urban land. Many of these schemes were trialled on a seasonal basis, such as in Leicester during the Christmas

shopping period when parking demand was particularly high, before been introduced full-time. P&R was thus a means to increase the accessibility of host centres with the provision of overspill parking.

Nevertheless, the success of these first schemes remained within peak shopping periods and during the 1970s all of them were withdrawn. Cairns (1997) attributes the initial failure of P&R to an absence of the environmental awareness that has encouraged P&R's subsequent success and a lack of focus on the needs of car users to encourage patronage. There was also an absence of accompanying restraint measures on car use, and even when such measures were used they were also abandoned, as with the case of the Nottingham 'Zone and Collar' scheme (Daniels and Warnes, 1980). The lack of restraint measures is of course a factor that is resonant today but traffic congestion levels in the 1970s were arguably too low to offer the P&R user significant time savings against conventional road access to centres.

The notable success within the Emergence phase however is P&R in Oxford, where services have been sustained since the 1960s. Although the scheme is the longest established in the UK and has become a benchmark of the P&R model (DETR, 1998a; Parkhurst, 1995), it was not without some of the common difficulties experienced by its predecessors such as limited popularity among motorists and resultantly low revenue (Papoulias and Heggie, 1976). The survival of the scheme was nevertheless due to the "*strength of political will*" (Parkhurst 1995, p.15-16) for it to succeed and the introduction of complementary measures such as stringent parking controls in the city centre (Williams, 1999). Financial difficulty was lessened in 1978 when much of the control of the service was transferred to the bus company, thus increasing efficiency and revenue (Bixby and Bullen, 1983).

From the wider perspective however, the success of P&R in Oxford can, at least in part, be attributed to the historic nature of the city. Such settings provide unique challenges for transport provision because of the limited scope for the development of central parking and road infrastructure caused by historic buildings and pre-car urban structures (Hughes, 2005). Thus for historic centres such as Oxford, perceivable transport problems exist for policymakers to address and potential demand exists for alternative means of access such as P&R (Simpson, 1994).

The early 1980's saw a number of new schemes in cities such as Cambridge and Chester that were stimulated by both the sustained success of P&R in Oxford and also because of the contextual similarities spurring policymakers to seek suitable solutions (TAS Partnership, 2000; Cairns, 1997). Thus, a process of 'policy learning' had begun (Rose, 1993) albeit confined at this stage to the most similar settings because of the earlier failures of P&R.

2.2 National awareness phase

Whilst P&R had remained under the auspices of local authorities within its Emergence phase, during the 1980s it became recognised by the UK Central Government. Initially the 1980's was the 'decade of the motorist' (Banister, 1992) with increasing car ownership, a deregulated planning system, and the Conservative Government's 'predict and provide' attitude to road building. The tenet here was that any disbenefits of road construction were insignificant by-products for the opulence of the nation afforded by an increasingly itinerant population. The zenith of 'predict and provide' came after the publication of the DoT's revised road traffic forecasts (DoT, 1989a) suggesting between 82-134% growth in car traffic between 1988-2025

and the White Paper *Roads to Prosperity* (DoT, 1989b) outlining plans for road construction to match demand with capacity. The more considered response however, was for the dogmatic 'predict and provide' philosophy to become less favoured as a possible solution. This was induced in part by recognition of the spatial constraints and induced demand inhibiting road construction (Goodwin, 1999) but also by the limited opportunity for its funding imposed by 1980s' weak economic conditions. Environmental issues were also becoming prominent within both the political and public psyches. This was spurred by the 1987 Bruntland Report (WCED, 1987) and the 1992 'Earth Summit' (UNCED, 1992). Significant media attention at the time was also given to protest of road building such as that for the M3 extension at Twyford Down and the Newbury bypass in the early 1990s (Bryant, 1996; Kingsnorth, 2004).

P&R was first recognised by the Central Government as a traffic management tool to deal with congestion whilst increasing the accessibility of host centres in *This Common Inheritance* (DoE, 1990), the 'landmark' environmental White Paper (Goodwin, 1999) and in the planning policy with (statutory) Planning Policy Guidance (PPG) Note 6 for *Town Centres and Retail Development* (DoE, 1993). Specific design details were also given with the *Traffic Topics* leaflet on the components of P&R schemes for their use in traffic management (DoT, 1993). Further adding to the appeal of P&R for local authorities was the increased financial assistance from the Central Government. P&R was funded from both the Transport Supplementary Grant (TSG) and the Government's programme for bus priority schemes (Huntley, 1993). By 1993 it could also attract funding through the Transport Policies and Programmes (TPP) process in which Government funds were allocated for local authorities' packages of transport policies (Parkhurst and Richardson, 2002). Local authorities thus perceived P&R as a "*relatively 'cheap' transport option*"

(CPRE 1998, p.11). Also, bearing in mind that the local bus industry was deregulated in 1986, Cairns (1997) suggests that "*the introduction of Park and Ride allow*[ed] *local authorities to re-establish some influence over local bus services"*(Cairns 1997, p.297).

By 1994 the role of P&R was becoming much more explicitly associated with reducing congestion but the potential disbenefits and the complementary measures required to enhance the success of schemes were also recognised. PPG13 *Transport* (DoE/DoT, 1994a) suggests that schemes are:

"*usually designed to avoid excessive congestion… Care should be taken (for example through tariff structures) to avoid encouraging additional travel, and especially commuting, by car. The impact…can be enhanced if accompanied by public transport priority measures.*" (4.30).

At the same time though, the economic benefits to "*improve the accessibility of urban centres*" (4.28) and "*increase the total public parking stock*" (4.30) were recognised which aligned more closely with the goals of the earlier local authority initiated schemes. Viability was also given to schemes with suggestions of additional funding sources "*from commuted parking payments, off-street parking revenue, and in the future, funds generated from on-street parking enforcement*" (DoE/DoT 1994b, p.119), which contributed towards an attractive package of funding options for local authorities (Table 1).

[INSERT TABLE 1 HERE]

Indeed, during the *national awareness phase* a number of P&R schemes were initiated, mostly in towns of a similar historic nature as the earlier schemes. Towns such as Shrewsbury, York and Winchester all adopted P&R in the late-1980s and early 1990s. Notably, P&R re-emerged in Nottingham in 1989 after its earlier failure as part of the 'Zone and Collar' scheme which was phased out in 1976. The goals for the schemes in this period echoed those of the National Government. For instance, Canterbury introduced full-time P&R in 1994 within a package of other measures including pedestrianisation, bus priority and central parking controls. The policy goals for the package were to reduce car traffic (particularly during peak hours) and pollution, and to develop the economic vibrancy of the centre (Roberts et al, 1998).

The perceptions of P&R at this stage however, were not all positive and in the aforementioned Government document (DoE/DoT, 1994b) there is caution over the lack of evidence on the mode previously used by P&R users and the risk of abstracting from existing public transport services, as well as the possibility of congestion relieved by P&R schemes releasing suppressed demand (p.117).

Nevertheless, P&R did have an important foundation in transport policy. PPG15 *Planning and the Historic Environment* (DoE/DoNH, 1994), for instance, suggested that P&R (along with parking charging policies and public transport priority) were a compromise between the extremes of road construction which would damage historic environments, and full pedestrianisation which would make centres "*sterile*" (p.23). By contrast however, the Royal Commission on Environmental Pollution 18th Report *Transport and the Environment* (RCEP, 1994) viewed the role of P&R as a complementary 'carrot' to be used alongside traffic restraint 'sticks', to deter car use and offer an alternative.

2.3 Promotion phase

Whilst the early-1990s saw Government awareness and new funding opportunities, Parkhurst and Richardson (2002) point out that this was followed by a significant turning point; "*by 1997, Government support for P&R has moved from recognition to active encouragement*" (p.196). They suggest that this was indicated by the revised PPG6 *Town Centres and Retail Development* (DoE, 1996) advising that traffic management strategies*"...**should include**…parking managed for the benefit of the town centre, including park-and-ride facilities as an alternative to town centre parking*" (Annex E, p.35; emphasis added).

It was the election of the Labour Government in 1997 however, that gave P&R new importance within transport policy. The first evidence of a transition in transport philosophy was a press release from the new Government declaring "*predict and provide is dead*" (DETR, 1997). Nevertheless, the Government's first transport White Paper *A New Deal for Transport* (DETR, 1998a) was published the following year, although it had been reportedly delayed to avoid "*backlash from middle England's two-car families"* (Tempest, 2002). It suggested that such a radical approach was not to be taken;

"*Our new approach is about widening choice, not forcing people out of their cars when using a car is their preferred option… We want to see more opportunities for cars to be used as part of an integrated transport system. We are therefore encouraging park and ride facilities to town centres to help beat congestion...*" (DETR 1998a, p.42).

Shaw and Walton (2001) thus suggest that there had been a retreat to "*Pragmatic Multimodalism*" in trying to deal with increasing traffic congestion and its environmental by-products whilst not provoking objection from the car owning public. This philosophy presented the opportunity for P&R to flourish, both as a visible model of the rhetoric of 'integration' at the time (May et al, 2006) and as a policy option which was generally saleable to the public, unlike some of the other instruments suggested, such as road user charging and workplace parking levies. Furthermore, Parkhurst and Richardson (2002) suggest that there was "*an aspiration that P&R* [would] *contribute to the achievement of the Air Quality Strategy in urban areas*" (p.196).

The support of the Government for P&R was illustrated in the report *Planning for Sustainable Development*' (DETR 1998b, p.100) in which it was recommended as a tool to reduce traffic congestion and air pollution. Furthermore, *The 10 Year Plan* (DETR, 2000) suggested that:

"[P&R schemes] *can offer an effective way of reducing congestion and pollution in busy urban centres, especially when combined with bus priority measures on the routes to the centre and parking controls… Park and ride therefore provides a flexible tool for local authorities, and we see considerable scope for new schemes in a wide range of towns and cities…*" (p.60).

Despite P&R initially experiencing success in medium-sized historic centres then, it was being supported in a broader range of settings. The *The 10 Year Plan* goes on to suggest that a "*heightened level of* [planned] *investment would be able to deliver…up to 100 new park and ride schemes…*" (p.65). Around this time and even before the publication of *The 10 Year Plan*, P&R was receiving much more popularity in towns

and cities somewhat different in character and size to the historic medium-sized towns with which it has previously been associated.. For instance, between 1998 and 2001, Leeds, Hull, Swindon and Swansea had introduced schemes.

2.4 Cautionary development phase

The role of P&R in reducing car use was brought increasingly into question in the late-1990s (CPRE 1998) and there was somewhat of a retreat in political support. This fuelled local opposition to the construction of P&R sites which had occurred on environmental grounds, especially where greenbelt land was used which was otherwise generally protected from development. Uncertainty over the impact of P&R on travel behaviour led the Government to verify its effects (Parkhurst and Richardson, 2000). The commissioned study by W.S. Atkins (WSA, 1998) however, was itself shown to have weaknesses by Parkhurst (2000), who demonstrated that P&R potentially increased the mileage travelled of its users. The revised PPG13 *Transport* (DETR, 2001) referred to it being suitable only "*in appropriate circumstances*" (p.21) and while it had previously been seen as a stand-alone measure, should "*be developed as an integral part of the planning and transport strategy for the area*" (p.22).

The emphasis had been taken off P&R as a means to reduce congestion and improved sustainability and it was becoming perceived as a method to promote public transport services which could then deliver these goals. The 2004 White Paper *The Future of Transport* (DfT, 2004) for instance, identifies P&R as a way to enhance light rail schemes and bus services (p.62) and in the DfT advisory leaflet on P&R (DfT 2005, p.1) it is seen as "*one of a range of transport planning tools that can be used to*

encourage car users to switch to public transport". The advisory leaflet also considers schemes useful in encouraging modal shift to traditional public transport by improving its image. Also, in contrast to the aforementioned DETR (2000) aspiration for P&R to be developed in "*a wide range of towns and cities*" (p.60), DfT (2005) outlines that "*its use will depend on local circumstances*…[it is] *not appropriate everywhere"* (p.1).

The current situation however, suggests that although there has been a retreat in support within the policy, the reality has not matched the rhetoric. Whilst not fully on course with the aspirations of the *Ten Year Plan*, between 2001 and early 2007 51 new sites had opened (TAS Partnership, 2007). Although many of these were sites added to existing schemes (such as in Norwich and York), there were also new schemes introduced, particularly in the final years of the first Local Transport Plan (LTP1) period (2001-2005). In Durham for instance, the scheme was somewhat unusual in that its three sites were introduced simultaneously, with most other schemes taking an incremental approach to site additions. While some of the goals for the Durham scheme were similar to those that had been typical throughout the development of P&R, such as increasing accessibility, reducing congestion and enhancing the image of public transport, the scheme's goals also reflected the Government's rhetoric of the time and it was seen to "*perform well on integration*" (Durham County Council 2000, p.153).

Indeed, the public popularity of P&R seems to be widespread which is highlighted by a CfIT survey (2002) for instance, which suggested that over 80% of the population in England were in favour of further P&R development. This popularity, combined with

a wide range of funding mechanisms available for schemes have fuelled the favourability of P&R for local policymakers and it remains a practical policy option.

3 The effects of Park and Ride

The previous section was concerned with eliciting the various policy goals for P&R, which can be broadly categorised into three strands, those that are associated with transport, the environment, or the economy:

- *Transport*

  The first P&R schemes were initiated by local authorities and were used to increase the accessibility of historic centres. They were introduced in response to limited opportunities for road or car park expansion within the urban core because of physical constraints. Subsequently there was a shift in Central Government road building philosophy and an emphasis on multi-modalism within transport policy. This resulted in P&R being promoted as an instrument to persuade motorists onto public transport to reduce congestion and overall car use within host centres.

- *Environmental*

  The objectives for P&R to reduce atmospheric and local pollution came to prominence in the 1990s as a result of an increasing awareness of the environmental disbenefits of car use. Receiving much more local attention however, has been the construction of P&R sites. Local environmental concern is intensified where greenbelt land is used but such land is often the most appropriate because of its location on the edge of urban areas. Scheme implementation is essentially the result of a trade-off between these local concerns and the perceived economic, decongestion, and emissions benefits of P&R.

- *Economic*

  The economic-related goals for P&R have essentially been the domain of local authorities competing regionally for economic activity within their centres. By providing additional parking stock to host centres P&R increases accessibility whilst avoiding car park construction in the urban core where land is more valuable. Any reduction in congestion from the transfer of motorists to P&R will free road space which may also induce further visitors.

Despite the rapid growth in the number of P&R schemes, their suitability to fit into these roles has not been established a priori (Parkhurst, 1996) and their effects are not yet fully understood. This section thus reviews the literature relating to the effects of P&R, providing evidence to show the extent to which it has fulfilled these intended roles. In the UK the previous work looking holistically at the role of P&R has been the reserve mainly of Parkhurst (1994, 1996, and 1998 for example) drawing primarily on early P&R user survey evidence. Based on this he argues that P&R has a limited, or even counter-productive, direct effect on transport goals because of the lack of evidence indicating a reduction in car use by its users. He suggests therefore that it may be confined to a 'psycho-political' tool, used as a 'carrot' for other measures. This section builds on this work and seeks to identify the gaps in current research.

3.1 Transport effects

At the most obvious level P&R has been used as a means to affect travel behaviour within its host centres, whether ultimately for increasing accessibility, reducing congestion (and its by-products) or avoiding road construction. These host centres are

not isolated entities though and P&R will have wider effects, both with transport interactions spatially and in terms of transport markets. A balanced assessment then and indeed the approach here, is concerned not only with the extent to which P&R accomplishes its intended goals but also its wider impacts. The key areas of concern identified within the literature are thus addressed in turn; namely, the abstraction of passengers from traditional public transport services and the generation and diversion of trips. This is followed by considering the definitive issue of how the total distance travelled by users is affected.

3.1.1 Abstraction from public transport

P&R schemes are targeted at intercepting car users from routes into centres, thus removing cars and reducing traffic flows downstream of P&R sites. Yet the incentives offered to motorists (price, frequency, comfort etc) also lend themselves to users of existing public transport services. To attract motorists P&R services are often subsidised for example, to compete with parking charges in the urban core (Pickett and Gray, 1996). By competing in this manner however, traditional public transport fares can also be undercut, which are not generally subsidised (Huntley, 1993).

The transfer (abstraction) of passengers to P&R from conventional public transport services may offset savings that are made by P&R from intercepted motorists. The potential of P&R to abstract passengers does depend on passengers' car access but if public transport was previously used out of choice rather than need then this abstraction generates car journeys for the P&R access trip. The degree to which this negates mileage savings made from intercepted motorists is likely to be considerable given that access journeys are generally longer than the trip leg between the P&R site and the urban core in which mileage savings are made (Parkhurst and Stokes, 1994;

Parkhurst, 1996). Spatially however, these mileage gains and savings are not comparable because public transport abstraction affects traffic flows upstream of sites whereas mileage savings are made downstream of sites.

In light of these potential transport effects the research shows that users abstracted from public transport form a significant proportion of P&R users. Surveys of P&R users have been used to highlight the magnitude of overlapping P&R demand from both motorists and traditional public transport users. Table 2 shows this survey data.

[INSERT TABLE 2 HERE]

An important line of differentiation should be drawn between the indicators for public transport abstraction; mode used before using P&R and the current alternative mode. Although the latter ought to be regarded as less reliable as it considers predicted behaviour, Parkhurst (1995) comments it is of particular importance in mature schemes where circumstances affecting modal split have changed since the introduction of P&R. Since the introduction of the early schemes the national trends have been for car ownership to rise substantially and bus services deteriorate, so whereas public transport was the mode from which some transferred it may no longer represent the alternative. The data do not generally conform to this view however and where both previous and alternative modes are considered, in most cases more respondents perceived public transport as their alternative than had previously transferred. Although a number of these users would have moved into the area or not visited, it should be remembered that P&R schemes are often introduced within some form of package of measures such as raised city centre parking charges, thus making central parking a less attractive option. It is not implausible however, that experience of P&R can change perceptions towards traditional public transport to some degree

(Parkhurst, 1996). Although not shown in the data table, it should be noted that a relatively small group of users access P&R sites by green mode, an average of 12% is reported by WSA (1998) for instance, which is in effect similar in transport (trip rate) terms as the previously used bus service.

Although with survey evidence it is tempting to generalise the data with the 'average effects of P&R', the variation in data should also be considered to understand what contributes to public transport abstraction. After all, P&R schemes and their host cities are not homogeneous. Demographics, the location of sites, and political differences are the most obvious differences, but other aspects may include the intricacies of the design, operation, implementation, and marketing of schemes. Further, Parkhurst (1999) suggests that the complementary policies such as central parking charges adopted by the host city contribute to the variation. Nonetheless the complementary 'sticks' employed, like central parking charges and standards, have been perceived insufficiently rigorous to make the presence of P&R felt on congestion levels (Huntley, 1993).

The variation can also, at least in part, be attributed to the comparative advantages of alternative modes prior to the introduction of P&R, with the urban structure of some cities will lend itself to the operation of bus services (Parkhurst, 1995). It follows that P&R is more suitable for some cities than others, namely those with more dispersed hinterlands and less uniform radial routes suitable for traditional bus services. At the most basic level, the variation in quality, frequency, and price of existing public transport (WSA, 1998) may provide a differing strength of 'push' towards P&R.

Although it is useful to consider the scale and variation of public transport abstraction, the next step is to recognise its implications; specifically, the distance travelled by

'new' car trips. This is particularly important given that savings made from intercepted car users will be rebalanced to some degree. In the research the significance of the distance travelled by users is often stated but rarely quantified. One exception is WSA (1998) who report that of the passengers abstracted in their eight case study cities, 68% travel less than 2km, and 15% more than 9km, to P&R sites. No other data on the matter is presented in their report. Meanwhile when considering trips to P&R sites by all users, Parkhurst and Stokes (1994) found a mean trip length of 20.2km (median 14.4km) in Oxford, and 13.2km (median 3.2km) in York.

Parkhurst and Stokes go on to analyse P&R users' access to existing public transport services using data on their origins and alternative mode choice, as well as public transport timetable information in their Oxford study. They found that most abstracted users are those that live closest to the P&R site whereas those from farther away are less likely to have high quality public transport access and would therefore not travel to the centre or drive all the way if P&R was not available. Similarly, WSA (1998) suggest that mainly intra-urban services are affected but provide limited evidence to support this view. Nevertheless, while the evidence suggests that most abstracted trips are short in length, it takes only relatively few abstracted trips to have a significant impact on the overall efficiency of P&R as car mileage travelled by these users for access trips is entirely accumulated (Parkhurst, 1999).

In terms of public transport services, the most obvious sufferers of P&R-induced abstraction are marginal bus routes, where the loss of relatively few passengers can seriously impact on the financial viability of services (Parkhurst, 1994; Pickett and Gray, 1996). The issue of equity is therefore raised which is particularly concerning given that P&R services are often subsidised from public funding.

Provided at the foot of Table 1 are examples of survey evidence from the North American experience of P&R for comparison, which unfortunately lack some of the detail provided by UK surveys. It is somewhat surprising that the data are within a similar range to the UK data given the contextual differences. Such differences include a general larger scale of operations, in terms of both the size of sites and the number of sites operating within single schemes (reflecting the large cities served), which in some cases involve multiple sites along single corridors into the host centre. Furthermore, US P&R tends to be much closer to traditional public transport operations in terms of image and operations (Turnbull et al, 2004), which can perhaps explain to some degree the slightly higher range of public transport abstraction and lower car interception.

Public transport abstraction is however relatively low for the rail-based scheme (Chicago), certainly in the context of the US schemes, although car interception is comparatively low also. This is unexpected given that bus feeder schemes operate to stations on the Chicago rail network (Foote, 2000).

3.1.2 Trip generation

At the local level, goals to improve the vibrancy of economic centres are generally in conflict with those to reduce traffic (Banister and Berechman, 2000). Trips that are generated as a result of the presence of P&R are no exception and while generated trips are good for business they increase the total amount of car mileage. To extrapolate the scale of generation the research has used similar survey techniques to those used for measuring abstraction; previous behaviour (proportion of users not travelling to the centre prior to the introduction of P&R), and alternative behaviour

(those that would not currently travel without P&R), the data is shown towards the right of Table 2.

While the intricacies of questionnaire design and sample selection should be borne in mind when considering a range of survey data and can indeed offer some explanation to the variation (see Parkhurst 1996), there is nevertheless a considerable range between studies. Clearly the location of sites will contribute to some degree. In the case of Brighton for instance, WSA (1998) suggest that nearby residents divert trips from local district centres. So it is also plausible that proximity to radial routes and taking it a step further, the relative strength of competing centres, will feature in the decision making process of potential users.

It is also interesting to consider the variation in data *within* centres where several datasets or survey days are considered. For those where weekday and Saturday survey data are presented it is unsurprising that Saturday trips are more likely to be abandoned in the absence of P&R given that shopping trips are generally more discretionary than commuting trips (Hewett and Davis, 1996). In addition, it is implied from the Oxford evidence, and to a lesser extent from the other instances where several datasets are presented, that the maturity of schemes may be linked to the scale of trip generation. In support of this, it would be expected that schemes become more influential on travel choices as they mature and awareness grows (Bixby and Bullen, 1983). The urban fabric of centres is also worth considering from the temporal perspective. Parkhurst (1996) for example suggests that prior to the boom of out-of-town retail centres there were limited comparable destinations and without P&R users had little choice but to continue to visit the centre.

The aggregate mileage implications of generated trips are dependent upon whether trips would not have been made at all in the absence of P&R, or if trips would have been made to an alternative destination for the same purpose (see the far right column in Table 2). With diverted trips the change in distance travelled hinges on alternative travel behaviour and specifically, the lengths of the alternative trips compared to those made using P&R. By reducing the generalised cost of travel, P&R is theoretically able to generate longer trips than would have otherwise been made (Parkhurst, 1999). Admittedly however, decisions to make trips and to which destinations involve multifaceted decision making processes that will depend on a range of benefits derived from a range of possible destinations.

Besides, the empirical evidence of the length of diverted trips is sparse. There is a view that diverted trips are relatively local; WSA (1998) for example, report that of all diverted trips 60% were less than 3km. Then again, much of this proportion of short trips was absorbed by a few of the studied centres and no reference is made to the remaining trips. Linked to this is the matter of the variation in length of generated trips between centres. Parkhurst (1999) for instance suggests that mature schemes generate longer trips. This is perhaps explained to some degree by the point made earlier that as schemes develop their sphere of influence will widen, attracting users from farther afield.

Because transport behavioural change may be the result of a number of transport policies, it is difficult to determine the long-term effects of trip generation by P&R *ceteris paribus*. Nonetheless a logical conclusion is that traffic growth is simply fuelled (CPRE, 1998). Further, transport is as a derived demand and as such generated

trips represent increased demand for the host centre, whose appeal is increased by P&R and this will result in a redistribution of trip-ends and therefore activity.

The amount of traffic generated as a result of P&R concerns not only those trips made to P&R sites. The relatively elastic demand for cross-centre or inter-urban journeys typical of UK urban centres may induce traffic as a result of the freed road space from P&R trips (Parkhurst, 1994), a contention which is certainly supported by the notion of induced traffic (Goodwin, 1996). Nevertheless, although there is a general dearth of evidence indicating reductions in congestion as a result of P&R, one exception is Canterbury where Roberts et al (1996) have reported a reduction of 9% in daily traffic flows during the first three years of opening. It is unclear however, if this reduction can be attributed solely to P&R or the overall package of measures (including central parking controls) within which P&R was implemented. Interception rates (the proportion of traffic diverted from radial routes to P&R) have however been reported for Oxford's sites as high as 17% (Huntley, 1993) and 25% (Mathew, 1990).

3.1.3 Total distance travelled

Understanding the aggregate transport effects of P&R is key in determining whether the total vehicle distance travelled is reduced or not. While there will be distance savings made from intercepted car users, there are also, as outlined above, distance gains from trips that would have otherwise been made entirely on public transport or not made at all. Although such analysis is fundamental to understanding the effects of P&R it is nevertheless fraught with difficulties. Not only must the current distance travelled by users be established but also the travel behaviour in the absence of P&R. This can perhaps explain the dearth of research *fully* evaluating the aggregate effects of P&R.

WSA (1998) provide an attempt to determine the change in distance travelled of P&R users in their eight case study cities. Their analysis is however limited to the 47% of users that parked at P&R sites and would have otherwise driven to the centre, so not including abstracted or generated trips. Nevertheless the results, shown in the left column of Table 3, suggest that in all cases distance savings are made from these users. Regarding the scale of savings, it is important to consider where these savings actually occur. Parkhurst (1999) suggests that any saving will be less than the distance between P&R site and the centre as this is the portion of trips in which vehicle mileage is removed from the network. It is unsurprising then that the variation in savings between cities is affected by the distance between their respective P&R sites and centres. Notably, the mean savings for each of the centres is about half of this distance, implying that some longer trips are taken to access P&R sites than would have otherwise been taken to the centre, although this detouring is insufficient to result in net mileage gains.

[INSERT TABLE 3 HERE]

Trips between P&R sites and centres however, do not represent complete savings of car mileage and users intercepted by P&R will make the trip using P&R bus services. It follows then, that these bus trips ought to be included in the assessment of vehicle distance travelled by users. Accordingly Parkhurst (1999) uses the analysis provided by WSA (1998), as well as estimates for the distance travelled by buses and external data for bus patronage, to include bus travel in the assessment, the results of which are shown in the right column of Table 3. To provide comparable mileage effects, Parkhurst uses a car-equivalent factor of bus mileage thus allocating it per passenger carried. In terms of the savings between cities the emphasis is thus shifted from the

distance between P&R site and centre to the load factors of P&R buses, which is in turn related to the size of sites, number of users and space turnover, and therefore the journey purpose of users (Parkhurst, 1999). This recalculation results in mileage gains in three of the centres as a result of P&R.

From the more general perspective and as mentioned above, the transport efficiency of P&R is also underpinned by users' origins. Because cities are neither homogeneous nor uniformly distributed entities, dealing with trips in a strictly quantitative fashion does not indicate if users travel from rural hinterlands or neighbouring conurbations. This is of clear importance in understanding the catchment area of P&R and therefore the proximity of users to existing public transport services and possible alternative destinations. Even so, it has been the tendency of policymakers to consider host centres in isolation despite P&R obviously generating wider impacts (Parkhurst, 1995).

Parkhurst and Stokes (1994) and Bristol City Council (1996) both provide analyses of the spread of user origins in relation to P&R host centres in their respective Oxford and Bristol studies. They suggest that whilst there is some spread of origins across the rural hinterlands, most concerning is the concentration close to the P&R sites and from neighbouring settlements. For those from farther distances, closer centres may represent a viable alternative destination although some of these would be remote from public transport services so P&R may provide car mileage savings. For those closer to P&R sites however, there may be existing public transport services that offer links to the urban core but P&R is chosen in favour.

3.2 Environmental effects

The environmental objectives for P&R became prominent in the 1990s after growing recognition of the environmental damage caused by traffic-related emissions. This role in reducing emissions is based on the aim for P&R to reduce car mileage. The assumption is somewhat challenged however by the lack of evidence indicating a reduction in the distance travelled by P&R users. Indeed, most of the literature on the environmental effects is based on such evidence of car use (for example Parkhurst, 1996; Pickett and Gray, 1996) while there is a dearth of quantitative evidence on the degree to which P&R influences the amount of emissions generated. The impact that P&R has on emissions however is not strictly proportional to changes in mileage as a result of P&R.

The level of pollutants emitted is affected by such factors as the change in distribution and speed of traffic as a result of P&R (NETCEN, 2006). Vehicle speed is clearly affected by an increase in the number of vehicles around P&R sites. After all, P&R fundamentally creates a traffic 'honeypot'. Yet from the wider perspective, there may be some removal of vehicles from the road network downstream of P&R sites, resulting in vehicle speed gains, but this will be offset by the induced traffic utilising any freed road space. Furthermore, Rosenbloom (1978) suggests that the complementing of P&R with bus-only lanes, which is a prevalent measure taken to reduce the travel time of P&R users and therefore attract patronage, may reduce the vehicle speed of non-P&R users accessing the host centre. The concentration of localised pollutants is also affected by changes in the distribution of traffic on the road network as a result of P&R, Namdeo and Bell (2005) for example suggest that P&R can reduce levels in the urban core from their modelling work.

Changes in the use of different types of vehicles however, should also be borne in mind. While there may well be some change as a result of the cars removed from the network (and those induced by the freed road space), the clear change that occurs is that of a shift to bus use. Although increasing improvements have been made to the efficiency of the car fleet, the rate of improvement has been much slower with buses in terms of noxious emissions (NETCEN, 2005; Highways Agency, 2005), thus limiting the overall environmental role of P&R.

With regards the environmental impacts of P&R however, it is the construction and localised effects of P&R sites that has generated the most media attention and public opposition (Clark, 2005). As well as localised pollutants from access trips around sites, further impacts include traffic noise and safety.

Political and environmental opposition in the planning stages of P&R sites is particularly heightened where sites are proposed on greenbelt land. In the planning policy this is permitted by PPG13 *Transport* (DETR, 2001), although only where "*non-Green Belt alternatives* [are] *investigated first*" (Annex E, 3.17). It is greenbelt land however that often covers the most appropriate location for P&R sites, on the urban fringe with limited existing development. Policymakers are therefore faced with a compromise between the opposition to site location and the wider perceived benefits of traffic and pollutant reductions (see for example WMPTA, 2003; Cheshire County Council, 2007).

3.3 Economic effects

In contrast to the transport- and environment-related effects of P&R there is generally a consensus within the literature that it can bring economic benefits to host centres.

Indeed, it has been suggested (Parkhurst, 1996) that these benefits have taken prominence for the local authorities implementing schemes in some cases over the issues such as congestion which have been primarily the concern of Central Government. Thus, while P&R is used as a tool for competitive advantage over neighbouring centres, by definition this has ramifications not confined to the host centre. But not only this, the discussion here is concerned with looking at the wider impacts temporally, as the effect of P&R on travel behaviour will to some degree induce shifts in the distribution of economic activity.

3.3.1 Local economic vitality

The economic vitality of a centre is influenced not only by the number of visitors that it attracts but also the value of these visitors. By deduction then, the value of P&R to its host centre can be established by understanding how the visitors contribute to the economy. Yet so far the research has not considered the economic effects of P&R in such detail as to isolate P&R in a top-down aggregate assessment. This is partially down to the difficulties associated with isolating the economic contribution of P&R which occurs over a long period. Fundamentally though, perhaps there has been no real demand for such detailed work as it has been a logical deduction for stakeholders that extra visitors provided by P&R boost the economy to some degree. Rather, the research available is concerned mainly with the number of visitor trips generated or diverted from other centres as shown in the survey evidence presented in Table 2 above.

The significant amount of generated trips undoubtedly contributes to the economies of host centres. There are however other contributors that are less obvious from the survey evidence. For instance, the induced demand effect for the road space released

by P&R intercepted car trips will clearly result in some degree of contribution that is unobserved (Pickett and Gray, 1996). Also, although no direct reduction of central parking spaces in line with the number of P&R spaces offered has been found in host centres (Huntley, 1993), some reductions are likely and indeed incentivised as central area land may be transferred to other more economically beneficial uses (Parkhurst, 1995).

There will of course become an economic reliance on P&R as schemes mature if not only because of the reduced pressure in central areas for additional parking. The creation of central parking may not only be at the detriment of other land uses but also indirectly to the city environment (Parkhurst, 1996). Indeed, this was the motivation for the early P&R schemes that historic centres pioneered enabling economic growth that would have otherwise been constrained by physical capacity (Cairns, 1997; Hughes, 2005).

What this does mean though is that while host centres enjoy economic benefits of increased capacity, neighbouring centres may suffer (Mingardo, 2006) particularly by the diverted trips identified by the survey evidence. The effect and desirability of this however, will depend largely on the particular centres affected. Bos et al (2005) for instance argue that if P&R reduces the demand for out-of-town shopping centres and reinforces the concentration of central activities, long-term mileage reductions will result. Parkhurst (2000) on the other hand suggests that diversions from more traditional centres that already suffer from local competition would be less advantageous. He goes on to point out that because of the limits of existing research there is a need to understand "*whether [P&R] schemes are beneficial to the overall*

economy in absolute terms, or mainly offer a relative benefit to the host settlement" (p.319).

3.3.2 Long-term economic effects

Almost by definition, measuring and evaluating long-term impacts is notoriously difficult. Not only do problems lie with consistent and continuous data collection, of which there is a dearth in the P&R research, but the economic impacts of P&R are difficult to isolate. Nevertheless, the notion of long-term effects which is concerned primarily with the distribution of economic activity is key in the understanding of P&R so is discussed here, if only anecdotally.

At the most basic level the employment-related impacts of P&R concern those employed as a direct result of P&R by the bus operator and on-site, such as security and so on (Pickett and Gray, 1996). Negating these employment benefits however, the abstraction of passengers from existing public transport services may ultimately lead to route closures. From the wider perspective, the same kind of effect also holds for indirect employment. P&R trips are predominantly shopping and commuting. Taking the former, it could be expected that P&R in inducing trips to a centre boosts its economic vibrancy particularly in the retail sector. However, in view of diverted trips particularly, the loss of activity in competing centres is an important consideration. As for commuting trips, transport infrastructure has a significant effect on relocation decisions of businesses (Gerrard et al., 2001; Nelson et al., 1994) so although it involves complex interactions, P&R will play a role to some degree

Similarly complex are residential location decisions. P&R reduces the generalised cost of travel so theoretically encourages residence farther away from its host centres.

This of course assumes that the centre is the economic focus of the area in which it is located, an assumption which is somewhat weakened by the upsurge of out-of-town development. Nevertheless, Parkhurst and Stokes (1994) suggest from their sample of Oxford users that up to almost 10% indicated that P&R had *some* influence in their residential relocation choice. This was the case for Friday users but much less so for those surveyed on Saturday, suggesting that P&R has stronger location influence on commuter trips than less frequent and more discretionary shopping trips. Interestingly, around 7% of users indicated that they would consider moving if P&R became unavailable. It is important to remember though that Oxford provides the most mature P&R scheme so is well embedded in travel behaviour.

3.3.3 Value for money

By lowering the cost of travel P&R generally offers good value to its users but this is enabled through subsidy support. It is important then to consider the value offered by P&R to those that set the goals for its use and invest the subsidy – local authorities and the Central Government. By extension this is also a matter of value for the public in general as subsidy is derived from public funds (see Table 1). Value for money depends however on the criteria against which it is measured.

Considering the economic benefits of schemes in a fashion akin to an input-output model, they are perceived valuable by policymakers in investing in the local economy. This is of course difficult to establish empirically because of the complexities involved in measuring the impacts, although perhaps perceptions, particularly of local businesses, are sufficient enough for local authorities to support P&R. Nevertheless, such analysis relies on isolating and measuring the impact of P&R on retail spending and employment activity for instance, but also concerns the

result of such activity on neighbouring centres. Another consideration though is the effect of P&R on the distribution of activity across the host centre, including out-of-town/suburban retail and the importance of destination bus-stop location.

The value in terms of the transport effects of P&R is a little more straightforward to estimate at least in a bottom-up analysis. Parkhurst (1999) uses the survey evidence from WSA (1998) as well as other external data to calculate the vehicle-km reduction (including P&R bus provision) per £1 spent. The results are given for the fare income of both car users only and all users and is shown in Table 4. Two schemes generate a surplus from the passenger fare income alone. However, in three cases it appears that a net increase in vehicle-km is effectively being subsidised. In Plymouth, Shrewsbury, and York mileage was reduced but this was at a cost of £1 for an average of 7km.

[INSERT TABLE 4 HERE]

4 Conclusions and recommendations

Although the origins of bus-based P&R in the UK are at the local level in response to localised capacity constraints on transport infrastructure, it has become widely adopted as a result of its encouragement by the Central Government. While there have been some well-publicised localised objections to schemes, the general perception of policymakers seems to be that P&R is a positive thing. Yet there is very little evidence to support this view. Nevertheless, this paper has shown that the evidence that does exist is sufficient to contest the orthodoxy that P&R fulfils its intended policy goals of reducing car use and its environmental by-products.

P&R increases the total distance travelled by some of its users, which in turn infers that there is also doubt that P&R will universally reduce transport-related emissions.

This is mainly because of low load factors on high-frequency dedicated buses but there are also increases in mileage from trips previously taken on public transport alone, and those that are newly generated or diverted from other centres. Because P&R attracts a significant proportion of these 'non-target' users the offsetting effect on reductions in car use may be considerable, although these trips have not yet been included in assessments of P&R-induced mileage change. The potential environmental role of P&R is also lessened somewhat by the technological advancements resulting in reductions in noxious emissions from the car fleet which have not been seen in buses.

Given the lack of direct fulfilment of its transport and environmental goals that has been highlighted, there may be some foundation in the argument that P&R plays an indirect role by offering a 'carrot' to implement restraint policies. This can occur where complementary measures are used but these have seldom been sufficiently strong and there is a lack of clear evidence indicating traffic reduction. This does raise the question of whether P&R could become more successful in this role if national road pricing is introduced in the UK.

Nevertheless, although not tested empirically with a great deal of detail it is generally accepted that P&R will bring economic gain to host centres. P&R improves a centre's accessibility by increasing the total parking stock because central area spaces are not typically reduced proportionally. There are concerns however over the degree to which P&R is economically beneficial; first, the large amounts of subsidy that P&R requires for construction and operation will mitigate the value of schemes; and second, the economic impact of P&R on competing centres could mean more

economic redistribution than growth, an argument reinforced by the evidence on the strength of P&R to divert trips.

This paper has shown that the current research challenges the suitability of P&R to fulfil its intended goals. Yet there are still considerable gaps in current knowledge that need addressing to move further towards understanding the full effects of P&R and how it should best be used within transport policy:

- understanding how national policy goals are interpreted by local policymakers and balanced with more local objectives to implement P&R, and how effective it is perceived at this level;

- evaluating the effects of schemes on traffic congestion using top-down assessment and taking into account other transport policies used in host centres;

- identifying the sphere of influence of schemes and their importance on trip making decisions within a range of alternative destinations;

- assessing the economic impacts of schemes, including their influence on the local economic vitality of host centres but also taking into account capital and operating costs;

- understanding the impact of local contextual factors on the effectiveness of schemes, such as the scheme design and the size and nature of the host centre. Attention should also be paid to including the temporal dimension when considering P&R and how its effects change over the course of a scheme's lifecycle;

- investigating whether the fundamental design of P&R can be adapted (such as longer-distance operations and integration with traditional public transport) to improve its effectiveness, and if it could maintain its popularity in this instance.

Acknowledgements

The authors are grateful to two anonymous referees for their constructive comments.

Any remaining errors are the responsibility of the authors.

References

AASHTO - American Association of State Highway and Transportation Officials, 1992. *Guide for the Design of Park-and-Ride Facilities*. Washington DC: AASHTO.

Banister, D., 1992. Transport. *In:* P. Cloke, ed. *Policy and change in Thatcher's Britain*. London: Pergamon, 1992, pp. 199-214.

Banister, D., and Berechman, J., 2000. *Transport Investment and Economic Development*. London: UCL Press.

Bixby, R.B., 1988. Park and Ride schemes. *Highways and Transportation*, 35(4), 12-14.

Bixby, R.W., and Bullen, D.P., 1983. Park and ride - the Oxford experience. *Municipal Engineer*, 110(1), 13-18.

Bos, I., and van der Heijden, R., 2005. Multi-modal transport services in urban areas: push or forget? *Proceedings of AESOP conference*. Vienna, July 2005.

Bos, I., van der Heijden, R., Molin, E., and Timmermans, H., 2005. The impact of policy measures on P&R choice: simulations based on a P&R choice model. P*roceedings of 84th Annual Meeting of the Transportation Research Board.* Paper 05-0769. Washington DC, January 2005.

Bowler, C., Noel, E., Peterson, R., and Christiansen, D., 1986. *Park-and-Ride Facilities - Guidelines for Planning, Design and Operation.* Washington DC: Federal Highway Administration.

Bristol City Council, 1996. A4 Bath Road Park & Ride 1996 User Survey. Bristol: Bristol City Council.

Bryant, B., 1996. *Twyford Down: roads, campaigning and environmental law*. London: E & FN Spon.

Cairns, M.R., 1997. The development of Park and Ride in Scotland. Journal of Transport Geography, 6(4), 295-307.

CfIT - Commission for Integrated Transport, 2001. *Study of European Best Practice in the Delivery of Integrated Transport.* London: CfIT.

CfIT, 2002. *Public Attitudes to Transport in England*. London: Commission for Integrated Transport/MORI.

CfIT, 2005. *Climate Change and Air Quality* [online]. London: Commission for Integrated Transport. Available at:

<URL:http://www.cfit.gov.uk/plenaries/0501mfp3.htm> [Accessed 8 June 2007].

Cheshire County Council, 2007. *Parking Strategy* [online]. Chester: Cheshire County Council. Available at: <URL:http://www.cheshire.gov.uk/roads/Policies/ParkingStrategy.htm> [Accessed: 1 May 2007].

Clark, A., 2005. Park and Ride 'is ruining rural land'. *The Guardian,* 8 June, 15-16.

CPRE - Council for the Protection of Rural England, 1998. Park and Ride - its role in local transport policy [online]. London: CPRE. Available at: <URL:http://www.cpre.org.uk/filegrab/park-and-ride.pdf?ref=1867> [Accessed 30 January 2007].

Daniels, P.W., and Warnes, A.M., 1980. *Movement in Cities: spatial perspectives on urban transport and travel*. London: Methuen.

DETR - Department of the Environment, Transport and the Regions, 1997. Press Release: New Roads a Last Resort – Strang [online]. London: DETR. Available at: <URL:http://www.gnn.gov.uk/content/detail.asp?ReleaseID=16192&News AreaID=2&NavigatedFromSearch=True> [Accessed: 01 February 2007].

DETR, 1998a. A New Deal for Transport: Better for Everyone. Cm 3950. London: HMSO.

DETR, 1998b. Planning for Sustainable Development: Towards Better Practice. London: HMSO.

DETR, 2000. Transport 2010: The 10-Year Plan. London: HMSO.

DETR, 2001. PPG13: Transport. March 2001 ed. London: TSO.

DfT - Department for Transport, 2004. The Future of Transport: a network for 2030. White Paper on Transport. Cm 6234. London: TSO.

DfT, 2005. Parking Matters: Bus-based Park and Ride. Traffic Advisory Leaflet 02/01. London: DfT.

DoE - Department of the Environment, 1990. This Common Inheritance. White Paper on the Environment. Cm. 1200. London: HMSO.

DoE, 1993. PPG6: Town Centres and Retail Developments July 1993 ed. London: HMSO.

DoE, 1996. PPG6: Town Centres and Retail Developments June 1996 ed. London: HMSO.

DoE/DoNH - Department of National Heritage, 1994. PPG15: *Planning and the Historic Environment*. London: HMSO.

DoE/DoT - Department of Transport, 1994a. PPG13: Transport. London: HMSO.

DoE/DoT, 1994b. PPG13: A Guide to Better Practice. London: HMSO.

DoT, 1989a. *Roads to Prosperity*. White Paper on Transport Policy. Cm 693. London: HMSO.

DoT, 1989b. *National Road Forecasts, Great Britain*. London: HMSO.

DoT, 1993. *Traffic Topics 5: Park and Ride*. London: DoT Traffic Advisory Unit.

Durham County Council, 2000. *County Durham Local Transport Plan 2001-2006.* Durham: Durham County Council.

EHTF - English Historic Towns Forum, 2000. *Bus-based Park and Ride: A Good Practice Guide*. 2nd ed. Bristol: EHTF.

Foote, P.J., 2000. Chicago Transit Authority weekday Park-and-Ride users: Choice market with ridership growth potential. Paper 00-0773. *Transportation Research Record*, 1735, 158-168.

Gerrard, B., Still, B., Jopson, A., 2001. The impact of road pricing and workplace parking levies on the urban economy: results from a survey of business attitudes. *Environment and Planning A*, 33(11), 1985-2002.

Goodwin, P., 1996. Empirical evidence on induced traffic. *Transportation*, 23(1), 35-54.

Goodwin, P., 1999. Transformation of transport policy in Great Britain. Transportation Research Part A, 33, 655-669.

Haller, M., 2006. Public Passenger Transport in Munich's Conurbation: Development and Measures [online]. Available at: <URL:http://www.rtk.sll.se/english/munich/Workshop_061023/T_MVV_Stockholm_231006.pdf> [Accessed 28 December 2007]. Munich: MVV (Munich Transport and Tariff Association).

Hewett, B., and Davis, P., 1996. A4 Bath Road Park & Ride, Brislington - Operation and usage characteristics. *Proceedings of CPRE Avon Transport Campaign Group Park and Ride Conference. Bath, November 1996.*

Highways Agency (UK), 2005. *The Role of the Highways Agency in Local Air Quality Management*. London: Highways Agency.

Hughes, G., 2005. Economic growth in a historic city - the transport challenge. *Proceedings of the Institution of Civil Engineers, Civil Engineering*, 158(5), 48-53.

Huntley, P., 1993. Park and ride: strategic modal shift or cheap overflow? *Local Transport Today*, 22 July, 12-13.

Kingsnorth, P., 2004. Road rage. The Ecologist, 34(2) (March), 32-35.

LCPD - Leicester City Planning Department, 1964. *Leicester Traffic Plan.* Leicester: Leicester City Planning Department.

Mathew, D., 1990. Oxford's traffic examination. *Surveyor*, 20 September.

May, A.D., Kelly, C., and Shepherd, S., 2006. The principles of integration in urban transport strategies. *Transport Policy*, 13, 319-327.

Mingardo, G., 2006. Urban accessibility, Park and Ride facilities and decoupling in the Netherlands. *Proceedings of European Conference on Mobility Management (ECOMM).* Groningen, The Netherlands, May 2006.

Namdeo, A.K., and Bell, M.C., 2005. Air quality modelling of a Park and Ride scheme in Leicester, UK. *Proceedings of 98th AWMA Annual Conference and Exhibition*. Paper 1224. Minneapolis, USA, June 2005.

Nelson, J.D., Leitham, S., and McQuaid, R., 1994. Transport and commercial location decisions: some recent evidence. *Transport Planning Systems*, 2, 41-47.

NETCEN, 2005. National Atmospheric Emissions Inventory: Emissions Factor Database [online]. Available at: <URL:http://www.naei.org.uk/emissions/selection.php> [Accessed 27 December 2007]. London: NETCEN/AEA Energy and Environment.

NETCEN, 2006. National Atmospheric Emissions Inventory (NAEI) UK Emission Mapping Methodology 2003. London: NETCEN/AEA Energy and Environment.

Papoulias, D., and Heggie, I.G., 1976. *A comparative evaluation of forecast and use of park and ride in Oxford*. Working Paper 22. Transport Studies Unit, University of Oxford.

Parkhurst, G., 1994. *Park and Ride: Determining Policy Aims, Evaluating their Success* London: ESRC Transport Studies Unit, University College London.

Parkhurst, G., 1995. Park and Ride: could it lead to an increase in car traffic? *Transport Policy*, 2(1), 15-23.

Parkhurst, G., 1996. *The Economic and Modal-split Impacts of Short-range Park and Ride Schemes: Evidence from Nine UK Cities.* Publication 1999/4. London: ESRC Transport Studies Unit, University College London.

Parkhurst, G., 1998. The economic and environmental roles of Park and Ride. *Proceedings of 6th PTRC Annual Conference on Park and Ride*. London: Confederation of Passenger Transport.

Parkhurst, G., 1999. *Environmental Cost-Benefits of Bus-based Park and Ride System*s. Working Paper 1999/4. London: ESRC Transport Studies Unit, University College London.

Parkhurst, G., 2000. Influence of bus-based Park and Ride facilities on users' car traffic. *Transport Policy*, 7, 159-172.

Parkhurst, G., and Richardson, J., 2002. Modal integration of bus and car in UK local transport policy: the case for strategic environmental assessment. *Journal of Transport Geography*, 10, 195-206.

Parkhurst, G., and Stokes, G., 1994. *Park and Ride in Oxford and York: Report of Surveys*. Oxford: University of Oxford Transport Studies Unit.

Pickett, M.W., and Gray, S.M., 1996. *The Effectiveness of Bus-Based Park and Ride.* Project Report 207. Crowthorne, Berkshire. Transport Research Laboratory.

RCEP - Royal Commission on Environmental Pollution, 1994. 18th Report: Transport and the Environment. Cm. 2674. London: HMSO.

Roberts, A., Parker, A., and Phillips, A., 1998. A review of the Canterbury park-and-ride scheme. *Proceedings of the Institution of Civil Engineers, Transport,*129(1), 1-13.

Roberts, A., Parker, A., Surl, R., and Gallop, K., 1996. Park and Ride: new case studies. *Proceedings of the Institution of Civil Engineers, Transport,* 117(3), 234-235.

Rose, R., 1993. *Lesson-Drawing in Public Policy.* New Jersey: Chatham House.

Rosenbloom, S., 1978. Peak-period traffic congestion: A state-of-the-art analysis and evaluation of effective solutions. *Transportation,* 7(2), 167-191.

Rutherford, G. S., and Wellander, C.A., 1986. Cost-effectiveness of Park-and-Ride lots in the Seattle Metropolitan Area. *Transportation Research Record,* 1081.

Shaw, J., and Walton, W., 2001. Labour's new trunk-roads policy for England: an emerging Pragmatic Multimodalism? Environment and Planning, 33(6), 1031-1056

Simpson, B.J., 1994. Urban Public Transport Today. London: E & FN Spon.

Spillar, R.J., 1997. *Park-and-Ride Planning and Design Guidelines*. New York: Parsons Brinckerhoff.

TAS Partnership, 2000. *Park & Ride Great Britain: a survey and report.* 2nd ed. London: Landor.

TAS Partnership, 2007. *Park & Ride Great Britain: a survey and report.* 4th ed. London: TAS Partnership.

Tempest, M., 2002. Timeline: Labour's transport policy. *The Guardian,* 13 December, 6-7.

Turnbull, K.F., Pratt, R.H., Evans, J.E., and Levinson, H.S., 2004. Park-and-Ride/Pool: Traveler Response to Transportation System Changes. TCRP Report 95: Chapter 3. Washington DC: Transportation Research Board.

UNCED - United Nations Conference on Environment and Development, 1992. 'The Earth Summit'. Rio de Janeiro, June 1992. Conches, Switzerland: Agenda 21, United Nations.

US EPA - United States Environmental Protection Agency, 1992. *Transportation Control Measure Information Documents.* Washington DC: Office of Air and Radiation.

WCED - World Commission on Environment and Development, 1987. *Our Common Future*. Oxford: Oxford University Press.

Williams, R., 1999. Oxford's park-and-ride system. Proceedings of the Institution of Civil Engineers, Municipal Engineer, 133(3), 127-135.

WMPTA - West Midlands Passenger Transport Authority, 2003. *Moving with the Times - West Midlands Local Transport Plan 2003.* Birmingham: WMPTA.

WSA - W.S. Atkins, 1998. The Travel Effects of Park and Ride. Epsom: W.S. Atkins Planning Consultants (for DETR).

Table 1 Funding sources for P&R schemes

Funding Source	Description
Developer Contributions	Made within a general planning agreement from anticipated extra business or lower costs.
Commuted Payments	Payments made by commercial sector developers using Section 106 planning agreements in lieu of communal parking/transport infrastructure improvements.
Local Authority Funds	Non LTP funding, from the sale of assets or Council Tax/Business Rate payments. Used to cover initial capital costs of operating deficits.
Central Area Parking	A levy can be charged on central parking facilities under Section 55 of the Road Traffic Regulations 1984 for P&R funding.
Central Government	Applications made though Local Transport Plans (LTPs), with Transport Supplementary Grant (TSG) or Supplementary Credit Approval (SCA). Unlikely to be made above the £5m threshold for 'major schemes'.

Sources: EHTF (2000), CPRE (1998), Pickett and Gray (1996), DfT (passim).

Table 2 P&R user survey evidence

Source	*Centre (Site)*	*Day*	*n*	*Proportion of all Park and Ride users (%)*											
				Mode						Didn't Travel to Centre Before P&R (%)	Visited More Since P&R (%)	Wouldn't Travel to Centre Without P&R (%)	*of which (%)*[4]	Travel Elsewhere (%)	Not Travel (%)
				Public Transport (%)		Car (driver) (%)		(Other) P&R (%)							
				Previous	Alternative	Previous	Alternative	Previous	Alternative						
WSA (1998)	Brighton	Mon-Fri	220	18	41	50	26	-	-	-	-	28		31	68
Hewett and Davis (1996) (Avon County Council)	Bristol (Bath Road)	Thurs	674	-	40	-	54	-	-	-	-	3		23	77
		Sat	902	-	18	-	70	-	-	-	-	12		30	70
EHTF (2000)	Bristol (Long Ashton)	Mon-Fri	651	-	22	-	71	-	-	-	-	4		50	50
		Sat	1211	-	14	-	80	-	-	-	-	5		40	60
WSA (1998)	Cambridge	Mon-Fri	204	10	24	58	39	-	-	-	-	12		38	63
Jones (1994)*	Chester[1]	Mon/Sat	124	13	14	74	60	7	15	6	15	12		-	-
WSA (1998)	Coventry	Mon-Fri	208	17	21	52	50	-	-	-	-	21		44	53
Pickett and Gray (1996)	Maidstone	Mon-Sat	1000	-	15	-	66	-	-	-	27	10		16	84
Pickett and Gray (1996)	Norwich	Mon-Sat	1000	-	12	-	78	-	-	-	15	5		38	62
WSA (1998)	Norwich	Mon-Fri	204	24	29	56	53	-	-	-	-	12		40	56
Pickett and Gray (1996)	Nottingham	Mon-Sat	1000	-	25	-	59	-	-	-	25	10		38	63
Collins et al. (1987)*	Oxford	Fri/Sat	553	39	-	42	-	7	-	-	-	-		-	-
Devonald et al. (1978)	Oxford	Wed	262	24	-	66	-	-	-	4	-	-		-	-
		Sat	391	13	-	81	-	-	-	4	-	-		-	-
Papoulias and Heggie (1976)*	Oxford	Tues	155	8	-	57	-	14	-	6	-	-		-	-
		Sat	99	5	-	68	-	12	-	2	-	-		-	-
Parkhurst and Stokes (1994)	Oxford[2]	Fri	741	36	31	55	33	-	8	-	-	7		-	-
		Sat	1000	35	20	58	43	-	4	-	-	21		-	-
White (1977)*	Oxford	Tues/Thurs	208	-	30	-	57	-	14	-	-	2		-	-
		Sat	207	-	22	-	68	-	16	-	-	6		-	-
WSA (1998)	Plymouth	Mon-Fri	208	14	32	70	47	-	-	-	-	11		23	77
WSA (1998)	Reading	Mon-Fri	220	28	31	66	43	-	-	-	-	18		31	69
SYPTE (1995)*	Sheffield	Thurs/Sat	176	13	-	64	-	15	8	-	-	-		-	-
Pickett and Gray (1996)	Shrewsbury	Mon-Sat	1000	-	11	-	67	-	-	-	34	17		46	54
WSA (1998)	Shrewsbury	Mon-Fri	205	15	18	71	53	-	-	-	-	14		21	72
Cooper (1993)*	York	N/A[3]	154	19	35	63	59	-	-	12	-	1		-	-
Parkhurst and Stokes (1994)	York	Fri	288	24	26	66	54	-	-	-	40	11		-	-
		Sat	310	13	9	85	65	-	-	-	48	15		-	-
WSA (1998)	York	Mon-Fri	221	15	26	55	57	-	-	-	-	7		13	87
Bowler et al (1986)[5]	*Vancouver*	-	*(1 Site)*	*21*	-	*38*	-	-	-	-	-	-		-	-
Bowler et al (1986)[5]	*Hartford, Connecticut*	-	*(14 Sites)*	*7*	-	*40*	-	-	-	*27*	-	-		-	-
Bowler et al (1986)[5]	*Texas State*	-	*(25 Sites)*	*11*	-	*58*	-	-	-	*4*	-	-		-	-
Bowler et al (1986)[5]	*Miami, Florida*	-	*(1 Site)*	*22*	-	*54*	-	-	-	*14*	-	-		-	-
Bowler et al (1986)[5]	*Milwaukee County, Wisconsin*	-	*(13 Sites)*	*32*	-	*47*	-	-	-	*6*	-	-		-	-
Bowler et al (1986)[5]	*Washington D.C.*	-	*(3 Sites)*	*29*	-	*25*	-	-	-	*0*	-	-		-	-
Bowler et al (1986)[5]	*Shirley Highway, Virginia*	-	*(1 Site)*	*42*	-	*38*	-	-	-	*9*	-	-		-	-
Rutherford and Wellander (1986)[6]	*Seattle, Washington*	-	*(26 Sites)*	*55*	-	*34*	-	-	-	-	-	-		-	-
Foote (2000)	*Chicago, Illinois*[7]	*Mon-Fri*	*1758 (15 Sites)*	*26*	-	*37*	-	*8*	-	*18*	-	-		-	-

* Reported by Parkhurst (1996)

[1]Survey of shoppers only. Results weighted for those not previously coming or would not come in the absence of P&R

[2]Only those users previously travelling to centre prior to the introduction of P&R are included in previous modes used

[3]Post survey of users holding payment card

[4]The generated trips reported by EHTF (2000), Pickett and Gray (1996) and Parkhurst (1996) are reweighted assuming all users no longer travelling would either travel elsewhere or not make the trip.

[5]Reported by US EPA (1992)

[6]Reported by Turnbull et al (2004)

[7]All data presented for Chicago are for rail P&R sites

Based on Parkhurst (1996) with additional data from EHTF (2000), Pickett and Gray (1996), WSA (1998), Bowler et al (1986), Rutherford and Wellander (1986) and Foote (2000).

Table 3 Mileage effects of P&R

	change in distance travelled per car parked (WSA,1998)*	change minus distance travelled by bus (Parkhurst, 1999)
Brighton	-4.02	-2.22
Cambridge	-1.5	1.02
Coventry	-1.66	1.76
Norwich	-3.46	0.22
Plymouth	-4.7	-2.54
Reading	-8.54	-6.51
Shrewsbury	-5.12	-3.77
York	-3.26	-1.08

**doubled to give return journey*

Sources: WSA (1998) and Parkhurst (1999)

Table 4 Reduction in vehicle-km per £1 spent

	Net vehicle-km per car parked per weekday	Net operating cost (£)		Reduction in vehicle-km per £ spent	
		Car arrivers	All users	Car arrivers	All users
Brighton	-2.22	-39	-488	surplus	surplus
Cambridge	1.02	2307	2044	net inc.	net inc.
Coventry	1.76	599	587	net inc.	net inc.
Norwich	0.22	1786	1057	net inc.	net inc.
Plymouth	-3.17	988	847	2.71	3.15
Reading	-6.51	-110	-284	surplus	surplus
Shrewsbury	-3.77	1527	1405	7.51	8.17
York	-1.08	968	219	2.17	9.57

Source: Parkhurst (2000)