

RESEARCHING THE RESEARCH

ADAM SNOW



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1. Introduction

This project examined the current state of research on parking and its relationship to a series of traffic management, policy and practice, law and enforcement and technological matters, as well as examining the current knowledge about the parking profession. It has involved the creation of a database of relevant research conducted in the UK as well as selected international publications that have relevance to the UK parking sector (public and private).

The project aimed to provide a comprehensive picture of the currently available research and to categorize such research so that it enables the BPA and its membership to draw from this body of work and/or to create suggestions for future research based on current gaps. There is certainly a need to develop future research. The mundanity of parking may lead one to think that it is a subject that is not worthy of academic investigation, yet the research highlighted in this report belies that claim. Parking is an essential part of everyday life and experience and can lead at times to extremes of emotion, furthermore the associated costs of parking are significant in terms of public policy, environmental impact and traffic priorities.

Parking regulation is an immensely complex and evolving system, that has, at its heart, an apparently simple aim: the **efficient** management of traffic. Added to this aim however are a number complimentary and competing considerations: traffic flow, strategic planning policies, safety, the environment and various other social and economic considerations. These aims are mediated, interpreted and reformed at multiple stages of policy implementation. Each of these stages has individuals, employees, officers, and organizations that have their own rules, practices and habits that impact on and reform, reconstitute or even develop policy and how it is experienced by the general public. It is thus essential to study parking and its processes to understand how governments, businesses and citizens all experience the phenomenon and how policy is shaped in this dynamic system.

Chapter 2 sets out the methodology used to capture the existing research and explains how it is presented in the research database. Chapter 3 reports on some of the more relevant and

comprehensive research that has been conducted and discusses the current state of knowledge. Chapter 4 then outlines a number of suggestions for future research based on the literature review conducted as part of this project.

Adam Snow (PhD, Keele University)

Adam Snow, e-xperiential.com; dradamsnow@gmail.com

2. Methodology

A number of strategies were used to identify relevant research in parking, these are described below. Each piece of research was then categorized based on a brief examination of the abstract and paper, this allowed for a rationalization of the research. Following this categorization it was felt necessary to further sub-categorize the research according to the specific topic being analyzed in the research, again these categories are discussed below.

Finding the research

The first approach to identifying the research was to use established search engines that searched relevant academic journals in the field of social science, technological science, environmental science and transportation research. The defined search terms were as follows:

- Park
- Parking
- Car park
- Parking lot

Web of Science (a subscription service) provided the most comprehensive (and accurate) search facility which allowed for searches based on country of origin, subject matter and date. In total there were over 1000 search results which were then examined, categorized (where relevant) and entered into the research database, approximately 100 research reports were found via this method.

Google Scholar was also used. Although free to all users, Google Scholar's search function was not as focused or always as accurate as Web of Science.

In addition the Social Sciences Research Network (SSRN) was used which found significantly less parking related research and tended to focus on the legality and law enforcement side of parking management. There is certainly a gap in the available knowledge here from research drawing on the social sciences method, particularly methods that capture the less objective / economic rationales that citizens use when deciding to park.

After collating the data from these three search providers a brief examination of the research collected indicated the most relevant, and prevalent, academic journals cited. Further searches were then carried out on these journals through the publishers own website. Again the terms noted above were used in the search. Approximately a further 30 studies were found using journal searches.

[Categorizing the Research](#)

At the outset it was felt there were a number of categories that research on parking could fall into. In discussions between the BPA and the author the following categories of the research were felt the most relevant and could be turned into separate research spreadsheets. The categories were:

- Traffic Management
- Policy and Practice
- The Profession (e.g. workforce survey)
- Law and Enforcement
- Technological Developments

Whilst these categories were at first essential in dividing the literature into relevant aspects of parking impact (and development) at times it was difficult to categorize the literature so clearly, particularly the distinction between Traffic Management and Policy and Practice. Accordingly a series of further sub-categories were used that highlighted particular aspects of parking impact. These sub categories are as follows:

- Park and Ride (extensive literature)
- Disabled Parking (extensive literature)
- Pricing (extensive literature)
- Cruising
- Airport Parking
- Town and Country Planning

Many other sub categories are also noted in the database and allowed for segmentation of the research according to the relevant audience who may want to examine whether research exists in a particular area.

UK Research

Although this project is concerned with the extent of parking research in the UK, both the BPA and the researcher felt it would be important to include research from other jurisdictions particularly where it could have some impact on the UK position. In particular research from our European partners (and globally) has been included where it was felt by the author that the research would have similar lessons for the UK.

Exclusion

Given that there were so many potential studies to draw from following the search engine review, there was a need to decide how to exclude research based on relevancy. Of course a significant proportion of the search engine hits were of no relevance to parking due to the increasing use of 'park' as a verb to mean 'set aside' as well as the overwhelming use of car parks as sites at which to carry out any survey research. Certain research studies were also excluded where it was felt that the findings indicated in the study had a certain uniqueness that meant the findings were not relevant for the UK parking context. In particular certain research projects on parking regulation and management in India and China weren't included in the database due to the unique factors of traffic management and cultural / political issues in both of these locations.

Research Quality

Assessing research quality is a difficult task and there are numerous problems with subjective judgments about research quality. This project does not seek to counter or contest the quality of any research reports that are contained within the database. Instead the research provides a comprehensive database of available research without subjective comment on the research weight of any paper. However the database does note the type of study commissioned, whether it is Academic, Public Body, Private, Third Sector or Other.

Although this project does not assess impact of the research reports there are a number of approaches that those using the database can take to identifying the most robust research evidence. Firstly one can examine the journal in which the article is published and assess its reliability based on impact factor of the journal (a measure of the number citations in academic journals per article published). The following journals have the highest impact of the research contained in the database:

Journal	Impact Factor 2013
Transportation Research Part B – Methodological (not cited in the database due to subject material not being relevant for project)	3.306
Transportation research Part A - Policy and Practice	2.525
Journal of Transport Geography	2.214
Transport Policy	1.718
Transport Reviews	1.551
Regional Science and Urban Economics	0.971
Journal of Urban Planning and Development	0.931

Impact factor is certainly a contested and imprecise method for determining how 'good' the research is. A number of other factors should be taken into account when assessing the weight to give to a particular piece of research, these include:

- Authorship: whether the author is considered an expert in the field
- Affiliation: Is the author / organisation affiliated to any particular groups or companies that may lead one to question the impartiality of the research.
- Peer Review: If the research has gone through a process of peer review (Journal Articles) then this is generally an indication of quality (although there have been notable controversies in the past over this issue in academia).
- Methodologies: particularly important in survey research, for instance sample size and sample demographics
- Article length: This is certainly no guarantee of research quality, however as a general rule the longer the article the more likely it is to involve more robust findings.
- Professional Opinion: perhaps the most important judgment of an articles weight is the respect it garners from other professionals involved in the field.

Thus there are no clear rules or guides on what makes good research. Certainly research from academic organizations that has gone through a process of peer review are considered to be the gold standard. However, research conducted through public authorities and expert private research organizations may have a greater impact on public policy and can sometimes have access to data that may not be available to independent academic organizations. The research contained in the database draws from a number of sources, but has avoided some of the more dubious anecdotal 'grey' literature that is available in online blogs or local newspapers. A common sense approach is perhaps the best way to gauge the reliability of the research, using professional judgement. Furthermore if one fundamentally disagrees with any research report there is always the option of commissioning further research in the area to counter or confirm the existing research findings.

Organizations Approached

The above approach was successful in collecting published academic, governmental and third sector research. However, so called 'grey literature' (unpublished in academic journals or

official reports) could not be collected using these steps instead contacts provided by the BPA and through a selection of organizations helped to identify possible sites of such literature. Special thanks are due to the following organizations for their input on research gaps and currently available research

- British Parking Association
- Parking Eye Ltd
- Social Research Associates
- Contributors to the BPA's Discussion Group on LinkedIn
- E-mpirical

In particular Dave Smith at the British Parking Association has been an excellent source of information and contacts.

3. What do we know: selected research

3.1 The Parking Sector

Given the continued growth of car ownership across most advanced economies the parking sector can be thought of as, to a certain extent, recession proof. The increased demand for places in which to end ones journey or to simply store ones beloved motorcar increases continually with increases in the number of vehicles on the road. That being said the ready availability of free parking at both home and at destination locations (or over-spill locations) is a challenge for the parking sector and its profitability. This challenge is imposed primarily by policy, it is a policy decision of local authorities (not to control parking at certain locations, or provide free on street parking), which may be entirely legitimate, but nevertheless can have the potential to impact on traffic management priorities.

The ubiquitous provision of free parking, as **Shoup** states, 'helps to explain why the United States now has more motor vehicles than licensed drivers' (1997: 11)¹. The situation in Great Britain has yet to achieve this dubious honour, but only just, with an estimated 31.9 million car driving license holders and 29.1 million licensed private vehicles². If one assumes the average car requires 12.5m² of parking space³ then 363,750,000m² (140.44 square miles, roughly an area the size of Bradford) are required to house the phenomenal amount of licensed vehicles (and it must be recalled that this is just private cars, the figures do not include motorbikes or larger goods vehicles.)

According to a **BPA report in 2013** (The size and shape of the UK parking Profession)⁴ there are estimated to be between 8 - 11.3 million public parking spaces⁵. A report for the **RAC foundation in 2011**⁶ estimated there were a further 22.2 million private⁷ parking spaces which suggests that demand has yet to exceed supply (a total excess of 55 million m² of spatial supply, or 4.4 million spaces. Assuming an average increase of 1% in the number of vehicles on the road per year suggests that by 2029 demand will have outstripped supply)⁸. The RAC report concluded that approximately 94% of parking acts result in no charge whatsoever, parking is very much a "free" activity. Despite such ubiquitous free parking local authorities in total⁹ made a profit in 2013/14 of £549 million with a total turnover of £1.4 billion (Liebling, 2014)¹⁰.

¹ ID71, in what follows research reports contained within the database are noted by a footnote showing their identification number in the database.

² This is primarily a result of an ageing population since driving licence holders over 70 years old has seen significant growth in the previous 10 years.

³ This figure represents the mean (rounded to the nearest 0.5m²) of the on street parking bay markings under the Traffic Signs Regulations and General Directions no. 3113/2002

⁴ ID59

⁵ Local authority and private car parks

⁶ ID78

⁷ Garages, off road parking and free on street parking

⁸ Of course these are very brute calculations and further study is recommended to estimate this relationship

⁹ An important caveat, since there are some very clear regional variations on profitability of local authority parking accounts.

¹⁰ ID161

However, as the RAC report (2011) concludes the average cost per household per year on parking is relatively small, approximately £47, which is an insignificant amount compared to the average car fuel bill (£1600: RAC, 2011). This is not to suggest that parking charges are not without controversy (or felt to be cheap by comparison) certainly ministerial announcements from the Department for Communities and Local Government suggest a level of outrage at car parking prices. Indeed research backs up the claim that although the figure may be an insignificant cost compared to the general costs of running a motor vehicle it nevertheless is an important factor in choice of journey method (by car or by foot). **Ryley's (2008)**¹¹ study in Edinburgh found an increased propensity to walk short distances rather than use a motor vehicle in response to increased parking costs. Increasing the price of car fuel had no similar effect, thus the end cost of a journey seems a more important factor in driving, than the actual journey cost. The 2011 RAC report also indicates that there may be a differential impact on parking costs between richer and poorer households, with poorer households with motor vehicles bearing the brunt of the cost¹²

The parking industry itself, as the BPA's 2011¹³ Workforce Survey shows, is a large industry employing over 82,000 people directly, with 542 private sector parking organizations and 388 local authorities providing public car parks (BPA, 2011: 22). By far the majority of employees are based in the private sector (an estimated 72,086 employees). In terms of turnover, based on the Workforce Survey statistics, the total figure is between £519.4 million and up-to approximately £938.4 million.¹⁴ For all of Europe the turnover figure, according the European

¹¹ ID87

¹² This is made on an assumption from the data contained in the RAC Foundation report (2011: 10) that poorer households will tend to be from the terraced – converted flat end of the chart on page 10. Of course in certain location this may not always be the case, particularly in desirable city centre locations.

¹³ ID59

¹⁴ Again this is a brute statistical analysis drawn from the turnover bands provided in the BPA's Workforce Survey (2011: 26) The true figure may be significantly more since there is no way of estimating the top band income (i.e. how much above £20,000,000 the 11 organisations approached were)

Parking Association¹⁵, is €29.3 Billion and an estimated 569,000 people employed within the parking industry.

Traffic management and sound policy decision making based on the best available evidence are therefore vitally important in ensuring successful accommodation of our desire for car ownership. Furthermore managing parking demand and the impact this has on industry as well as local, and national, transport priorities is of great national (and local) importance. Understanding how policy and behavior impacts upon transport and parking priorities is crucial.

3.2 Traffic Management and Policy

Discussions about parking tend to concentrate on enforcement. But all local authorities need to develop a parking strategy covering on- and off-street parking that is linked to local objectives and circumstances. They then need Traffic Regulation Orders (TROs) to put it in place and appropriate traffic signs to show the public what the restrictions mean. This strategy needs to take account of planning policies and transport powers and consider the needs of the many and various road users in the area, the appropriate scale and type of provision, the balance between short and long term provision and the level of charges. (Operational Guidance to Local Authorities, Department for Transport, November 2010)

The provision and management of parking is clearly integral to achieving traffic management objectives. The sheer scale of private car ownership combined with the limited supply of available space means that parking remains, and will continue to remain, an essential facet of traffic management, and, one dare say, a particularly challenging one. As Budd, Ison and Budd state 'The car plays a major role in travel, and every car journey, irrespective of its motivation, duration, or location, requires there to be a space available at its destination to

¹⁵ ID64

park the vehicle' (2013: 26)¹⁶. Strategies for controlling parking behavior, and thus congestion, tend to fall into either decisions about pricing, or controlling spatial demand by providing parking places where land is more readily available (Park and Ride Services). Both approaches can also have positive benefits in terms of environmental quality in urban locations through reduced traffic flow.

Park and Ride

The provision of parking places in urban locations (Town and City Centre's) is clearly limited by a number of factors, not the least being the available space. In this regard there has grown an interest in alternative parking locations (suburban and / or rural) which offer a park and ride service. The research on park and ride services is well developed at both national and European Level. The evidence suggests that at present P&R adoption increases private car use and vehicle miles travelled due to the drain on public transport (i.e. people forgo public transport for all their journey and now rely on it for only part of their journey from the P&R location), some research, particularly Meek et al (2011)¹⁷, examines ways in which P&R services can be improved to combat this problem. In what follows the most relevant research drawn from the database is highlighted.

- **Bos et al (2004)**¹⁸ examine a large number of factors that impact on the decision to use park and ride facilities and find that the three most significant factors are social safety, quality of connecting public transport and the relative travelling time. These are all indicators of a successful park and ride.
- **Meek et al (2008)**¹⁹ examine and review the policy context of Park and Ride in the UK. This research identifies the effective policy goals for Park and Ride services and finds that P&R increases journey distance due to a number of factors.

¹⁶ ID1

¹⁷ ID17

¹⁸ ID42

¹⁹ ID88

- **Meek et al (2009)**²⁰ examine further the policy goals of P&R and incorporate interviews with policy makers about the successes and aims for P&R particularly at the local government level. The report identifies goals beyond motorcar traffic reduction to which P&R services can provide including the potential to have a role as a public transport interchange.
- **Meek et al (2010)**²¹ examine the reasons behind use of P&R in various local authorities (both those with and those without the facility). There is a divergence of evidence on the impact of P&R services on traffic but the authors do find continued support for P&R and support for finding ways to increase its effectiveness.
- **Hounsell et al (2010)**²² reports on a model for P&R facilities in Southampton that uses public transport links to the city centre through a variety of smart traffic planning (bus lanes and access control) techniques. Using the model developed the authors estimate that using P&R with signalized access control for link busses was the best option for keeping steady traffic flow into the city.
- **Meek et al (2011)**²³ P&R services have tended to increase traffic congestion, fuel use and emissions in their current guise. Drawing on evidence from user surveys in Cambridge, UK, the study suggests that P&R does significantly increase vehicle miles travelled and suggests some alternative models to offer significant improvements.
- **Clayton et al (2014)**²⁴ provide an empirical examination of the relative attractiveness of city centre car parks (CCCP) versus P&R locations in Bath, UK. Important factors in the choice of which type of parking venue to use were: P&R in direction of travel, gender, age, income and party size. Without one of the options (P&R or CCCP) then it is likely that increased use of public transport or walking / cycling would be the preferred method.

²⁰ ID24

²¹ ID21

²² ID84

²³ ID17

²⁴ ID3

In helping to direct drivers to P&R facilities a study by Khattak and Polak (1993) in Nottingham found that information campaigns about parking, providing real time parking information and newspaper advertisements about P&R facilities was successful in achieving increased use of P&R facilities which in turned helped to manage traffic levels in the city centre.

Pricing

Pricing General

Pricing decisions are perhaps the most important and most controversial aspect of parking and parking policy. Sound pricing decisions are key to both profitability and the wider interests of traffic management and traffic policy. Research into pricing decisions and pricing effects on traffic management is relatively well developed, in what follows the key points of the current state of research are highlighted.

- **Glazer and Niskanen (1992)**²⁵ If road usage is sub-optimally priced then lump sum fees can increase welfare but fee per unit of time does not. Increasing price leads to reduction in time spent parked allowing for greater flow and more traffic.
- **Arnott & Rowse (1999)** In this paper the authors develop a model of parking using economic analysis that seeks to understand the intrinsic costs of cars as well as the complex external costs of parking. The model itself is phenomenally complex representing the complex nature of traffic management using simple economic analysis.
- **Hensher & King (2001)**²⁶ examined the difference between a curfew on parking before 9.30am and pricing such parking. They found that curfews provided a small reduction in parking choice, with most choosing to park in a different but close location. Pricing had a more drastic effect and results in significant reductions in use and a switch to public transport.

²⁵ ID106

²⁶ ID47

- **Beunen, Jaarsma and Regnerus (2006)**²⁷ Implementing parking charges to control visitor numbers only brings temporary relief to congestion, the number of spaces and spatial location are more successful in reducing demand.
- **Kelly & Clinch (2006)**²⁸ Price demand is also sensitive to trip purpose choice with business users less likely to respond to significant price increases. With non-business users price increases do have an effect on parking choice, although this effect is only seen the higher the price increase.
- **Ryley (2008)**²⁹ People are more likely to walk following increased pricing than they are following an increase in petrol price.
- **Kelly & Clinch (2009)**³⁰ Following a 50% increased price in on street parking in Dublin the average price elasticity of demand was -0.29, with Thursday Late Night Shopping being a period for which lower price sensitivity was observed.
- **Stienstra & Betts (2009)**³¹ the quality of inner city or the shopping center is the prime determinant of the fee that customers are willing to pay.³²
- **Simicevic, Milosavljevic, Maletic and Kaplanovic (2012)**³³ 56% of respondents stated they would not give up driving to destination regardless of the price of parking, nevertheless using various coefficients of price elasticity the authors were able to achieve a supply and demand level of between 84%-98% utilization of all spaces.
- **Caicedo (2012)**³⁴ Charging by the minute rather than hour can increase turnover whilst decreasing the amount of time for drivers spent waiting for a space. Put simply charging by the minute reduces the likelihood of overstaying to get the customers 'money's worth' which frees up spaces quicker and results in less congestion.

²⁷ ID31

²⁸ ID111

²⁹ ID87

³⁰ ID109

³¹ ID145

³² Although McDonanld's ReThink Parking on the High Street suggests otherwise, with some locations charging more than the national average for their comparator locations.

³³ ID11

³⁴ ID108

- **Kobus, Gutierrez-i-Puigarnau & van Ommeren (2012)**³⁵ In situations where on street parking is ubiquitous and off street parking is further from the target location users will pay a premium of between €0.37 to €0.60 for on street parking. This is certainly an interesting finding that could be applied in future research to assess the cost of 'free' on street parking (see below). Small reductions in price correspond with large increases in street parking.
- **Ottossona, Chena, Wanga & Linb (2013)**³⁶ Price elasticity of parking occupancy is inelastic and varies by time of day and type of neighbourhood. Pricing does effect parking duration (higher price = shorter stay, lower price = longer stay)
- **Snider et al (2015)**³⁷ in this study the perceptions of visitors to North Carolina's beaches were asked about parking preferences and journey choices. The study found that neither price nor supply impacted on trips. Thus, as the study concludes, tourists' decisions are not driven by concerns over parking.

The above studies demonstrate that pricing decisions are influenced by a number of policy inputs that should be considered in making the decision to set an appropriate charge. Given the focus on congestion and traffic management of these studies it is quite clear that most will be relevant to public authority pricing. In relation to private car park pricing the literature is slight, reflective perhaps of the commercial sensitivity of the pricing decision. That being said, some of the studies referred to above have application to the private parking pricing decision, in particular Caicedo's (2009) study on charging by minute rather than hour is clearly applicable to private car parks in terms of supply, vehicle turnover and pricing sensitivity. Furthermore a small number of studies have examined private parking pricing decisions, albeit from a model based perspective.

³⁵ ID103

³⁶ ID117

³⁷ ID159

- **Anderson & De Palma (2004) (US)**³⁸ using economic analysis the authors claim that private provision of parking supply that prices in a monopolistically competitive manner will attain optimal welfare. Although this is undermined when cruising for parking is prevalent.
- **Chang, Chung, Sheu, Zhuang and Chen (2014) (Taiwan)**³⁹ This study examines the pricing decision at shopping malls and examines the multiplicity of decisions that affect the decision on pricing parking. The authors develop a decision model that takes into account multiple agents involved in the decision (visitors, the mall, marketplace, parking departments) and applies the model to data from a shopping mall in Taiwan. The authors claim the model can be generalized to any commercial market that requires a parking pricing policy.
- **Hasker & Inci (2014)**⁴⁰ Both shopping malls and society want to embed the price of shopping in the goods rather than price the parking supply. Customers who have to pay by the hour to park are unlikely to search for goods they cannot find and instead leave in shorter periods. The analysis in this paper is limited to shopping malls that are single choice destinations (i.e. there is no other purpose to visit the mall because it is remote). If the mall is in a town centre / convenient location then charging for parking is supported.

Pricing is thus an incredibly complex area of research with numerous suggestions and findings as to its efficacy in achieving stated aims (some of which confound each other). It is perhaps time for a meta-review of pricing literature to understand the full effects of price (and the significance of those effects).

³⁸ ID72

³⁹ ID121

⁴⁰ ID147

Free Parking?

There is no such thing as free parking it comes with a 'high cost' (Shoup, 1997)⁴¹ the question remaining is who bears the burden of paying that cost. Donald Shoup's 1997 *The High Cost of Free Parking* provides an excellent introduction into the problem of estimating the actual cost of free parking and the impact of factoring in those costs into traffic and residential planning. Shoup examines the subsidy that free parking represents to motorists and provides an excellent introduction into some of the issues of free parking that town planners, transport professionals and the retail sector should factor into analysis.

Shoup estimates (on a very conservative basis) that the average price of a free parking space is \$124 per month (1997 prices, adjusted for inflation this is \$472 per month). There is no research that looks at costs in the UK context or that has sought to improve upon Shoup's admittedly conservative estimate (1997: 15). It is worth revisiting particularly in light of the claims from government ministers that parking charges are affecting high street trade (Pickles, 2013)⁴².

The 'cost' of free parking is also a clear concern for local authorities who may wish to understand the effect of 'free parking' on a number of other local priorities including the vibrancy and profitability of town centre businesses. Certainly anecdotal evidence exists that 'free parking' in off-street car parks can improve footfall in town centres (see "Free parking helps Northampton buck decline in shoppers", BBC News Online, 10th February 2015, in which Northampton Borough Council claimed a 400,000 increase in footfall due to the provision of free parking. It is important to point out that this was not an independent study and the councils own report implies that correlation between free parking and town centre visitors is the same as causation, no independent study would be so forthright)⁴³.

⁴¹ ID71

⁴² Eric Pickles, DCLG Announcement, 26th August 2013

⁴³ ID146

The BPA's report⁴⁴ into high street prosperity did not examine the provision of free parking, however, when it came to paid for parking there was no clear relationship between the amount charged and the amenities on offer in the local area. Although the areas studied did provide parking locations that were sensitive to demand (i.e. equal to footfalls by location), pricing that demand seems haphazard, although there was some evidence that charging more than the national average led to a higher than average decline in footfall. Thus overcharging can decrease footfall but there is yet little evidence (beyond anecdotal) to suggest undercharging increases footfall. This should certainly be a priority for future research as Local Authorities are at present without a full understanding of the impact of 'free parking' or indeed its real cost.

Shoup's figures relate to off street parking, there is no research on the cost of free curbside parking. Indeed such an analysis is fraught with methodological problems, nevertheless this is a clear area in which there is a gap in the knowledge about the true cost of parking. Certainly the cost of free parking on-street is necessary in order to understand the dynamics of cruising in traffic systems. Furthermore, as stated above, with the continued growth of the vehicle ownership curbside parking is set to become a key issue in parking management.

Shoup has also examined the pricing of on street parking (curb parking) (2004)⁴⁵ and the effect this has on car cruising. Shoup finds that market clearing prices can yield 5%-8% of land rent value and eliminate significant amounts of traffic involved in cruising for spaces.

- **Caicedo & Diaz (2013)**⁴⁶ Free parking leads to excess demand and consequently cruising for spaces
- **Van Ommeren, De Groot & Mingardo (2014)**⁴⁷ On street residents parking permits that are free in city shopping locations lead to a yearly welfare loss of €275 per permit, or 15% of the supply cost of the parking space. The widespread use of free residential parking permits substantially increases the cost of parking supply. The authors

⁴⁴ ID60

⁴⁵ ID41

⁴⁶ ID122

⁴⁷ ID102

suggest that in order to maximize welfare in a situation where residents would be unwilling to maximize the welfare of the whole system, residents should be allowed to sell or lease their permits.

Shoup advocates a system of curb charging for non-residents to maximize spatial use and reduce cruising potential.

Shoup's analysis certainly needs updating and applying to the British context, as Shoup recognizes his estimate is a conservative estimate and it would be worth working with both commercial organisations and public sector bodies to try to obtain an estimate of the extent of free parking, its effect on business and crucially how much free parking actually costs. In order to conduct such a study there certainly needs to be an increased transparency over pricing at the local government level and the extent to which free curbside parking is available and how this impacts on traffic priorities.

Cruising

Sensible traffic management and parking provision can help to reduce congestion. However in understanding levels of congestion that are due to vehicles seeking parking spaces (and not through traffic or other commercial traffic) one needs to estimate the impact that searching for a parking space has on levels of congestion.

- **Arnott & Inci (2006)**⁴⁸ this paper examined the phenomenon of cruising for parking from an economic perspective. The authors found that regardless of whether on street parking is optimal (i.e used at the right level) it is efficient to raise the price of on street parking to the point where cruising is eliminated without actually eradicating on street parking completely. If the fee for on street parking is sub optimal then increasing curb space is the second best strategy for eliminating cruising.

⁴⁸ ID29

- **Arnott & Rowse (2009)**⁴⁹ Integrates Arnott and Inci's study into a model incorporating off street parking and traffic congestion. The study concludes that raising on street fees is a very attractive policy because in addition to raising revenue it also leads to efficiency gains that are even larger than the revenue gained.

To plan for the phenomenon of cruising for parking space within traffic models **Gallo, D'Acerno and Montella (2011)**⁵⁰ develop a model of urban networks that incorporate parking choices and cruising behavior. The authors find the model can simulate parking choice behavior and cruising impact where parking saturation exceeds 0.7.

- **Van Ommeren et al (2012)**⁵¹ move the discussion of cruising for parking spaces out of the economic model into the empirical domain, by studying a random sample of car trips in the Netherlands. The authors find that the average length spent cruising per car per trip was only 36 seconds (the average overall journey length was 20 minutes) although this was where both on-street and off-street prices were the same and thus price incentives were not in action⁵². The authors also find that cruising is not random, it is common in larger cities particularly where there are shopping and leisure activities, and also is more likely in the morning.
- **Kobus et al (2013)**⁵³ Use a mixed methods analysis of cruising for parking involving economic modelling and empirical evidence. The study finds that drivers are sensitive to small price increases for longer durations of stay (one hour or more) for shorter durations there is less price sensitivity (20 mins). The study also found that drivers are prepared to pay extra for street parking of € 0.37 to € 0.60.

Cruising for parking spaces is thus an interesting phenomenon that tends to affect larger cities and it is certainly worth conducting further empirical studies to test its effect on traffic in

⁴⁹ ID26

⁵⁰ ID118

⁵¹ ID14

⁵² Although the authors make the valid point that not all drivers will have known about price parity.

⁵³ ID9

locations where price incentives exist that make cruising a more attractive option. Kobus et al certainly suggests some effect of price incentives whether this holds in locations throughout the UK is something which is worth investigating.

3.3 Technology

Assessing the extent and current reach of technological research is difficult due to a number of factors. Firstly there is the ever present problem of technological development that it soon becomes obsolete and is replaced, furthermore the commercial sensitivity of technological development means that public research is rare and tends to focus on either the sociological impact of relying on technology or the emerging problems of existing technological research. In the latter category the use of ANPR technology is relatively well developed.

ANPR

The use of ANPR in general law enforcement is regulated through technical standards developed by ACPO (The Association of Chief Police Officers) and requires that static ANPR cameras provide a 98% capture rate and a correct read rate of 95%.

It is very difficult to provide guidance on the research on ANPR systems as a whole, although the database contains a few studies that have involved designs of ANPR which meet the ACPO standards (see Wang, 2003⁵⁴; and Chang et al, 2004⁵⁵). Recent investigations by the College of Policing into ANPR accuracy give some guidance on appropriate concerns in using ANPR technology

- **Gurney et al (2013)**⁵⁶ find concerns about reflectivity and ANPR capture, and recommend that a new British Standard for number plate design should be developed incorporating reflectivity standards. The study also found that ANPR systems have a far greater success rate when facing front rather than rear number plate capture.

⁵⁴ ID153

⁵⁵ ID152

⁵⁶ ID155

- **Gurney et al (2013)**⁵⁷ This paper lists a number of technical factors and standards that should be taken into consideration when using ANPR. These include camera alignment, picture sharpness, depth of field, motion blur, lighting, iris control and contrast. The authors find that ANPR performs worst during the evening rush hour particularly where ambient light is dark (dusk / darkness). The authors also recommend regular testing of ANPR systems to ensure continued accuracy and read rate levels.

Regardless of the concerns about ANPR accuracy the system also relies on systems accuracy following a positive reading by a camera. There is no research that deals directly with this in the parking sector, although Webb (2005)⁵⁸ has made the point that a total systems approach is necessary to gain the full benefit of ANPR. There is anecdotal evidence that some car park operators systems need correction, especially the stages between number plate capture and issuing a penalty notice.

Given the recent transfer of responsibility for off road parking from the Department of Transport to the Department for Communities and Local Government (and the DCLG's recent approach to CCTV technologies for local government parking enforcement) it may be worth investigating the reliance placed on such systems and how accuracy checks are built into parking CCTV systems.

Mobile Technology

Smart phone technology is certainly changing the ways in which we live and the travel choices we make. In order to keep pace with such technology there is an ever present need for more data, more transparency and more efficient means of using such data to improve the experience of the end user. Certainly it seems the research on cruising and price incentives could be developed into algorithms for software systems that help consumers make the most appropriate choice of parking location (based on speed and price) which may, in the long term,

⁵⁷ ID154

⁵⁸ ID54

also feed into traffic management goals. There is little academic research specifically in the field of mobile technology being deployed in parking management, however one study has examined the potential value of mobile technology for parking businesses' although it is a relatively old study by technological standards

- **Van der Heijden & Valiente (2002)**⁵⁹ The authors examine the value of mobile technology for business processes. They find that the success of mobile technology depends on a number of contingencies including the difficulty of coordination and the cost and availability of acceptable substitutes for mobile technology.

Again it is worth noting that this study is now 13 years old and pre dates the iPhone by some 5 years. Thus it is certainly likely that business process have been significantly impacted by mobile technology and it is worth examining how current technology affects business practice.

A proposal by **Chai, Wai Chong, Salimi and Nami (2013)**⁶⁰ to use QR codes to reserve spaces, in addition to providing valuable technological knowledge, highlights just how much mobile technology has changed since the **Van der Heijden and Valiente (2002)** report was written. Certainly it is worth investigating user opinions on the role of mobile technology in parking management and in particular how such technology is, or would, be used by potential future users.

3.4 Enforcement

The use of the motor car, more than any other object, has the potential to bring motorists into the system of law enforcement where, without such vehicles, they would more than likely live lives free of legal problematisation. Not only is the average driver more at risk of being a victim of a crime but is also more likely to be involved in behavior that is legally dubious (be it speeding, careless driving or simply illegal parking in those local authorities that have yet to

⁵⁹ ID66

⁶⁰ ID10

adopt the decriminalization process). The car park is a fascinating site in which these issues of legal regulation for control (and protection) of motorists are played out on a daily basis.

The enforcement process: front stage

There is very little academic research on the enforcement of parking, the most comprehensive study dates to the 1970's. Richman's 'Traffic Wardens: An ethnography of street Administration' is perhaps the most comprehensive academic examination of the work patterns and behaviours of traffic wardens (an extremely rare profession nowadays). Given the great changes in legislation and traffic in the intervening period it necessary to carry out research in the contemporary practices of enforcement. The authors PhD thesis (Snow, 2015) also examines, albeit not the main focus of the thesis, the work of civilian enforcement officers and how their discretion is controlled through local policy and social values. Snow then discusses the enforcement of parking within a broader framework of out of court penalties and the practice (and experience) of parking enforcement policy.

No similar literature exists on the enforcement of private parking requirements, indeed the enforcement process and activities of private parking enforcement bodies is relatively unknown. Certainly serious thought should be given to studies involving companies that undertake private parking enforcement. Both private operators and local authorities should be interested in this research since there is a possibility that perceived illegitimate practices in one sector impact the other. Jonsson, Greve & Fujiwara-Greve (2009) make this point in relation to corporate misfeasance in general; here '[a]udiences categorize organizations by comparing shared characteristics, and a contagion of legitimacy loss can take place among organizations that are categorized as similar' (2009:196) even where these similar organisations are not implicated in bad practice (ibid:221)

In relation to local authority enforcement seemingly no studies exist examining the phenomena of differential enforcement practices across the 350+ local authorities. In statistical analysis carried out by the author it is clear that prime facie evidence exists that local authorities

approach both the enforcement process and the appeals process according to widely differing standards. Here the risk for local authorities is not that feelings of illegitimacy spread from the private sector but from their own sector, as it is unlikely that⁶¹ citizens make any distinction between local authorities to any great extent. Serious thought should be given to improving the research knowledge in this area, at present we don't even know whether most citizens are aware of the difference (in terms of process, law and consequences) between private and public parking enforcement. In short there seems little point in designing systems or policies to improve legitimacy and standards in one sector if citizens make no distinction between sectors.

The enforcement process: Appeals

Again the academic literature on the appeals process is slight with just one study assessing user opinions on the Traffic Penalty Tribunal.

- **Raine & Dustan (2006)**⁶² examined appellant experiences at the traffic penalty tribunal and found that personal participation in appeals increases comprehension of the appeals process and importantly the independence of the adjudicators (even where the outcome was negative for the citizen).

This report led to the setting up of telephone hearings at the TPT which sought to bridge the gap between the desire to appear in person and the impracticality of this for some drivers.

Again Snow's (2015) PhD thesis also examined the work of the TPT in relation to user expectations of procedural justice⁶³ and found evidence that involvement in TPT hearings demonstrates important aspects of fair procedure. However it is unknown whether such fairness can then lead ticket recipients to view the parking enforcement process, as a whole,

⁶¹ Again no research exists on this point either

⁶² ID56

⁶³ This is the idea that people are more concerned with the process they go through rather than with the outcome of that process (this may seem counter intuitive but there is a wealth of data that supports procedural justice as far more important in people's views about fairness than outcome based justice.) Put simply people care more about process than outcome.

as fair. Snow's research suggests not, and calls for further study in this area, particularly on the process between the informal and formal appeals stage, there is potential here for some interesting research to draw out best practice and methods for comparing authorities.

In relation to private parking enforcement appeals there is no research at present on the process. What information that exists is courtesy of POPLA's annual reports, and it would appear that concerns about impartiality are likewise an issue. Given the fact that POPLA does not operate a personal hearing service then such concerns, based on Raine and Dustan's (2006) study may stay for a significant period, and possibly may never be resolved. Again there is a pressing need to research this process in terms of user satisfaction, the process itself, the approach taken and its effect on parking management. This is all the more necessary considering the proposed ADR directive from the European Union, understanding how the current system works and its impact on consumers and operators can help to understand how the ADR directive will impact on the process (and any potential problems it may cause).

Certainly the statistics produced by POPLA which breakdown success rate at appeal by operating company provides potential for some interesting research regarding best practice in the private sector.

Parking and Crime

The design of the car park has long been recognized as a potential way to impact upon the more serious end of criminality, through community safety ideas of "designing out crime" by architectural methods. Here the use of CCTV has often been recommended as a method for improving safety (and feelings of safety.)

- **Eck (1998)**⁶⁴ In a meta review of crime prevention interventions, Eck examined a number of studies that assessed the use of various devices for security at off street

⁶⁴ ID57

parking locations. There was mixed evidence for the effect of security guards, certainly they are likely to decrease motor vehicle theft although there is little evidence to suggest they have any effect on theft from motor vehicles. Again the review found limited evidence for the effect of CCTV on both acquisitive crime and violent crime, however at that time there had been limited studies to this effect. Although not examined under the car park section the use of lighting as a crime control mechanism was also examined and found little evidence to support its use as an effective crime control method, it depends on whether the lighting suited the purposes of the crime. Certainly applying this to parking one could see how lighting could provide a benefit for those engaging in theft from motor vehicles where illumination serves to highlight valuables.

- **Smith, Gregson & Morgan (2003)⁶⁵** have examined the use of car park design, specifically under the 'Secured Car Park Award Scheme', and its effect on crime and disorder in and around car parks. It is perhaps fair to say that the impact of secure car parks (those with CCTV, adequate lighting, formal surveillance) was on the fear of crime rather than crime itself, although both are problematic. In terms of actual crime there was little to differentiate between car parks that were part of the scheme and those that weren't. Although there was some evidence to suggest that where car park crime was very high, redesign according to the SCP standards may have led to a reduction in crime levels"
- **Webb (2005)⁶⁶** reviews the evidence for crime prevention and car parks in Tilley's leading text on Crime Prevention. Webb finds that unmanned car parks using pay and display were the riskiest places to leave vehicles for car theft and theft from cars, particularly long stay and located near train stations. Exit barriers are effective in controlling theft of vehicles but not theft from cars, instead having manned exits (supervision) was more effective for theft from cars. Interestingly this finding

⁶⁵ ID53

⁶⁶ ID54

confounds Eck's earlier claim that manning exits has no effect. CCTV does have an effect although it would appear it is only where the would-be thief believes the system is effective. Once it becomes clear that the CCTV may not be, then it loses its effect, suggesting a general deterrent (against all would be thieves) but not a specific one (against particular thieves).

Research on the link between crime and parking (where the parker is potential a victim) is thus relatively well researched. Where the parker is a perpetrator of crime is not well researched. There is evidence to suggest that there is a link between illegal parking and other illegal behavior:

- **Chenery, Henshaw and Pease (1999)**⁶⁷ this study found a link between parking in a disabled bay without a badge and more serious crime (as indicated by an entry on the police national computer).

It is certainly worth revisiting this research since the available data for study has vastly expanded, particularly DVLA systems. Police Authorities, Police and Crime Commissioners and the Home Office may certainly be interested in further investigating the link between illegal parking and general illegality. Chenery, Henshaw and Pease's point is important here, 'making full, real-time checks on those [illegally] parked in disabled spaces seems a cheap way to target currently active offenders and currently illegal vehicles' (1999: 3). Similar research on general non-compliance with parking regulations may provide further insight.

4. The Research Gaps

In conducting this project there have been a number of research gaps that have been identified throughout this text. In terms of the whole currently available research perhaps the biggest gap is the overreliance on quantitative and model based research. Certainly such research provides excellent insight at the global level of the impact and potential problems of various

⁶⁷ ID55

policies and strategies. There is little by way of qualitative research and yet it certainly does have the ability to illuminate reasons behind confounding findings as well as provide excellent data on the experiences, expectations and intentions of all those involved in parking and parking management.

Qualitative research can help to understand situations where the rationality of various actors in the process cannot be guaranteed. This would, in this driver's experience, be in a significant number of parking situations. Indeed **Haveaneanu, Havarneanu & Corneliu (2012)**⁶⁸ found that traffic laws are anything but experienced through rational calculation. Instead drivers are more than willing to engage in rule breaking where their own interpretations of safety and risk demand they do so. The author's PhD thesis also found similar concerns in parking enforcement where rational calculations of deterrent penalties are completely outweighed by factors that are specific to each parking decision. Capturing that data, as the author's PhD thesis demonstrates, can help to understand the pollutants that occur between policy desires in traffic management and actual policy outputs.

In terms of more specific research the following table lists the research gaps that have been identified through the literature review. It is important to note however that no gap analysis can ever be completely comprehensive, there will always be extra research needs that organizations have in any complex social system. One is reminded of Donald Rumsfeld's famous quote:

There are known knowns; there are things we know we know. We also know there are known unknowns; that is to say we know there are some things we do not know. But there are also unknown unknowns -- the ones we don't know we don't know

⁶⁸ ID13

Discussed above is the current state of research (the known knowns), and what is listed below represents some of the more pressing needs for contemporary, and future, policy (the known unknowns).

Research	Gap
<p>Pricing</p>	<ul style="list-style-type: none"> • Some thought should be given for producing a meta review of pricing literature to examine the varying successes of pricing policies. Certainly it is worth investigating a typology of locations which are (and are not) sensitive to pricing decisions. From the research it would seem that public parks / amenities / beaches are not overly sensitive to price nor are low quality shopping locations. It would certainly help to have research which identifies where price is a dominant factor or supply is a more pressing issue. • Shoup's 'free parking' estimate could certainly be updated perhaps using new methods to obtain a less conservative estimate • Methods should be designed for understanding the price of free on street parking • There is a need to understand further the provision of free parking and retail impact, we are in danger of this becoming something of an orthodoxy without any rigorous analysis of free parking's contribution • Overspill factors are also under researched, the extent to which price rises lead to overspill parking in free locations (particularly residential) should be examined either on its own or as part of a study into free parking.
<p>Technological</p>	<ul style="list-style-type: none"> • There is certainly a need to update our understanding of the role of technology in shaping both the profession and its customers. What form that research should take is difficult to assess, although process research can provide guidance and is perhaps a short term priority

	<ul style="list-style-type: none"> • The use of ANPR should be part of a system of enforcement, not the single determinant, thus there is a need to understand how ANPR is used through systems analysis in parking enforcement. • Furthermore the impact of ANPR enforcement on traffic management priorities has yet to be studied and is certainly worthy of investigation. <p>Technology and Pricing:</p> <ul style="list-style-type: none"> • Given the focus on pricing as an essential strategy for controlling parking and traffic it seems strange that technological research hasn't yet developed sufficient processes for incorporation of parking algorithms into satellite navigation systems. There is certainly scope for such algorithms to provide the highly rational approach to parking choice that the pricing literature suggests. There are certainly commercial opportunities for software designers to develop models for parking apps that design routes based on price, distance and availability that can avoid the problem of cruising. Of course such research depends upon real time data which at present is difficult. Certainly if one were to incorporate charging by the minute models it may even be possible to build that data into the algorithm.
<p>Law and Enforcement</p>	<ul style="list-style-type: none"> • Research into non-adoption of the DPE process is necessary to understand why certain authorities still use the criminal law in a system that few see as criminal activity. Investigating why they do, and what impact this has, can help to understand the role of criminal law in helping to control parking behavior. • There is a significant amount of research in the social sciences that highlights how policy intentions are frustrated, polluted or ignored in policy practice. There is certainly a need to understand this in the parking sector, Richman's study is over 40 years old. Snow's (2015) work dealt with this issue but as part of a broader criminal justice focus. There is a need to understand the effect and impact of (what is known as) street level bureaucracy (discretion) on policy aims and parking management. • Such research is also pertinent to the private parking sector where the desire to achieve 'results' may sometimes be

	<p>undermined or misinterpreted by front line staff and can lead to an incongruence between action and intentions.</p> <ul style="list-style-type: none"> • There is no research on why people do not pay their penalty notices, this is a real gap in our knowledge. Raine et al (2004)⁶⁹ conducted a study into non-payment of magistrates' court fines and it is certainly worth repeating the study in the parking enforcement context to highlight the reasons and suggestions for improvement. • There is a need to develop techniques for local authority comparison and the differential approaches to parking enforcement particularly on its impact on the penalty tribunals. Analysis of the statistics suggests that authorities approach appeals in considerably different ways and it is worth investigating this phenomenon. • The commitment to localism in government policy (although clearly disputed) also leads to a difficult problem for local authority parking, benchmarking performance. There is a need to develop with local authorities a means of identifying comparative authorities and then benchmarking that performance. • Given the increasing use of shared services between local authorities it is also worth examining the impact this has on shared policy / standards. Whether authorities that pool resources also share the same approach to parking management and enforcement. • Raine and Dustan's (2006) research into the traffic penalty tribunal suggests that personal interaction is preferred in parking appeals. POPLA does not offer this service thus it is essential to obtain user data about the service (particularly as competitor providers become more prevalent) to see how it is viewed by users in terms of its impartiality, effectiveness and fairness. • Popla's annual reports have drawn a parallel between the statistics on appeals allowed with other penalty tribunals. It would certainly be worthwhile investigating the respective approaches of the organisations involved and see how
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⁶⁹ ID142 "Who pays, who doesn't and why not?"

	<p>this impacts on views on the system and crucially further compliance.</p> <ul style="list-style-type: none"> • In that regard there is no data at present on the extent to which the decisions are the tribunals (and ADR) are complied with post decision. This should be investigated as a priority since it could raise questions about the legitimacy of the system. • Once the above study is conducted then it may be possible to develop our understanding of why people do and don't pay their parking penalties • What is the 'dark figure' of parking 'crime'? assessing the extent of non-compliance with parking regulations is difficult (and the reasons for non-compliance) yet policy is still aimed at deterring motorists when perhaps other means may be available. Until we estimate the extent of illegal parking we don't really know whether the current system of punishment is fit for purpose. It would certainly be worthwhile attempting to investigate the extent of illegal parking to see how far the system "works" at present. • Certainly police and government authorities should welcome further research on the link between "real" crime and illegal parking particularly with the increasing amounts of data that are available in this regard.
<p>General</p>	<ul style="list-style-type: none"> • Value added services: there is very little research on what value added services are offered by parking operators and how they are valued by consumers. Certainly operators should be interested in investigating how they can add value (or what value they add) to the parking decision and whether this impacts choice. • One area of research that has yet to be conducted, and certainly is particularly pertinent to the parking sector and public opinion, is the accountability and transparency relationships within the sector. The increasing use of outsourcing in both public and private parking organisations means that accountability and transparency can become diffuse and difficult to map (e.g. ANPR reliability). Having a sound understanding of these relationships is absolutely crucial for public confidence. • There is also a constant need to collect and disseminate data on supply, cost and

	price. This data, at present, sits in a maze of various operator publications. There is certainly a need to have some overarching statistical monitoring of such data.
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Conclusions on the current Research

Research on parking is certainly a growing area of interest which at present brings together diverse traditions from the social sciences. This report, and the accompanying database, have sought to centralize the available research into an easy to access format for members. There is more research in the database than contained in this report which merely highlights some of the areas where research is either well developed or in need of further development.

Although this report categorizes the research it would be a mistake to think that the research will always sit in isolated categories. The potential of technology to provide ever greater processing powers means that some of the best models and empirical findings could be synthesised to produce smart systems for controlling parking management and the parking experience. Certainly designing navigation systems that use algorithms drawn from the research into cruising, pricing and choice can help to overcome one significant problem in designing traffic management systems, the driver. No driver can be expected to be in state of supreme rationalism when searching, or deciding, to park. Many factors will impact on that driver, including habit, routine, preference, choice, general irrationality, however it is possible that technology can help to deliver more rational decisions (or choices at the least) for drivers. The hope is that with greater information, and an easy means through which that information can be processed, it can help to rationalize appropriate parking behavior through various navigation techniques.

In order to reach this point however there needs to be a clear transparency within the process on available space, pricing, and time constraints across the sector. Whether the eagerness for such transparency exists (due to the inevitable costs involved) is perhaps a more pressing

question. Nevertheless all of the individuals and organizations approached during this research project all shared the same desire, to improve the amount data that is available on the supply, method of supply (surface, multistory etc) and real time pricing data of car parks. The commitment to provide such data is, of course, not a free activity and requires investment and constant monitoring / updating, the organisation responsible for taking on this role is also a difficult question that needs resolution.

Certainly it is hoped that this report will lead to an investment in parking research, it is a much maligned area of research. Again to quote from Chenery et al (1999) 'A common reaction to our conduct of this study was wry amusement' (1999: 3) similar reactions have been experienced by the author throughout this project and throughout the authors PhD in criminology. Nevertheless parking is such an integral part of our daily experience (and one dare say a major cause of our daily frustrations) that research is vital in understanding how we manage the insatiable desire for the motor car given the limited space we have available. Furthermore citizens' reactions to parking, particularly parking enforcement, are unlikely to be positive for the foreseeable future and could (if not already) suffer long term damage unless organizations commit to understanding, through research, the importance of legitimacy in any system of regulation.

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