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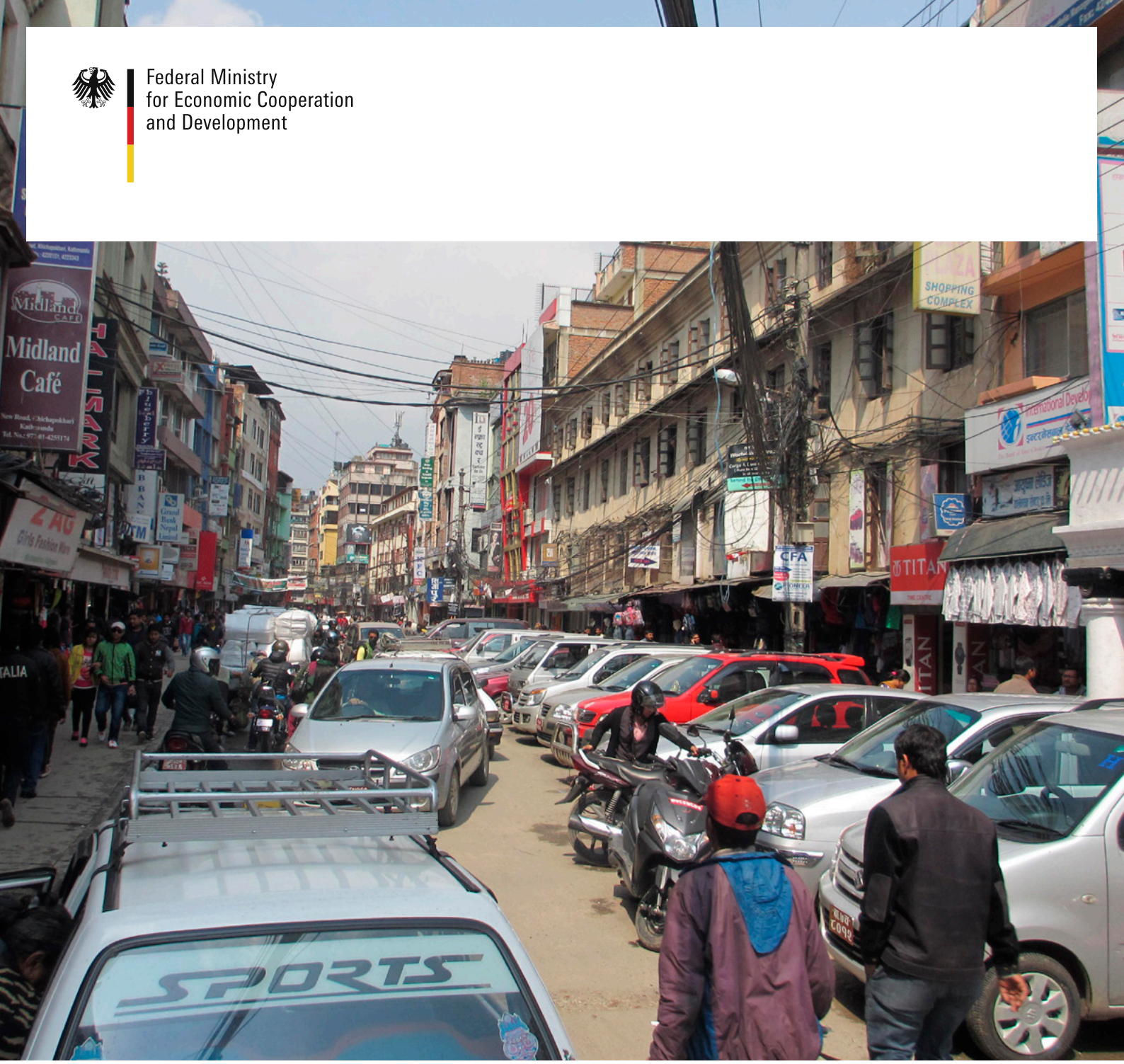

On-Street Parking Management

An International Toolkit

Sustainable Urban Transport Technical Document #14

Published by

giz Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH

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Acknowledgements

We would like to thank all those who have reviewed earlier versions of this document, including ***Vedant Goyal***, ***Michael Kodransky***, ***Frank Schleicher-Jester***, ***Carlosfelipe Pardo*** and ***Manfred Breithaupt***.

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About this publication

Quick Guide via 10 Key Questions

My citizens are asking for more parking spaces — what shall I do? ➟ Chapter 2.1

Can we implement parking management if public transport remains poor? ➟ Chapter 2.3

I got an interesting offer from the private sector — how can they help? ➟ Chapter 2.6

Does every street really need strong parking management? ➟ Chapter 3.3

Where should we allow on-street parking and how should we design it? ➟ Chapter 4

Is there any way to make parking fees less unpopular? ➟ Chapter 5.3

How can I know the best price to set for on-street parking? ➟ Chapter 5.5

I got an offer from the private sector. How should I respond? ➟ Chapters 2.6 and 5.7

What should I do if illegal parking is completely out of control? ➟ Chapter 6.9

Do I really need to bother with systematic collection of parking data? ➟ Chapter 7.1

1. Introduction and Overview

Is your on-street parking chaotic and conflict-ridden? Is it making the streets dangerous? Is there parking on walkways? Is parking claimed to be difficult to find? Is there insufficient street space for pedestrians, cyclists and public transport?

Don't accept such conditions! This toolkit explains, in a non-technical way, how to do better.

1.1 The secret to parking success is on-street parking management

The answer to most parking problems is not glamorous and is not costly. ***The answer is better on-street parking management***.

Good on-street parking management can end on-street parking chaos. It enables streets to function more efficiently and to be better places. It makes them safer.

Parking management helps local commerce, residents, bus service, bicycle users, people on foot, and vehicle users of all kinds. It enables efficient and fair use of street space. It can ease local traffic problems at low cost. Of course, it eases parking conflict.

On-street parking management also helps the wider off-street parking system and encourages more sustainable urban mobility.

It does all this at low cost and sometimes even makes a revenue surplus.

Good on-street parking management is essential for every busy area of every town.

1.2 Who is the toolkit for?

This toolkit is aimed especially at local government staff whose work touches on urban parking.

It is also for anyone working on urban management, particularly street management, urban planning and design, and transport planning and policy.

This toolkit is especially relevant to places where parking management capacities are limited due to a lack of experience or knowledge, due to a lack of staff dedicated to parking, or because of a lack of detailed attention to parking policy in the past.

Cities with sophisticated parking management are not the main intended audience but such places may still benefit.

1.3 Types of parking

It is possible to distinguish many kinds of parking but this guide focuses on just two key distinctions and four main types of parking (see Table 1).

The first distinction is between on-street parking and off-street parking. On-street parking takes place within public rights of way. On-street parking is easily found and entered from the street. Off-street parking is entered

Box 1: What is parking management?

According to the Victoria Transportation Policy Institute (VTPI), parking management includes "a variety of strategies that encourage more efficient use of existing parking facilities, improve the quality of service provided to parking facility users and improve parking facility design".

On-street parking management influences the manner, location, timing and duration of parking along streets to ensure that such parking is used efficiently and is consistent with wider goals for the street, for the area, and for the transport system.

Specific objectives include rationing available spaces, establishing orderly and efficient streets, and preventing negative impacts on traffic, public transport and people on foot or bicycles.

More broadly, parking management goals, including off-street parking management, may include travel demand management, economic vibrancy, or favouring certain user groups.

On-street parking management goals are pursued using a wide range of tools, including marking where parking is allowed and prohibited, designing parking spaces and associated facilities and signs, limiting access to certain groups, setting time limits, charging fees, enforcing compliance with all of these arrangements and monitoring success.

Table 1: Parking types based on two key criteria

	Open to the Public on a short-term basis	**Private** (open to eligible groups only or to the public only on a long-term basis)
On-street	***Public on-street parking***	***Private on-street parking***: Residents only zones, permit-only zones, specially reserved on-street spaces.
Off-street	***Public off-street parking***: Most parking in municipal public facilities, Private-sector public parking facilities, (regardless of their form, and regardless of whether linked with a building).	***Private off-street parking***: Tenant-only off-street parking, employee-only off-street parking, customer-only off-street parking, resident-only off-street parking.

via a driveway (making barrier-based payment systems feasible) and is often not visible from the public streets. Off-street parking may be in a built structure (underground, at ground level or above ground level) or may be out in the open as surface parking.

The second key distinction is between public parking (which is open to the general public even for casual short-term parking) ***and private parking*** (which is reserved for specific groups of users, such as residents or tenants).

Fig. 1: *Public off-street parking in Toulouse.*
© Andrea Broaddus

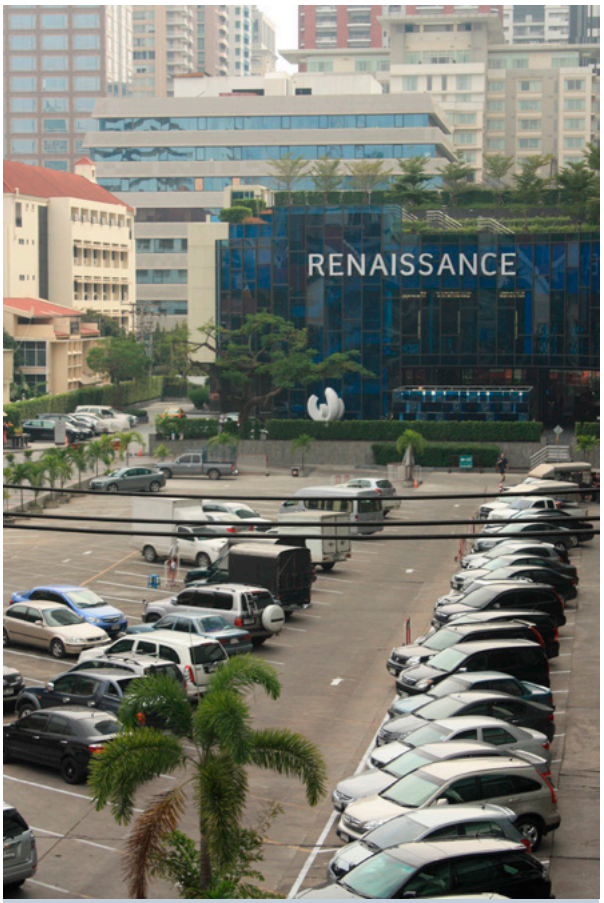

Fig. 2: *Public off-street parking in Bangkok.*
© Santhosh Kodukula

Fig. 3: *Specially reserved on-street spaces, here public space reserved for carsharing in Heidelberg.*
© Kevin Korffmann

The framework above is simple but there are some grey areas to be aware of:

- Parking on streets but inside a gated area is more akin to off-street parking than on-street parking.
- Parking that is open to the public only on a long-term basis (such as via monthly or yearly passes) is best grouped with private parking, not public parking.
- Some parking that is intended to be private, such as customer-only parking at shops, may actually be more akin to public parking in practice if the restriction is not enforced strongly.
- It is becoming easier for previously private parking to be made more public with the help of new mobile app-based businesses that allow private households or businesses to open their off-street parking spaces to short-term paid parking by the general public.

Note that public off-street parking can be owned by the private sector or the public sector but that this distinction is usually unimportant.

Fig. 4: *Private non-residential off-street in Bangkok.* © Vedant Goyal

1.4 The toolkit's focus

The main focus of this guide is the basics of on-street parking management. Better managed on-street parking is a key to wider parking success. Many wider parking policy and management efforts stumble because of weak on-street parking management or due to a lack of faith in on-street parking management. Unwise responses to on-street parking problems can set the whole parking system onto wasteful and unsustainable paths.

The toolkit is for an international audience, especially in low-income and middle-income countries.

Car parking and motorcycle parking are most discussed in this guide. However, other vehicles, including goods vehicles, taxis and non-motorised vehicles are mentioned in certain sections, as are other uses of street space, including street vendors.

1.5 Consequences of weak on-street parking management

If parking demand rises without relevant improvements in parking management, on-street parking problems can become extreme (Figures 5, 6 and 7).

Fig. 5, 6, 7: *Obstructive on-street parking in Amman, Jordan; Kiev, Ukraine; and Beijing, China.*

Common scenes include the following:

- Commercial streets tend to be first to be overrun with parked cars and motorcycles at the roadside, straddling kerbs, and even on footways. Buses and general traffic are obstructed. People on foot are forced to walk in the dangerous space between parked vehicles and the traffic flow.
- 'Everyone knows' that the area has a parking 'shortage' but few people notice that nearby off-street parking areas are never full.
- At night, older residential areas may see rampant illegal and obstructive parking in streets, on walkways, and even on green spaces.
- Interpersonal conflict over parking can escalate into violence. For example, in Delhi in recent years several parking-related fights have caused deaths.

Chaotic parking in streets is not merely an irritation or inconvenience.

- Poorly managed on-street parking harms safety and liveability and causes costly congestion and public transport delays.
- Even in places where on-street parking spaces are well-organised, on-street parking can cause congestion if it is allowed to become full or close to full (see Section 2.4).
- Saturated on-street parking makes people assume there is a parking shortage even when there may be no such shortage (see Section 2.1).
- Poorly managed on-street parking creates an opening for informal fee collectors, even gangsters, to fill the vacuum (Section 5.2). [1]

1.6 Benefits of good on-street parking management

Effective on-street parking management has strong benefits, greatly reducing the problems mentioned above. These benefits are achieved by nudging some motorists to change their parking behaviour slightly (or significantly) or to change their mobility choices (Box 2 and Section 2.3).

Parking management improves liveability. The most obvious benefit is a rapid reduction in obstructive and chaotic parking. Parking can then be made more compatible with the intended roles for the street, including more pleasant public spaces, better conditions for walking, cycling and better access to public transport stops and stations. Better parking management can greatly ease traffic congestion (see Section 2.4).

Conflict over parking can be greatly reduced. Everyday frustration is eased. The role of informal or criminal actors can be halted. Trust and confidence in the parking system increases.

On-street parking management makes the whole parking system work better (see Sections 2.1, 2.4 and 2.7). For example, reducing the incidence of on-street parking saturation reduces the urgency of parking supply investments. Good management, including efficient pricing, makes unwise supply investments less likely. So, on-street parking management is helpful even if more off-street parking is needed:

Box 2: Parking Management on Shopping Streets

Parking management on shopping streets gives priority to shopping visitors.

The key is shifting long-duration parking (mostly by employees) away from the most convenient on-street spaces. A prime on-street space used by nine shopper's vehicles in a day benefits retail businesses much more than if it is used by one employee's car all day.

This is best achieved via pricing. Even a modest price per hour can nudge most long-duration parking to more appropriate options, such as under-used off-street parking.

Parking management sometimes also nudges motorists to visit at off-peak times. A small number may shift to other modes of transport. However, it is important to avoid making people shun the area altogether.

[1] See articles by Paul Barter at the Reinventing Parking website 'Parking protection rackets', January 2012, http://www.reinventingparking.org/2012/01/parking-protection-rackets.html and '"*Gangsters*" in Indonesian parking', May 2012, http://www.reinventingparking.org/2012/05/gangsters-in-indonesian-parking.html

Fig. 8: *Central Makati is an oasis of well-managed on-street parking in Metro Manila.* © Paul Barter

- On-street parking management makes it easier for a district to get an efficient amount of off-street parking supply investment (neither too much nor too little).
- It makes off-street parking facilities more financially viable by improving the willingness of motorists to pay and by increasing the usage of off-street parking.
- Good on-street parking management also provides useful information that can help guide parking investment decisions, whether by government or by private developers and building owners. It gives them the right incentives to aim to provide parking in about the right quantity at the right price in the right places.
- Parking management can ease parking demand, reducing parking investments needed.

On-street parking management can indeed be improved. A key aim of this toolkit is to make it easier to establish good on-street parking management, even in difficult circumstances.

But proposals to boost parking management are often met with pessimistic predictions that any real improvements would require heroic efforts.

Be encouraged by international experience which shows that even places with awful on-street parking situations can quickly improve. Many of the places shown in Figure 9 have made dramatic progress with their on-street parking situations in short periods of time.

Fig. 9: *Examples of cities that have improved their on-street parking management in recent years.* *)

*) Sources for Figure 9:

Abu Dhabi: 'Paid Parking in Abu Dhabi', Abu Dhabi Government Gateway site, https://www.abudhabi.ae/portal/public/en/gen_info_detail?docName=ADEGP_DF_223468_EN;

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Taipei: Barter, *Parking Policy in Asian Cities*;

Tel Aviv: See Chapter 5 of this document;

Tokyo: Barter, *Parking Policy in Asian Cities*.


Tokyo
Enforcement reforms in 2006 dramatically reduced illegal short-term on-street parking activities
Seoul
Improved on-street parking management in key business districts (better enforcement, resident permits, five price zones)
Taipei
Motorcycle parking made much more orderly, dramatically improving the pedestrian environment.
Makati
Since 1988, via new Makati Parking Authority, this Metro Manila business centre became an island of efficient on-street parking management with effective enforcement and pricing
Moscow
Since 2012, pricing introduced and delineation and enforcement improved
Istanbul
On-street parking in dense areas under better control via a strong new parking agency/company (ISPARK)
Shenzhen
Pilot of reintroduced on-street parking fees with mobile phone payments and improved enforcement in 2014
Chennai
Ongoing efforts to improve on-street parking management, including pricing and reclaiming pedestrian space
Budapest
Dramatic improvements from chaos towards best-practice on-street parking management
Tel Aviv
On-street parking pricing via mobile payments only (phone or in-vehicle meters) integrated with enforcement
Abu Dhabi
Much improved since 2009, including paid on-street parking
Dar-es-Salam
Greatly improved city centre parking management and pricing
Barcelona
Rapid transformation from on-street chaos to orderly and well managed parking in the 2000s
Kampala
City centre parking management and pricing improvements
Rosario
Since 2001, on-street pricing (via meters with phone payment option). Extended throughout core since 2012
Mexico City
The Ecoparc program has drastically improved on-street parking management in pilot areas with efficient pricing and enforcement
Calgary
Well-managed CBD parking with responsive on-street prices in central area (using simple price zones)
Seattle
Demand-responsive on-street parking pricing with simple price zones
Medellin
Since 1999, Regulated Parking Zones are areas of effective on-street parking management, including pricing that varies depending on the zone

Of course, many of these places continue to face challenges and no one would claim they have perfect on-street parking management. But they do demonstrate that it is possible to quickly make remarkable and rapid improvements.

1.7 Step-by-step towards better on-street parking management

Successful on-street parking management usually emerges in stages, as the need for it arises. Here is a simplified overview of the stages by which excellent parking management can arise. This is based on the example of cities that now have strong and effective on-street parking management in locations that need it most. Cross-references to other sections of this document are provided.

STAGE ONE: Parking management not yet needed

Observed issues	Contexts	Opinions	Management steps	Results
■ Low parking demand ■ Only minor local conflict over nuisance parking behaviours ■ No need yet for formal on-street parking management	■ Small towns, ■ low-density areas or ■ cities where vehicle ownership is very low	■ Parking is not yet seen as a problem ■ Unregulated free parking is seen as 'natural' ■ Common sense should prevent problems	■ Management takes the form of local community norms over where, when and how to park	■ For a time, community norms may be enough ■ But if vehicle ownership is rising or the settlement is growing then Stage 2 may be imminent

STAGE TWO: Nuisance parking emerges, prompting on-street parking regulation

Observed issues	Contexts	Opinions	Management steps	Results
■ On-street parking becomes saturated in certain places and at certain times ■ This prompts more widespread nuisance parking (chaotic parking, obstruction of traffic, parking at intersections, parking on footpaths, double parking)	■ Commercial and shopping districts especially ■ As towns and cities grow larger and denser ■ Or as vehicle ownership increases (even in small settlements)	■ Rising concern over 'parking chaos' ■ Pleas for more considerate and disciplined parking ■ Pleas for off-street supply begin to emerge	■ Build institutions for both parking & street management (Ch. 3) ■ Decide where and when parking can be allowed and make this clear with signage and markings (Ch. 4) ■ Build a parking enforcement system (6.1, 6.2 and 6.7)	■ Clear rules on where and when to park and ways to enforce them ■ Better parking conditions for a time ■ Solid foundations for Stage 3 below ■ If parking demand keeps increasing, saturation will expand and Stage 3 is needed

STAGE THREE: Saturated on-street parking becomes a serious and widespread problem				
Observed issues	**Contexts**	**Opinions**	**Management steps**	**Results**
■ On-street parking is fully occupied across more areas and times ■ Off-street public parking is often underused because of lower convenience and higher prices ■ Illegal parking again becomes common and stretches enforcement ■ Full on-street parking harms traffic (2.4) ■ Illegal parking fee collection often appears if formal pricing is absent	■ Many parts of many cities and towns have these problems ■ All such places would benefit from this stage of on-street parking management to address them ■ Increases in vehicle ownership, economic growth and urban growth can rapidly increase on-street parking demand in many busy areas in a wide range of urban settlement types	■ Undersupply of off-street parking is widely assumed to be the key problem (but see 2.1) ■ Initial use of pricing to manage on-street parking is often resented ■ But public confidence increases as parking management delivers better conditions, including enabling motorists to find a free parking space when they need one most.	■ Prioritise management as more urgent than supply (2.1) ■ Conduct key parking surveys in problem areas (2.5 and Ch. 7) ■ Apply on-street parking pricing (digital methods) to saturated areas and times (5.1, 5.3, 5.4, 5.5) ■ Further improve enforcement (6.3, 6.4, 6.5, 6.6) ■ In busy locations, improve parking design (Ch. 4)	■ These well-tested steps ease saturated parking and its side-effects ■ Many cities have seen their on-street parking management improve dramatically over time ■ This also enables well-targeted off-street parking investments and off-street parking management (2.1 and 2.7)

STAGE FOUR: Mature on-street parking management needs constant refinement				
Observed issues	**Contexts**	**Opinions**	**Management steps**	**Results**
■ Basics of on-street parking management are in place ■ However, serious local problems with full on-street parking and illegal parking can return unless frequent refinements to parking management are made ■ Various more specific parking problems and conflicts also emerge and require less generic solutions (see examples in 1.8)	■ Well governed local governments often reach this stage ■ Many examples in high-income countries ■ Some examples among large high-capacity local governments in middle-income countries	■ Debate focuses on how (not if) on-street parking management should be carried out ■ Debate becomes muted with parking management success (it quietly works and is taken for granted) ■ But mistakes in enforcement and pricing sometimes provoke a backlash ■ Local debates also arise from parking conflict between stakeholder groups	■ Parking management areas often need enlargement as parking demand shifts ■ Refine pricing with zone-by-zone price differentials and time-of-day pricing (Ch. 5) ■ Step-by-step improvements to parking design, delineation and communication (Ch. 4) ■ Adjust enforcement to changing problems, technology and best practice (Ch. 6)	■ Once key elements of parking management are in place, only refinements are needed to maintain good outcomes ■ Best practice cases are making their parking management more responsive to each local context and to changing conditions ■ Failure to do so can cause relapses of local saturation problems

This strategic overview provides a simple picture of the key stages and steps in developing an effective on-street parking management system. However, in addition to the key strategic issues above, there are various other parking conflicts, problems and objectives, some of which are specific to particular kinds of places. Many of these are mentioned below in Section 1.8.

Please note that on-street parking management is a highly local matter: Localities with pressing parking management needs can and should progress towards strong on-street parking management much more rapidly than areas that have less urgent parking problems (Section 3.3).

Unmanaged free-of-charge kerbside parking is not 'natural'. In Stages 2 and 3, parking management must overcome a lingering widespread belief left over from Stage 1 that free-of-charge parking without management is somehow the natural and desirable state:

- But free and unmanaged parking is 'natural' only in the unusual circumstances of Stage 1 above, such as in tiny towns, where vehicle ownership is very low, or on the far outskirts of cities where kerb space is so plentiful that there is no conflict.
- As the densities of people and vehicles rise, conflict over on-street parking emerges very quickly, even in small towns.
- So, across most parts of the world's urban areas, on-street parking is overburdened and in need of strong parking management.
- Using terms from economics, such parking is an overused common property resource, NOT a public good. But kerb parking is a public service and part of the public realm.
- Overused common property resources always need management to avoid conflict and to ensure efficient use.
- So it is natural and normal for urban on-street parking to be highly managed (including being priced). Parking that is unmanaged and free of charge is the aberration.

1.8 Common parking problems, their causes and solutions

Table 2 provides an overview of common parking problems in typical types of location. It includes many situations to which the basic parking management stages above apply. It also includes a few particular problems to which more specific and tailored parking management approaches are needed.

Table 2: Common on-street parking problems of typical locations, their causes, and promising solutions

	1	2	3	4	5
	Location type	**Visible problem**	**Commonly assumed causes**	**More useful ways to frame problems**	**Promising parking management solutions**
a	Many busy locations	Double parking, illegal parking, waiting and cruising for parking;	Parking shortage; Inadequate on-site parking;	Saturated on-street parking, under-used off-street parking; Weak parking management; Weak mobility options;	Pricing aimed at efficient occupancy rates (just below 85 %). See also f) below. Enhance non-driving options;
b	Many busy locations	Nuisance on-street parking even if legal spaces are not full;	Parking shortage; motorist indiscipline;	Weak enforcement;	Phasing in of stronger enforcement; strategies to reduce unpopularity of enforcement;
c	Many busy locations	Nuisance parking on pedestrian facilities;	Parking shortage; motorist indiscipline;	Weak enforcement; poor delineation or design; neglect of two-wheeler parking;	Better enforcement; self-enforcing design; better design and management of two-wheeler parking;

	1	2	3	4	5
	Location type	**Visible problem**	**Commonly assumed causes**	**More useful ways to frame problems**	**Promising parking management solutions**
d	Many busy locations	Nuisance pedicab (rickshaw), three-wheel taxi (auto-rickshaw) or taxi waiting/parking;	Driver indiscipline; pedicab/ taxi oversupply;	Failure to organise suitable waiting points/queues); Weak enforcement;	Well-organised, well-designed queues/waiting points with good enforcement;
e	Residential streets around commercial nodes	Competition for parking in residential streets increased by "spillover" parking of commercial node visitors and employees;	Parking shortage within the commercial node; belief that any spillover parking at all is unacceptable;	Weak management of parking in the residential streets;	Accept visitor parking but manage to reduce nuisance for residents and avoid saturation: Price for optimal occupancies; Strategies to win residents' support for management in such streets;
f	Commercial areas with significant retail	Double parking, illegal parking, waiting and cruising for parking (parking search traffic);	Parking shortage (yet off-street parking and other nearby parking often under-used);	Saturated on-street parking (high occupancies); employee parking in convenient spaces;	Price for optimal occupancy and to nudge all-day parking to lower-demand, less central spaces (including off-street);
g	Major commercial areas	Traffic congestion and traffic nuisance on approaches and within commercial node;	Limited road capacity; parking undersupply;	On-street saturation (causing search traffic); Weak mobility options; Parking oversupply;	Enhance non-driving options; TDM; Strengthen on-street parking management; Discourage employer-paid employee parking; Gradually ease parking oversupply;
h	Dense residential areas	Saturated overnight & weekend parking (competition for parking among residents themselves);	Parking shortage; Inadequate on-site parking;	Under-used off-street parking; weaknesses in management; vehicle numbers may exceed accessible legal parking; Weak mobility options;	Enforcement; Unbundled off-street parking; Sharing of business parking; On-street residents permits priced to promote use of existing off-street parking; Discourage car owners from moving to such areas. Enhance non-driving options;
i	Significant streets (important for both traffic and as centres of activity);	Conflict over space (parking, bicycle lanes, bus lanes, walking space, taxi queues, etc.);	Loss of on-street parking spaces feared (from belief on-street parking is large % of local total);	Design priorities with excessive space for high-speed traffic;	Better on-street design processes can ease conflicts and enable some parking to be compatible with street goals (especially via design for lower traffic speeds);
j	Restaurant, nightlife areas	Double and illegal parking, waiting and cruising for parking;	Parking shortages; Inadequate on-site parking;	Weak management and enforcement;	Pricing aimed at optimal occupancy; Valet parking; Improved enforcement;

	1	2	3	4	5
	Location type	Visible problem	Commonly assumed causes	More useful ways to frame problems	Promising parking management solutions
l	Roadways adjacent to ATMs, banks, snack stalls, newspaper vendors, etc.	Very short-term stopping or double parking causing disruption. Low compliance with parking rules;	Motorist indiscipline; Vendor indiscipline;	Design (attractors located where they attract stopping that cannot be allowed); Inadequate enforcement;	Self-enforcing design; Intense enforcement (CCTV); Suitable legal alternatives; Relocate attractors to suitable locations;
m	Streets and roads near industrial areas, goods logistics nodes	Heavy vehicle parking in inappropriate places (noise nuisance, safety impacts, etc.);	Indiscipline by heavy vehicle operators; On-site shortage of heavy-vehicle parking space;	Weak enforcement (drivers, businesses lack incentive to seek better/legal options); Poorly located heavy industry;	Enforcement; Work with industrial area business associations to find or create appropriate off-street facilities; Designate suitable on-street locations;
n	Hospital vicinities in dense areas	Double parking, illegal parking, waiting and cruising for parking (parking search traffic);	Inadequate on-site parking supply;	Weak on-street management; weak on-site management (parking conflict among patients, visitors, employees, outside free-riders);	Price for optimal on-street occupancy; Seek better on-site management in line with hospital mission (with assistance for hardship cases and negotiation over employee parking);
o	Higher-education campus vicinities	Double parking, illegal parking, waiting and cruising for parking (parking search traffic);	Inadequate on-site parking supply; Belief that any spillover parking at all is unacceptable;	Weak on-street management; saturated on-street parking; weak on-site management; Weak mobility options;	Accept parking spillover but reduce nuisance and avoid saturation via management; If residential area, then see e) above; Enhance non-driving options;
p	School vicinities	Chaos, danger at drop-off and pick-up time; Double parking, illegal parking, parking search traffic;	Inadequate on-site parking and inadequate on-site drop-off and pick-up places;	Poor drop-off and pick-up design and management; Poor alternatives; Weak parking management;	Better design and strict management of drop-off and pick-up places and times; Improve non-driving options; Strengthen parking management;
q	Stadium/sports arena vicinities	Double parking, illegal parking, waiting and cruising for parking (parking search traffic); Nuisance to residents;	Inadequate on-site parking;	Poor location; Peaky parking demand so dedicated on-site supply is poor solution; Poor non-driving options; Weak on-street management;	Choose transit-accessible locations for arenas; Special event public transport; Enhance on-street parking management; Foster sharing of local parking and locate with complementary parking peak land-uses;
r	Places of worship vicinities	Double parking, illegal parking, waiting and cruising for parking (parking search traffic);	Inadequate on-site parking;	Parking peaks at congregation times (so on-site parking is poor solution); Locations without public or shared parking; Poor on-street parking management;	Strong on-street management (possibly only at congregation times); Foster use of public parking and/or shared parking deals; Enable mixed-use area for complementary parking peaks and use of shared or public parking.

Notice that parking 'shortage' features often among the 'commonly assumed causes' of the parking problems in Table 2. Yet Column 4 focuses on other ways to look at the problem and new off-street supply is missing from Column 5 on 'promising solutions'.

- This does not mean that off-street parking investments are never a good idea.
- However, the focus here is on-street management solutions not off-street solutions.
- We will see later that new off-street supply should always be considered a last resort, after parking management efforts have been tried first (Section 2.1).
- Furthermore, in dense and congested areas new parking supply may be incompatible with the capacity of the road network and the environmental traffic capacity of the area.

2. Keys to Better On-Street Parking Management

This chapter provides an introduction to the ideas that good on-street parking management rests upon. It also highlights why effective on-street parking management is important and why every city needs to make it a high priority.

2.1 Management first, not supply

As suggested in Section 1.5, weak on-street parking management makes parking seem scarce, even when it is not. Chaos in the streets makes people assume there must be a shortage. Often there is no such shortage, as ITDP found in Harbin, China (see Box 3)[2].

Without effective parking management, the most convenient and easily-found parking spaces tend to fill up. Yet, less convenient parking often remains lightly used.

For example, prime parking spaces in shopping districts tend to fill with employee parking before the first shoppers arrive.

When faced with an apparent parking shortage, it is best to try improved on-street parking management before rushing into supply expansion.

Visibly improved street parking conditions can then help ease political pressure to expand parking supply. This makes it easier to avoid wasteful investments and supply-focused policies, such as excessive off-street parking requirements imposed on new or upgraded buildings.

Even if the shortage is real and new supply seems inevitable, parking management is still the best first response.

- Supply shortages can also be addressed by improving other mobility options, and better parking management often plays a supporting role in such improvements.
- New supply takes time and is costly.
- Parking management as the first step can put the parking system into a much better position to make wise and financially viable parking investments.
- Parking management improves the willingness of users to pay for off-street parking, making it more financially viable.
- Parking management reveals precisely where supply is adequate and where it is not.
- This enables parking investments to be better targeted where they are needed and helps avoid wasteful investments.

Box 3: On-street chaos does not prove shortage: Harbin

Around the world, districts with parking problems in the streets often have under-used off-street parking. Rushing into building extra parking would be a waste. In 2009 ITDP found this to be the case in the Daoli District of Harbin, China, which was thought to have a dire parking shortage: "*... the existing demand can be met entirely through the use of on-street roadway parking and existing off-street parking. There is no need for parking on walkways or in setbacks. In other words, Daoli has a parking management problem, not a parking shortage... Peak demand on a typical weekday is just over 8,000 cars. More than 3,000 spaces are available off-street (this is an underestimate as not all off-street parking could be counted). More than 7,500 spaces can be provided on the roadway (1,058 existing and 6,502 new). In addition, charging for parking is likely to reduce demand by between 5 % and 25 %.*"

2.2 Make on-street parking serve the goals of the street

Good parking management makes parking serve the wider goals of the street rather than undermining them (see Chapter 4).

So allocating space for parking needs to be carefully weighed against many other needs and roles of street space, such as traffic flow, public transport movement, walking, bicycle users, loading/unloading (both goods and passengers), taxis and taxi-like modes, public space

[2] ITDP and Nelson/Nygaard, 2009. *Harbin Daoli Parking Analysis*, 16. Available via https://sites.google.com/a/itdp-china.org/harbin/documents-1

for people to spend time, vendors, and street trees. Note that traffic flow is often not the primary purpose of urban streets.

Good on-street parking management is not just about parking vehicles. It presents an opportunity to achieve a liveable and efficient street environment. Such improvements should always be seen as one of the key goals of on-street parking management.

2.3 Make good use of motorist flexibility

The ability of motorists to modify their parking behaviour (even if only slightly) is central to parking management.

Almost all parking management involves nudging motorists to modify their choices and exercise flexibility.

Skilful parking management requires awareness of which kinds of parking behaviour are most easily modified and which are less flexible.

There are many possible motorist responses to parking management (see Table 3).

A common set of objections to parking management focuses on the weaknesses of public transport. "Pricing parking will do no good because public transport is inadequate" is a common cry. Such objections ignore all of the options shown in Table 3 that do NOT require good public transport. Motorist flexibility is much wider

Table 3: Common motorist responses to on-street parking management efforts (such as pricing)

Type of response	Examples and comments
Choosing a different on-street parking location	■ Shifting from one on-street section to another that is free or at a lower price or beyond a time limit or permit-only zone. This may sometimes involve valet parking (or professional drivers) rather than walking. ■ This response does not reduce driving directly but eases parking problems of busy locations, spreads out demand for parking, and eases pressure to expand off-street supply.
Switching from on-street to off-street	■ Parking with durations of many hours is easier to shift off-street than short-term parking. ■ Off-street parking is often under-used (being out of sight, often less convenient, offering poorer personal security, and sometimes priced higher than on-street). ■ Residents often use their off-street parking spaces for other purposes such as storage. Pricing on the street (including pricing of residents' permits) can discourage this.
Adjusting the time of the visit	■ Choosing to visit and park at a cheaper time or at a time when restrictions don't apply. This enables parking management to ease parking demand at very busy times.
Modifying the duration of parking	■ Planning activities to make a visit shorter and to therefore park for a shorter time. (But shifting long-duration parkers to alternatives makes more difference to on-street durations).
Car-pooling/ ride-sharing	■ Examples include ride-sharing for commuting and colleagues sharing one car to go to a meeting or a lunch.
Switching to another transport mode altogether	■ Switching to public transport is a significant response in certain situations, especially by employees when parking management is used as a Travel Demand Management (TDM) tool. ■ Switching to taxis (four-wheel, three-wheel, two-wheel or non-motorised). This does not necessarily reduce traffic directly but can ease demand for parking. ■ For short trips, switching to bicycle or walking. This should not be under-estimated, since a large proportion of urban motor vehicle trips (especially non-work trips) are short.
Avoiding the area completely and choosing another destination	■ Parking management planning must ensure that this response is not too common. Completely discouraging visitors may undermine the economic success of the area. Some TDM-focused parking management makes an area less attractive for car-based visits (especially work trips) but such TDM policy always aims to improve access by other modes.

than just switching to public transport. Of course, shifts in transport mode are indeed often an important goal of parking management. But never forget that, even in cases where mode shifts seem infeasible, parking management can usually still achieve significant benefits via less ambitious behaviour changes.

Motorist flexibility varies depending on several variables.

For example, motorists' willingness to modify their parking behaviour depends in part on parking duration. Parking durations also relate to the purpose of their trip of course (see below). Themes in the responses to parking management shown in Table 4 include:

- Flexibility to change parking location increases with the intended duration of parking.
- The likelihood of changing travel modes also increases with duration.
- Very short-distance trips show a high willingness to shift to walking or bicycle for all parking durations. Otherwise, trip length is not a strong influence on parking flexibility.
- Flexibility to change the time of a visit is more likely for short duration parking.
- Willingness to shorten durations is common mainly for long-duration non-work parking.

Table 4: Flexibility in response to parking management depends on parking duration

Response / Duration	Shift parking location to less convenient on-street or off-street option	Flexibility to ...		
		Change time of day of parking	Shorten duration of parking	Shift to another mode (walk, bike, taxi, ride-share, public transport)
Short errands (<15 minutes)	Very limited (instant access desired, unless errands can be combined in mixed-use areas for longer visit)	Significant	Very limited relevance	Very limited except for shifts to walk, bike for short trips
Short visits (15 minutes to 2 hours)	Limited (no more than a few minutes walking or access time desired)	Significant	Some	Some, especially to taxi, car-pool and walk/bike for short trips.
Longer visits (2 to 6 hours)	Some flexibility to significant flexibility (proportional to intended duration of stay)	Some	Some	Significant flexibility (including to public transport)
'All-day' (>6 hours)	Very significant (10 minutes walking or access time to/from parking acceptable for many; price signal is powerful for long-duration parking)	Limited	Some but limited for work-based	Very significant (many modes possible; price signal powerful for long-durations)
All night (home-based parking)	Most express unwillingness but walking/access times up to ~10 minutes are common in cities	Rarely relevant	Limited relevance	Not applicable

Different parking purposes are also key factor in flexibility.

- Different parking purposes are often discussed in terms of the characteristics, preferences and flexibility of different demand groups.

- These include residents, employees, students, customers and clients, visitors and guests, service providers and so on. These purposes or groups are defined relative to each destination.
- Parking management often needs to be attuned to the mix of parking purposes or demand groups expected at each location.
- On-street parking is generally open to all parking purposes or demand groups. However, depending on the location, parking management will often seek to favour particular purposes or to influence different demand groups in different ways towards different parking or mobility choices.

Table 5: Parking purposes or user groups and their flexibility and preferences

Parking purposes / user groups	Flexibility and common preferences with respect to ...				
	Parking locations	**Parking times**	**Parking durations**	**Mode shift potential**	**Parking management (PM) effects**
Employees at/ near workplace	Proximity preferred of course. But often flexible in practice	Inflexible. Daytime working hours usually (but many have other hours)	Inflexible long-durations, most typically 6 to 10 hours	Relatively flexible, especially for jobs in major centres with mainstream work hours	Most PM impact is on locations and mode shift. Sensitive to pricing because repeated and long-duration parking
Post-secondary eduction	Often flexible (depending on duration)	Wide range of hours and often flexible.	Wide range of durations (2 – 12 hours) and often flexible	Often flexible but depends on mobility options of course	Full range of PM impacts. Sensitive to pricing (low-incomes, repetition and durations
Shopping customers	Relatively inflexible (due to durations, loads)	Often flexible but still prone to peaks	Relatively short. Often flexible	Varies	Most flexible on times and durations. Retailers fear change of destination if strong PM
Service business clients	Relatively inflexible.	Often flexible	Relatively short. Often flexible	Varies	Similar to shopping customers
Residents	Some flexibility. Expectations vary with context (*e.g.* on-street parking may be choice not necessity)	Inflexible (need potential to park anytime)	Inflexible (long to extremely long)	[Not applicable. This is home-based parking]	PM focus (if any) is on parking locations (nudge off-street usually). But parking costs/issues can also (slowly) influence vehicle ownership
Visitors and guests of residents	Some flexibility	Often flexible	Relatively short. Often flexible	Varies	PM efforts to influence this group often resented by residents
Service providers for residents (including carers, cleaners, repairers, etc.)	Some flexibility usually	Often inflexible	Varied lengths (<1 hour to many hours). Often inflexible.	Often inflexible	Exemptions to usual PM often sought by residents for services deemed essential and for which flexibility is limited

- Table 5 discusses this in simple terms for commonly discussed categories of demand.

Motorist flexibility is vital to parking management. So any obstacles to motorist flexibility can undermine parking management and its public acceptance.

Common obstacles to flexibility include:

- Public transport weaknesses, poor cycling environments, and unreliable taxi systems which all affect the willingness to shift modes.
- Low-quality or hazardous walking environments which do not just impact on mode shift to walking but also reduce flexibility on parking locations.
- Hostile weather conditions or climates that may also impact walking.
- Physical abilities, with some less able to walk far.
- Preferences and attitudes that result in a reluctance to be flexible.
- Passenger characteristics, for example, it may be infeasible for young children or passengers with certain disabilities to be dropped off and left unattended.

In some situations it may be important to take steps to minimise such barriers to flexibility to make parking management work better and to make it more acceptable to motorists. Do not be overly pessimistic however. We do not need everyone to exercise flexibility for parking management to work well and for it to be accepted well enough. When parking management is stepped up, we often find that motorists display more flexibility than was expected.

Most motorists want to do the right thing and enabling flexibility helps them to do so. All want to avoid enforcement consequences, if they can. Most seek to minimise cost and effort, including the effort of finding parking and walking. However, if doing the right thing is difficult and violating parking regulations is easier, then it is predictable that many motorists will park in ways that inconvenience others.

2.4 Understand links between parking and congestion

The impacts of parking on traffic and traffic congestion are varied. It is wrong to assume that all on-street parking causes congestion or that off-street parking automatically eases congestion.

On-street parking can worsen traffic congestion in several ways (Table 6).

Table 6: Ways in which on-street parking can cause congestion

Mechanisms		Brief explanations
Direct obstruction		Parking can obstruct traffic if at inappropriate locations or in inappropriate orientations (whether legal or illegal).
Traffic friction		Parking manoeuvres create traffic friction in adjacent lanes. Extent of this depends on factors such as road width, traffic levels, traffic speeds, parking orientation, and speed of entry and exit.
Saturated parking	When parking is close to full (from around 85 % occupancy) motorists have difficulty finding an empty space. This causes several problems.	Increased illegal parking.
		Prompts double-parking (including loading/unloading).
		Waiting in the traffic lanes for a parking space to open.
		Searching for an empty parking space ('cruising for parking') generating extra traffic in busy areas.

The impacts of saturated parking (at the bottom of Table 6) deserve much higher awareness. Parking search traffic has been especially neglected because it is an 'invisible queue'. In dense areas with full parking, this can be a large percentage of the traffic flow, often higher than 30% [3]. These impacts occur even if the on-street parking is well-located, well-designed and orderly.

Improved on-street parking management can ease congestion in several different ways:

- Directly by reducing obstructive parking and by reducing friction through better design of spaces and via better enforcement. Note that if parking on a street contributes to congestion, the answer is not necessarily to ban parking there. The solution may be better parking management or better design (Section 4.10).
- Indirectly by reducing saturation and therefore keeping on-street spaces open (for example via pricing that targets an efficient occupancy range– see Section 5.5). This reduces search traffic, waiting, illegal parking and double parking.

Do not assume that only on-street parking is associated with congestion and that off-street parking is the answer. Off-street parking can also contribute to congestion.

For example, off-street parking can cause congestion via queuing. These queues are often a direct cause of congestion if they extend into a major street.

- One cause of queues is poor design of ingress or of internal vehicle movements, delaying inflows at busy times.
- Queues can also form outside off-street parking facilities if they fill up. But do not assume that the solution must be more parking supply. Such queues can be avoided via good management, including pricing.

Excessive off-street supply is also a source of traffic congestion by promoting traffic growth.

- Excessive off-street parking encourages both car ownership and car use. Oversupply, leading to low-priced or free-of-charge parking, has been called a 'fertility drug for cars' [4].
- Excessive parking supply in employment centres strongly encourages cheap or free workplace parking [5].
- All-day parking is more sensitive to price than short-term parking, so cheap or free parking especially encourages driving to work.
- In business districts, a large supply of parking often generates traffic that exceeds the capacity of the surrounding streets.
- Policies that expand residential parking supply beyond what car owners would be willing to pay for explicitly also increase car ownership and traffic.
- Regulations that focus on increasing the parking supply (such as excessive minimum parking requirements) can hinder transit-oriented development and contribute to sprawling low-density car-oriented patterns of development, which fuels traffic growth.

2.5 Do better than relying on casual impressions

Casual observations of parking problems often lead to mistaken assumptions about the nature of the problem and its underlying causes. Such impressions are usually very different from reality as revealed by more careful study (Table 7).

It is extremely important for parking management decisions to be informed by systematically collected parking information (see Chapter 7).

[3] Paul Barter, 'Is 30% of traffic actually searching for parking?', Reinventing Parking website, October 2013, http://www.reinventingparking.org/2013/10/is-30-of-traffic-actually-searching-for.html.

[4] Donald Shoup, *The High Cost of Free Parking* (Chicago: American Planning Association).

[5] Shomik Mehndiratta and Diego Canales, 'Can your employer affect your commute?', Transport for Development blog – World Bank, 16 May 2014, http://blogs.worldbank.org/transport/can-your-employer-affect-your-commute-0.

Table 7: Casual observation misses many insights from systematic data collection

Common casual observations	Data collection method	Key insights from data that are missed by casual observation
This area has a parking shortage! Losing these 20 on-street spaces would be disastrous! Redevelopment of this open parking lot would create a shortage of parking!	**Parking inventories** (which systematically document the number of parking spaces and their characteristics in a small area).	■ Inventories usually surprise local stakeholders by revealing a larger number of spaces than most people realise. ■ On-street parking is usually revealed to be a smaller percentage of spaces than most people assume. ■ Sometimes even local parking authorities/managers are surprised, since private spaces are often hidden away and inaccessible to the public.
Finding parking in this area is a nightmare! This area has a parking shortage!	**Occupancy surveys** or occupancy data via sensors or digital payment mechanisms.	■ Reveal streets and off-street facilities with low occupancies. ■ Reveal times of the day and week when even the busiest sections of street have low occupancies. ■ Highlight opportunities for parking management to nudge some motorists towards lower demand places and times.
This area has a parking shortage! I can never find a convenient parking spot in this street!	**Surveys of parking duration** (via license plate surveys or via data from digital payment mechanisms).	■ Reveal if long-duration parking in inappropriate locations is an important part of the problem on prime street sections. ■ Reveal where all-day parking may be occupying a large proportion of the space (despite serving very few people). ■ Highlights opportunities for nudging long-stay parking to under-used street sections and off-street facilities.
This district has awful traffic congestion. We need to expand traffic capacity.	**Parking occupancy surveys.**	■ Reveal if high on-street occupancies may be causing traffic congestion in the area (by causing parking search traffic). ■ If so, parking management may offer a cheap solution. There may not be a need for more traffic capacity.

Notice that the final casual observation in Table 7 is not even about parking but parking occupancy surveys often reveal on-street parking saturation to be a key cause of local traffic problems (as mentioned in Section 2.4).

Fig. 10, 11: *Over-saturated on-street parking in a business district of Shenzhen, China, but with half-empty underground parking under neighbouring office buildings.* © Paul Barter

2.6 The private sector can help (but be careful)

Off-street parking is usually best left to the private sector. However, public sector leadership is essential for on-street parking.

Nevertheless, even for on-street parking, some degree of private sector participation can be desirable. Cities with strong on-street parking management vary widely in the extent to which they involve the private sector.

Reasons to consider using the private sector in on-street parking management include:

- *Internal capacity limitations*. Local governments need basic parking management capacity but often cannot handle all technical aspects of parking management, especially those involving high-technology systems.
- *Economies of scale*. Large parking-related firms that provide the same specialised service in many local governments may have lower costs.
- *Human resource management advantages*. Private sector entities may have more flexibility than municipalities to deploy employees cost effectively. Care needs to be taken that this is not a cover for exploitative work practices.
- *Benefits of competition* among vendors of various parking services and technologies should enable efficiencies, so long as the competitive tendering process is clean and competitive.

Be careful however. Do not assume that private sector involvement is a panacea for weaknesses with on-street parking management.

Private participation does not avoid the need for good governance of the parking system:

- Municipalities with weak in-house parking management capacities still need enough in-house capacity to make key decisions on parking management, to choose among tenders, and to monitor and control contractors.
- Key parking management objectives must remain primary. No contract should undermine the local authority's ability to manage parking for the public interest.
- Private participation is rarely a successful remedy for internal corruption or a way of bypassing such corruption unless accompanied by other strong anti-corruption efforts.

Box 4:
Aspects of on-street parking management that are often contracted out to be handled by private sector businesses include:

- Signage
- Pricing equipment
- Pricing operations
- Payment mechanisms (credit card systems, smart cards, mobile wallets, etc.)
- Handling of parking funds (financial services)
- Enforcement equipment and systems
- Enforcement operations against pricing violations
- Enforcement operations against illegal and dangerous parking, including commonly towing and clamping activities
- Parking monitoring systems and/or their operation
- Parking information management systems and/or their operation
- Parking policy advisory services (usually including parking data collection and analysis)
- Street design services
- Street reconstruction services

- Outsourcing rarely overcomes political obstacles to parking management reforms. In some cases, the political costs of mishandled parking management reforms can be magnified by private participation, especially if the public suspects corruption.
- The complexities and transaction costs of outsourcing public services sometimes outweigh the gains. Evaluate carefully and monitor.

It is important to establish robust procedures for making decisions on private participation and for awarding and overseeing the contracts.

- Be especially wary of unsolicited proposals from the private sector. Considering unsolicited proposals is an extremely poor way to make key parking-system decisions even if the proponent is a reputable company with a strong track record.
- Instead, carefully prepare a Request for Proposals (RFP) or, at the appropriate time, a Tender or Request for Bids (RFB).
- Preparing such requests requires preparation to be able to specify requirements based on a clear

understanding of the needs (based on parking management goals).

- Decide clear and appropriate criteria by which such proposals or bids will be evaluated. These go beyond simply meeting the key requirements in a cost-effective manner. Other factors include the company's financial status and track record among others.
- Contracts need to be carefully prepared (possibly with the help of outside expertise).
- Establish a robust system for managing and overseeing the contracts.

2.7 On-street management widens off-street parking policy options

Good on-street parking management helps more than just the streets. It is one of the keys to success with managing parking more generally. On-street parking management expands the choices on how to deal with off-street parking.

Figure 12 provides a way to visualise the main options of off-street parking supply policy. These are based on attitudes to parking supply. These attitudes are expressed by the answers to the three questions. Each question defines one of the axes in the framework.

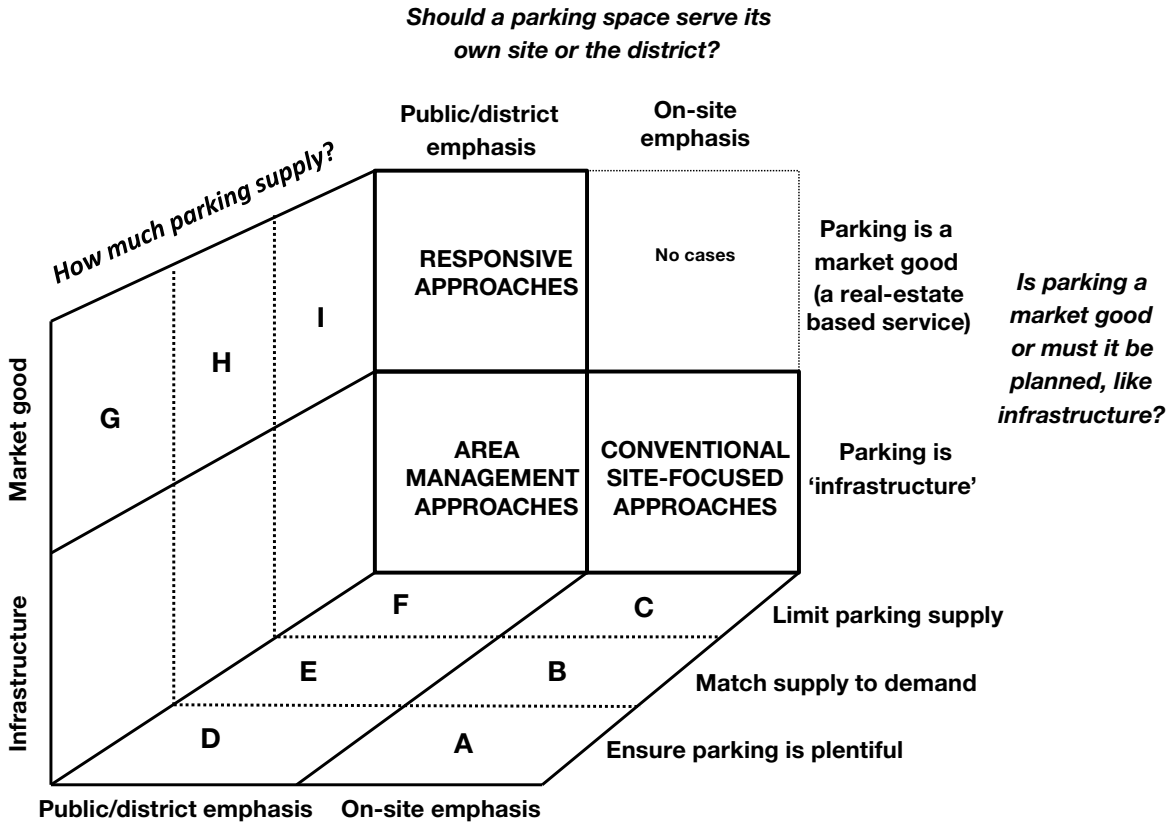

Fig. 12: *An approach to classifying different parking policy types.* © Barter 2014

Source: Paul Barter, A Parking Policy Typology for Clearer Thinking on Parking Reform, *International Journal of Urban Studies* (2014), DOI: 10.1080/12265934.2014.927740.

Weak on-street parking management tends to trap municipalities in the lower right part of the diagram:

- In this approach, local governments try to solve parking problems by promoting off-street parking supply and seeking 'enough' parking within every development site.
- This is the approach labelled A on Figure 12 and it tries to ensure plentiful off-street parking supply using minimum parking requirements.
- It is closely associated with costly, sprawling and car-dependent development patterns.
- Indeed, the automobile-oriented suburbs of most North American cities are the heartland of this approach but it is now common worldwide.

Many places feel unable to reform away from Position A (or from positions B or D) because they do not trust on-street parking management to prevent on-street parking problems.

Other useful approaches shown on Figure 12 become feasible ONLY if on-street parking management is strong:

- *Treating parking as something that serves a whole area* means shifting to the left column in Figure 12. This involves planning for 'park-once-and-walk' districts in which most parking is public. This is space-efficient and generates less traffic than private on-site parking.[6]
- *Avoiding oversupply* is easier when on-street management helps reduce the fear of a slight shortfall in off-street capacity. This means shifting backwards on Figure 12 away from positions A or D towards B, E and F.
- *Using parking as a TDM tool*, by limiting the supply of off-street parking, as many city centres including those in Seoul, London, Sydney and San Francisco do (Position F).
- *Making parking prices and supply more market responsive*, such as occupancy-targeting in price setting and abolishing minimum parking requirements (or making them more flexible) [7]. This means a shift towards the top-left part of Figure 12 (Position H for example).

2.8 Work to win stakeholder support

Parking management is often hampered by controversy and conflict and establishing good on-street parking management can sometimes be politically painful, especially at first. Winning over key stakeholder groups is essential.

Be realistic that general motorist opinion cannot easily be won over to support parking management. Even though parking management makes parking a less painful experience for motorists, they are generally not happy about the enforcement, the regulations and the pricing that enable such improvements.

The key stakeholder groups that need to be won over for on-street parking management are extremely local (see Box 5). These groups pay very close attention to any proposed changes and they usually wield much more influence over local parking management outcomes than do motorists in general across a metropolitan area.

It is usually not necessary to worry too much about hostile reactions from general motorist opinion. Nevertheless, Sections 5.3 and 6.3 highlight ways to make pricing and enforcement less unpopular than they usually are.

But focus most effort on winning the support of these local stakeholders.

Unfortunately, the need for parking management to 'sweeten the deal' for the local actors is rarely given the attention it deserves. This is a key reason that parking management proposals so often face great difficulty gaining public acceptance.

Many places with successful on-street parking management quietly make sure that local stakeholders are happy. There is a great need for more study of these successes so that others can learn from them.

[6] Paul Barter, 'From private parking to public parking: part of the Adaptive Parking agenda', Reinventing Parking website, November 2011, http://www.reinventingparking.org/2011/11/from-private-parking-to-public-parking.html

[7] Paul Barter, 'Shoup's parking ideas offer MUCH more than a nifty way to price on-street parking', Reinventing Parking website, August 2010, http://www.reinventingparking.org/2010/08/shoups-parking-ideas-offer-much-more.html

Promising approaches to making sure that parking management provides enough 'local dividends' (or local benefits) include:

- Make sure that parking management yields very visible (and popular) improvements in conditions in the local streets. This may sometimes require complementary street improvements that go beyond parking management.
- Offer special arrangements for key local stakeholder groups (for example, residents) to moderate the pain of parking management for them. However, this requires care. Such deals must not be allowed to seriously undermine the effectiveness of parking management.
- Keep any parking revenue surplus very local and spend this surplus in ways that pleases key local stakeholders (ideally involving them in the decisions through mechanisms such as Parking Benefit Districts [8]). Consider simply distributing part of the surplus locally, for example via a local property tax rebate or to local charities.

The timing of parking management changes can also be important for public acceptance. For example, a tightening of enforcement might be timed to coincide with other improvements in parking conditions or with openings of new supply or with clear improvements in public transport, walking, cycling conditions and street design.

Make a strong effort to earn public trust in the key parking management tools:

- Base pricing and fines decisions on parking management goals rather than revenue. It is disastrous for public support of parking management if people think of parking fees or fines as taxes, with revenue as their main goal.
- On-street parking management needs to be carried out with full legal backing and conducted in a professional way by actors who are properly sanctioned.
- It is important to earn trust in procurement processes.
- Motorists need strong assurance that parking revenue goes where it is meant to go according to legal procedures and contracts.
- Strong efforts are needed to eliminate illegal fee collection, extra payments, negotiated discounts, soliciting of bribes, extortion, illegal enforcement activity or leakage of revenue.
- Enforcement consequences need to be proportionate to the offense.
- Design and communication need to avoid confusion and make the desired parking behaviour as clear as possible.
- Rules must be reasonable and connected with clear parking management goals.

Box 5: The key local parking stakeholders are usually

- ***Local residents*** who may be unhappy over 'outsiders' parking in 'their' street (in other words, they fear 'spillover'). They expect to find a convenient space whenever they return home. Some feel a sense of ownership over specific spaces.
- ***Local retail businesses***, especially on shopping streets, often fear that parking changes may deter customers. They also worry about goods deliveries and their own parking or that of employees. Some view parking in front of their shops as 'theirs fundamental right' to some extent.
- ***Property owners*** may worry about the impact of parking changes on their property values and rental yields, even if they are not actually local residents or business owners.
- ***Large institutions under a single management***, including large shopping complexes, 'office park' campuses, large hospitals, higher education campuses, sports arenas or large entertainment or recreation venues. Owners/managers of these have their own complex internal parking and access strategies and interests. Spillover parking into the local area usually helps them but, if not well-managed, can harm relations with neighbours.
- ***Local employees*** are less powerful than the groups above but are still relevant. Those with parking privileges, such as cheap or free parking, will resist changes that threaten these.

[8] Kolozsvari, Douglas and Donald Shoup, 'Turning small change into big changes.' *Access Magazine 1*, no. 23 (2003) and Metropolitan Area Planning Council (MAPC), 'Parking Benefit Districts', in *Sustainable Transportation: Parking Toolkit*, http://www.mapc.org/resources/parking-toolkit/strategies-topic/parking-benefit-districts, Updated on Fri, 29/01/2010.

3. Institutional Basics

This short chapter provides brief guidance on basic institutional arrangements for on-street parking management. This includes choices on where intensive parking management is needed and which organisations should be responsible. Effective institutions can make a huge difference but this is a complex issue. So the main focus here is to simply highlight its importance.

3.1 Parking management needs institutional and legal backing

Throughout this guide it is often assumed that local governments have the institutional capacity and legal authority to implement the suggestions.

This is not true for many places. Some cities unfortunately still need to build crucial institutional and legal foundations for effective on-street parking management.

Note that enforcement has some specific legal and institutional reform issues. Most of these are discussed in Section 6.7

Local governments need legal authority to enable them to carry out essential parking management activities.

Legislation or gazetted regulations are needed to enable all of the basics of on-street parking management.

Neglecting this can be costly. Abuja in Nigeria recently faced parking management disruption when a court found that the city's parking fees system lacked the necessary enabling law [9].

National government should generally focus on enacting enabling legislation to empower local governments to take the necessary measures to manage parking. More active intervention in parking management by national governments is generally unhelpful:

- In Ukraine, for many years a ban on towing illegally parked cars (enacted at the national level) rendered local-level parking policies ineffective.

However, there are exceptions:

- In the late 2000s national law in Hungary established useful constraints upon on-street parking price setting. These helped depoliticise on-street parking pricing at the local level and prevents competition between municipalities to have the cheapest parking [10].
- Japan's general ban on overnight on-street parking combined with its 'proof-of-parking' law are generally regarded as having had significant benefits [11].

Higher levels of government occasionally fail to empower local government parking management with the necessary legal backing. Examples include:

- Russian law, until July 2011, made it illegal for local governments to charge hourly fees for on-street parking so on-street pricing in Russian cities was impossible [12].
- Japanese national law severely limits the options for on-street parking pricing and unfortunately gives traffic police the primary responsibility for most on-street pricing [13]. Fortunately, there is little on-street parking in Japan (see Section 4.11).

Should parking management authority be at metropolitan or a more local level? Some cities have more than one level of 'local' government. For example, some large cities have a metropolitan layer of governance and a set of smaller local municipalities. There seems to be no clear cut case for or against either having the main institutional authority over on-street parking. In cities where the metropolitan level of government is strong, then this may be the best option. Where metropolitan government is weak relative to the more local level, then decentralised parking management may be best.

However, there is a persuasive case for the creation of a strong parking authority.

[9] Amina Mohammed, 'UPDATE: Why Court ordered Abuja administration to stop Park and Pay policy', Premium Times (Abuja), 17 April, 2014, http://www.premiumtimesng.com/news/158954-update-court-ordered-abuja-administration-stop-park-pay-policy.html

[10] Paul Barter, 'Is Budapest in the demand-responsive parking pricing club?', Reinventing Parking website, June 2014, http://www.reinventingparking.org/2014/06/is-budapest-in-demand-responsive.html

[11] Barter, *Parking Policy in Asian Cities*, 2011

[12] Roland Oliphant, 'Paid Parking Essential to Congestion Charge', Moscow Times, by 3 Aug. 2011, http://www.themoscow-times.com/news/article/paid-parking-essential-to-congestion-charge/441506.html

[13] Barter, *Parking Policy in Asian Cities*, 2011

- Ideally, this authority should be empowered to handle as many aspects of parking as possible, in order to do so in a coordinated way.
- Whether parking is handled at local level or at metropolitan level, establishing a parking authority should still be a helpful step.
- For example, ITDP in China [14] has been calling for such authorities with powers to manage both on-street and off-street parking together. Antwerp, San Francisco, Barcelona, and several other European cities are mentioned as examples.
- Another option, suitable for some cities, would be to establish a less powerful coordinating mechanism, such as a parking committee, to enable better coordination among agencies handling different aspects of parking management and policy.

3.2 Other reforms to enable good parking management

Effective parking management is much easier if complemented by the following initiatives associated with good governance and effective institutions:

- ***Create an efficient computerised vehicle registration database with up-to-date addresses***. This is generally done at national or provincial/state level, not local government level. The lack of a reliable vehicle registration database in Indonesia, for example, is a serious obstacle to both parking management and road safety enforcement (Chapter 6).
- ***Local governments need adequate access to this database on reasonable terms***. Lack of access to the national vehicle register by Malaysian local governments unnecessarily hampers their parking enforcement.
- ***Efficient street management institutions***. Fragmented responsibilities for street management are extremely common. This can be a serious challenge for parking management and for coordinating parking design and delineation with management. Weak street management also undermines walkability, which also helps on-street parking management which depends on encouraging at least some motorists to be willing to walk to and from public parking options.

Of course, institutional reform is much easier said than done. Don't wait for perfection. Make the reforms that are achievable, create the best institutions that can be achieved under the circumstances, and implement the best parking management that the situation permits.

3.3 Make it possible to intensify on-street parking management where necessary

Not every street needs intensive parking management, such as priced on-street parking, intensive enforcement of detailed regulations, numerous signs and markings, and much attention to the details of the design of parking spaces. For example, such efforts may not be necessary in low-density areas. Intensive parking management should be focused on the busier places that need them most, such as locations mentioned in Table 2 in Section 1.6. In high-density cities most streets will need intensive parking management.

It is important to establish institutional arrangements so that parking management can be intensified where needed and that it can remain at a basic level wherever such simple management is enough.

In some jurisdictions, parking management can be gradually intensified, as needed, in a series of small steps, so that there is no very sharp boundary between areas where parking management is intensive and those where it is light.

However, in other countries the shift to more intensive parking management is abrupt and is associated with significant differences in regulations, procedures and even which agencies handle parking. England is an example of this (see Box 6).

In either case, local governments need a set of objective criteria or guidelines for deciding where and how steps towards more intensive on-street parking management are warranted.

Intensive on-street parking management is usually necessary at locations and times that:

- have high parking demand pressure (resulting in high occupancies);

[14] Rachel Weinberger *et al.*, *Parking Guidebook for Chinese Cities*, ITDP China, 2014, https://www.itdp.org/parking-guidebook-for-chinese-cities

- are a focus for complaints over anti-social parking or other parking conflict;
- attract high demand for very short-term parking (such as street-side ATM machines, post offices, shops selling takeaway snacks, etc.).

Fig. 13, 14: *Singapore streets with actively managed (and priced) parking (top) versus unmanaged parking (bottom) (but notice signs of parking conflict suggesting a need for management).* © Paul Barter

Box 6: England's approach to declaring areas of intensive parking management

In England local authorities need to seek the gazetting of a controlled parking zone (CPZ) to gain legal authority to carry out intensive parking management. Such CPZ now cover most of the densely built up areas of London for example, but exclude most low density housing areas.

In most other countries introducing intensive parking management is legally simpler. Nevertheless, it always needs careful planning.

Easy-to-notice warning signs of a need to improve on-street parking management include:

- double parking (parking in traffic lanes next to other vehicles parked at the kerb);
- illegal and/or obstructive parking (including parking partially or fully on walkways);
- Illegal reservation of on-street parking spaces.

These warning signs may be intermittent at first but over time usually become more serious, more obvious, and occur more often and for longer and longer periods. If so, systematic surveys become necessary to get a clear picture of parking management needs (see Chapter 7).

Fig. 15: *Illegal parking on walkways in Mexico City.* © Carlosfelipe Pardo

Fig. 16: *Illegal parking on walkways in Hanoi.* © Manfred Breithaupt

Fig. 17: *Illegal parking on walkways and cycling paths in Sibiu.* © Manfred Breithaupt

What to do in areas that DON'T need intensive management.

Streets beyond the areas discussed above may not require intensive parking management at all. For example, low-density residential streets distant from commercial areas often face little competition for on-street parking space.

Nevertheless, there is always a need for simple parking rules to keep parking orderly and to avoid anti-social parking behaviour. These rules need to be simple, standardised and predictable. They are best standardised at national or state/province level.

Such simple regulations include:

- parking allowed by default except where explicitly banned using markings or signs (for example along a busy road);
- orientation of car parking is parallel by default;
- parking banned within a certain standard distance of minor intersections and within a longer distance of major intersections;
- parking banned on or across footpaths including where they cross driveways (vehicle access to off-street sites);
- double parking banned (parking in traffic lanes beyond other parking);
- parking must not obstruct a driveway (vehicle access to sites);
- parking must not block fire hydrants, emergency access, etc.

Even these simple rules need some basic enforcement to encourage compliance:

- Such enforcement is often carried out by the authorities that enforce other road rules (usually traffic police), rather than by dedicated parking enforcement (as is usual in intensively managed areas).
- Most such enforcement is triggered by complaints rather than patrols.

Such light enforcement is usually inadequate to ensure broad compliance. This can be acceptable in areas with little parking conflict.

Box 7: The dilemma of places with brief but recurring parking problems

There is a dilemma over on-street parking problems that recur regularly but which are brief in duration. These need intensified parking management only on a part-time basis.

Examples include:

- school vicinities (problems only in morning and afternoon drop off and pickup times);
- areas around places of worship (problems at times of large prayer congregations);
- other weekly or occasional events, such as farmer's markets and major sports events.

Parking management in such cases usually involves a partnership between local government and the organisation generating the traffic.

For example, schools may take responsibility to employ part-time or volunteer wardens. Places of worship may enter into shared parking agreements with nearby sites, and so on.

4. Physical Design of On-Street Parking

This chapter offers guidance on the physical design of parking. This includes the delineation of parking spaces or areas, choices on where parking should be banned or allowed, and design issues associated with communicating which parking behaviours are acceptable and which are not.

A strategic vision for the area or street should ideally inform parking design. This requires clarity on the overall design goals of the street.

Guidelines need to be sensitive to context. For example, on a street that is intended as a low-speed environment, angled parking may be appropriate even if it would be anathema on a street where traffic flow is an important priority.

In practice, parking design is often *ad hoc*, taking the existing situation as a starting point and proposing adjustments. Close observation of existing behaviour is an essential part of the process. But do not forget to be consistent with goals for the street.

We begin with key influences on where to allow or to ban parking.

Box 8: The international audience for this toolkit creates a challenge for this chapter

- Street conditions and institutions vary so much from country to country that it is difficult to make specific design prescriptions to suit every country.
- Furthermore, local government choices are usually constrained by technical guidance from higher levels of government or from professional associations (such as traffic engineering bodies).
- Nevertheless, this chapter will be as specific as possible while still remaining relevant to a wide international audience.
- It also provides relevant principles, enabling you to be discerning in applying technical guidelines. It may even prompt you to challenge some of them.
- Local designs must take account of the variations in the size of typical passenger cars in different countries. For example, North American parking spaces are larger and South Asian spaces are smaller than the typical dimensions in most other parts of the world.

Prescriptive guidance is often not possible but this chapter still provides many specific examples.

4.1 Make space for other uses of streets

Decisions on parking space in streets always needs to be weighed, not only against traffic flow, but against all of the objectives of streets and the facilities that serve them, including public transport space, walking, bicycle users, public space, vendors, and street trees.

Important streets are often also important public places. In some cases, enabling space for people to spend time in the street may be a higher priority than on-street parking. Ideally, this public space priority is achieved in the overall street design.

An example is 'pop-up parks' or 'parklets', created by converting single parking spaces to small public spaces, often with seating and often sponsored by a local business. These are a growing trend in North America. Such conversions can be permanent or temporary.

Fig. 18: *"The walking distance to a parking place has to be at least as long as the walking distance to the public transport stop" – Hermann Knoflacher, Inventor of Walkmobile.* © Michael Kodransky

Fig. 19: *Stockton Street Parklet, San Francisco.* © San Francisco Planning Department on Flickr https://www.flickr.com/photos/sfplanning/8139536163/in/set-72157630780431414)

Make space for other kinds of kerbside stopping

Allocation of precious kerb space among the various competing vehicle stopping needs is another key decision. ***Such needs include bus stops, taxi or private car drop-off/pick-up points, goods loading and unloading, and heavy vehicle parking***.

Bus stops are a very important use of kerb space. For kerbside bus stops on streets with on-street parking, it is not only the bus stop itself that must be kept free of parked vehicles but also a certain distance before and after. This allows ease of entry and exit. For example, Australian cities commonly ban parking for 20 m before and 10 m after a bus stop on a significant road. As physical measure, the installation of bus boarders helps to reduce illegal parking at bus stops.

Fig. 20: *London.* © Andrea Broaddus

Space for drop-off and pick-up points is especially important around railway stations, schools, mass transit, and such like. If kerb space is not allocated for this and well-managed, there is a strong risk that vehicles will stop in traffic lanes.

Loading and unloading of goods is an important use of kerb space in business districts. There are several options:

- High-quality parking management may enable some such loading/unloading (by small delivery cars and vans for example) to be done in ordinary parking spaces. This is feasible if pricing can successfully ensure that on-street parking vacancies are almost always present (see Section 5.5).
- However, intensive loading/unloading activity and larger vehicles require special loading zones restricted to the use of goods vehicles. If off-street loading areas are not adequate then some will be needed at the kerb in the streets. These must be designed to suit the vehicle types and sizes that will use them.
- An alternative to dedicated loading zones is to designate sections of kerb or groups of parking spaces to have very short time limits, such as 15 minutes or as general loading/unloading zones. This option allows private motorists (and not just goods vehicles) to run errands using such spaces. This can be suitable if such private errands are mostly at times that differ from the busiest loading/unloading time periods.

Fig. 21: *Abu Dhabi.* © Manfred Breithaupt

Taxis (and taxi like modes such as rickshaws and auto-rickshaws) will need dedicated pick-up points in busy areas that have scarce kerbside space. These must be well-designed and kept clear of all other parking and stopping. Depending on the local situation, such 'stands' or 'ranks' may need provision for several vehicles to queue. These are often a priority use of kerb space at the same kind of locations that need general drop off and pickups, as well as in entertainment districts, large retailers and in any very busy locality.

Fig. 22, 23: *Taxis of all kinds need suitable places to wait: Istanbul, Turkey and Ubon Ratchathani, Thailand.*
© Ko Sakomoto and Dominik Schmid from the SUTP collection on Flickr

Car-sharing services are, in an increasing number of cities, being allocated prime on-street parking spaces to car-sharing. Sometimes car-sharing companies tender for the lease of such spaces. Sometimes the spaces are provided free in an effort to boost the industry. Despite the 'loss' of general parking spaces involved, this should be seen as part of the solution to parking problems, by helping reduce car ownership and use.

Bicycle parking as a replacement for kerbside car parking spaces may be justified in areas with high bicycle use, chaotic bicycle parking problems and a lack of alternative locations for bicycle parking. Often 10 to 12 bicycle spaces can be created from one car space.

Fig. 25: *Car-sharing by Car2Go with electric Smart in Stuttgart, prime parking spot near central station.* © Kevin Korffmann

Fig. 24: *Chaotic bicycle parking on walkway and street in Berlin.* © Kevin Korffmann

Fig. 26: *Car parking spot, reused as bicycle parking in Lima.* © Kevin Korffmann

Motorcycle parking is also important, but often neglected, even in cities with large numbers of motorcycles. Kerbside two-wheeler parking designs are discussed below, in Sections 4.7 and 4.8 (motorcycle and bicycle on-street parking).

Heavy vehicle parking is an often neglected issue that often requires some kerbside space.

- Many cities lack sufficient off-street depot and parking space for heavy vehicles;
- On-street resting places and off-peak/overnight parking for buses or trucks may be needed;
- Carefully choose stretches of street for this purpose in locations that are suitable;
- These locations should be outside residential areas but usually not too far from housing, since vehicle

crews may need to walk or cycle between homes and parking locations;
- They should be in locations with low on-street parking demand. At least other parking demand must be low at the times when they are used for heavy vehicle parking, (such as at night).

Tour buses/coaches parking and waiting areas:
- Urban sites of strong tourist interest may be visited by large numbers of tour coaches.
- These often need suitable kerbside locations to drop off and pick up their passengers
- They also need different suitable locations some (short) distance away from the site of interest to park/wait for 30 to 120 minutes or so before returning to pick up passengers. Time restrictions are a good idea for such zones.
- Choosing suitable stretches of street (without active street frontages and away from busy pedestrian traffic) can be challenging, since many such tourist sites are typically in busy urban core areas.

4.2 Minimise road danger (maximise road safety)

Danger deserves to be a more significant criterion not only in parking design but also in deciding where to allow parking.
- Averting danger is a key reason to ban parking too close to intersections. Parking should not obscure essential sight lines close to intersections (keeping in mind that such sight lines can be short in low-speed streets).
- Parking and stopping must also be kept a safe distance from school entrances (and similar).
- Allowing parking or stopping too close to pedestrian crossings causes danger by obscuring sightlines. Depending on speeds, parking and kerbside stopping may need to be banned for up to 20 metres before and 10 metres after a mid-block pedestrian crossing.
- Parking often needs to be banned to design safe bicycle routes.

Parking can sometimes benefit safety, if planned with care.
- Well-designed on-street parking can be part of good traffic calming street designs, for example by narrowing perceived roadway width.
- Parking can sometimes form a buffer between traffic and pedestrians or bicycle paths, so long as cyclists are not forced to ride in the door-zone and so long as the parking allow sufficient visibility and safe intersection designs.

Both safety and traffic capacity are reasons to keep both parking and kerbside stopping away from intersections. But a uniform stopping-ban distance from all intersections is not appropriate. The appropriate distance depends on design speeds and the nature of the intersection.

Fig. 27: *Parking plays a role in traffic calming in this Frankfurt-am-Main streets.* © Kersten Ögel via the SUTP photo collection

Box 9: How Montreal defused parking as an issue in a bicycle lane debate

In 2005, Montreal, Canada was planning a key city centre bikeway on Boulevard De Maisonneuve. It involved removing 300 on-street car parking spaces. Focusing only on on-street parking could have provoked headlines screaming that 'half of the parking' was being removed.

Instead, the city counted, then highlighted, the total number of car auto parking spaces within 200 meters of the project. There were 11,000! Turning one of the two parking lanes into a protected bikeway would remove less than 3 percent of them. Parking-related opposition to the project almost disappeared.

- For example, in order to add traffic lanes, parking and stopping are often kept 100 m away or more from major intersections on the approach (and a little less after the intersection).
- However, on minor streets with little traffic movement role, safety for vulnerable road users is the main criterion for setting no-stopping and no-parking zones around intersections. In such cases, the distance from the intersection in which stopping at the kerbside must be prevented can be as little as 6 to 15 m (the length of one or two car spaces or so).

4.3 Keep any losses of on-street parking in perspective

Proposals to remove some on-street parking are often controversial. This can be eased through better understanding of the wider parking context.

Any loss of on-street parking spaces should be assessed relative to all relevant parking, including nearby off-street parking and parking in nearby streets, not just the parking on the controversial street section itself. This wider perspective often reveals that the lost on-street spaces, which may seem like a large percentage loss of on-street spaces, are a much smaller percentage of the wider local supply (see Box 9 [15]).

4.4 Parking orientations for cars

Parking orientation refers to the direction that parked vehicles are expected to face. The key choices are parallel, angled and perpendicular.

[15] Michael Andersen 'How Montreal Built a Bike Lane by Debunking the Autoparkolypse', People for Bikes, 24 April, 2014, http://www.peopleforbikes.org/blog/entry/how-montreal-built-a-bike-lane-by-debunking-fears-of-autoparkolypse.

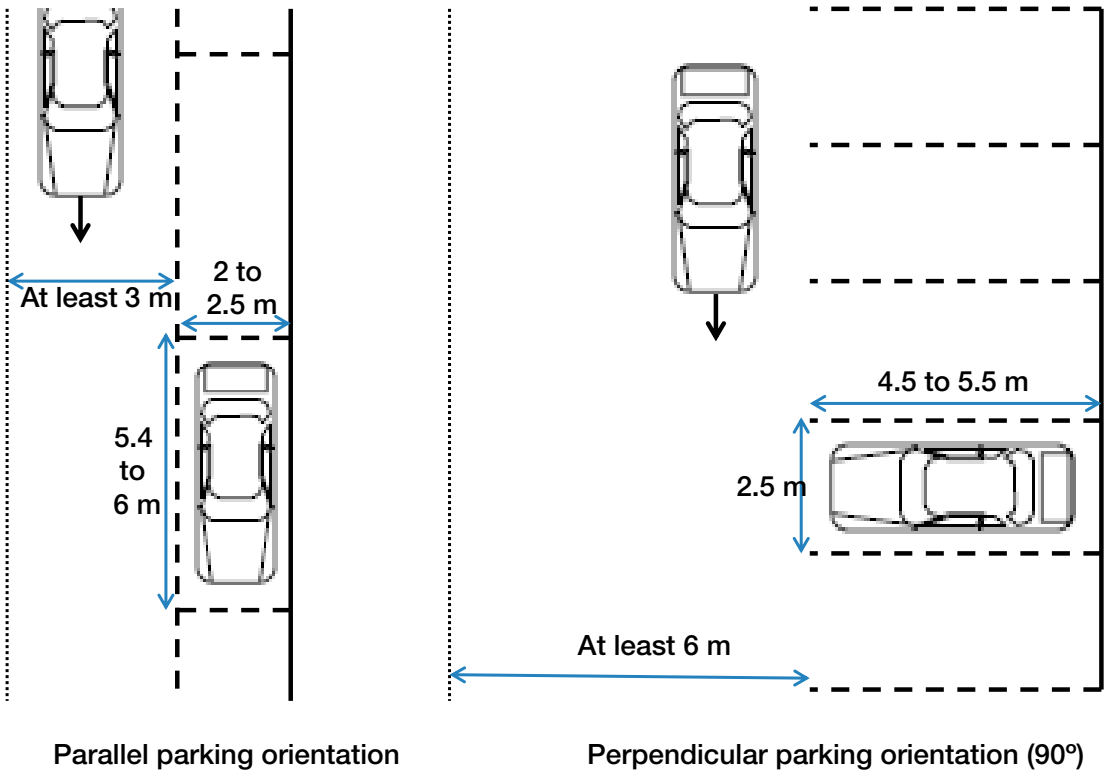

Fig. 28: *Common dimensions for parallel and perpendicular car parking orientations.*

Parallel parking is the most common orientation for on-street parking.

- ***It is the choice that uses the least street width***. A 'parking lane' for cars can be as narrow as 2.0 m but a width of about 2.5 m is more usual.
- Marked parallel parking spaces are 5.4 to 6.0 metres long but can be shorter (4.5 m) for spaces at the end of a stretch of spaces (provided that reversing in is possible). Where any obstacle prevents reversing in, the parallel space must be at least 7.2 m long.
- When individual car spaces are not marked, the parking capacity is increased slightly, making it possible for about one car to be accommodated for every 5 to 5.5 m on average.
- For parallel parking, the "friction zone" is up to 3 metres in width. This refers to the width of roadway within which parking events will briefly delay moving vehicles.

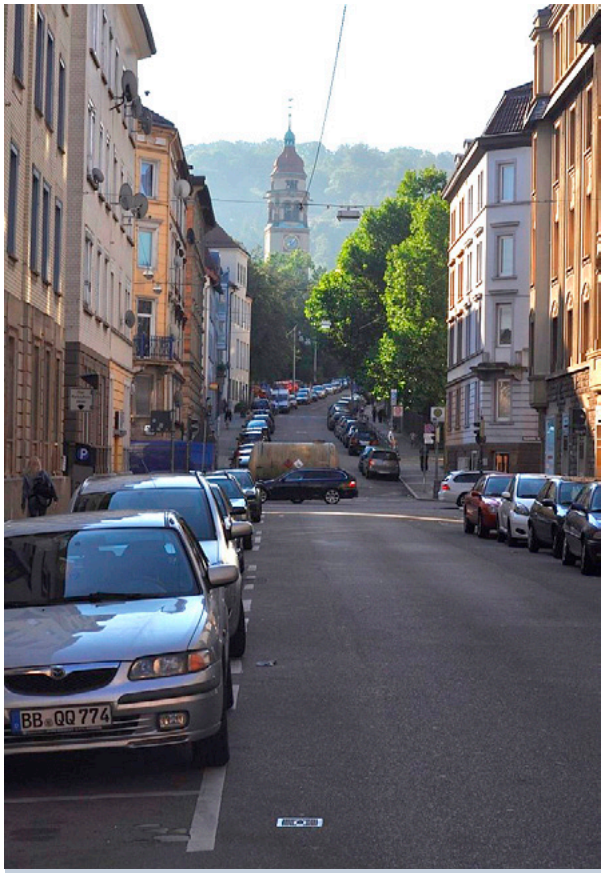

Fig. 29: *Stuttgart.* © Carlosfelipe Pardo

Advantages of a parallel parking orientation include:

- A narrow profile in the street compared with other orientations and a narrow friction zone;
- Allows wheelchair users to enter and exit parked vehicles without being obstructed by neighbouring vehicles. This also applies to certain others who may require a wide clearance to enter or exit a vehicle;
- Relatively good vision of moving traffic when entering or exiting (especially compared with nose-in angled or nose-in perpendicular arrangements).

Disadvantages of a parallel parking orientation include:

- Relatively low parking capacity per unit of street length;
- Danger from drivers and passengers flinging open vehicle doors on the traffic side of the vehicle. This is especially hazardous to bicycle users (who rightly fear "getting doored").

Parallel parking with the vehicle pointed in the opposite direction to traffic must be banned because it involves dangerous manoeuvres while entering and exiting parallel spaces.

On-street parallel parking may be marked or unmarked:

- completely unmarked: common in areas of light parking management, where only parking bans are marked or signposted;
- marked parking lane and markings/signs to indicate where such parking lanes end;
- individual parking spaces can be specifically marked out using as rectangular boxes.

The choice of whether or not to mark individual parallel spaces is not clear cut.

Arguments for marking individual spaces include that this option:

- Is necessary for some pricing mechanisms, such as single space meters or any approach that involves pay-by-space (in which a code number for each marked space is used).
- May slightly reduce parking conflict and frustration, with fewer cases of vehicles becoming hemmed in too closely or upset over unusable gaps between vehicles.
- May reduce illegal parking slightly, since marked spaces provide clarity on where parking is allowed and where it is not allowed.

Reasons to avoid marking individual spaces include that this choice:

- Increases parking capacity by decreasing the length of kerb per car from about 5.5 to 6.0 m to about 5 to 5.5 m for typical mixes of car sizes.
- Enables the reaping of parking space gains from unusually short vehicles.
- Accommodates long vehicles, without needing to mark special locations for such vehicles.
- Copes with changes to typical vehicle dimensions over time, which make it difficult to get parking space dimensions 'right'.
- Is more compatible with part-time parking bans than marked spaces.
- Prevents conflict or confrontations resulting from poor parking that straddles the boundaries of marked spaces (which many people find infuriating).
- Is compatible with some pricing mechanisms, such as pay-by-plate approaches that are increasingly seen as a best practice (See Section 5.4).

Notice that a key benefit of not marking spaces is the ability to cope with a diverse vehicle fleet. This is especially important in certain countries.

Fig. 30, 31, 32, 33: *Parking orientations: parallel (top left), perpendicular (top right), angled (at an unusual 30°) (bottom left), perpendicular without markings (bottom right).* © Paul Barter

Perpendicular and angled parking cannot be dismissed completely for on-street parking.

- These orientations involve parking oriented so that the front or back of the vehicles faces the kerb can be arranged at various angles to the kerb line, most commonly 45°, 60°, 70° and 90° (perpendicular). Angles of 30° or 70° are also occasionally used.
- They are generally poorly suited to roads on which speed and traffic flow are high because of the roadway width taken, including the width of their friction zones.
- These orientations can be suitable where traffic calming is a key goal. They are useful precisely because they narrow the roadway and help slow traffic.
- Entering and exiting these orientations is easier for most motorists than parallel parking.
- They allow people to enter/exit vehicles without being exposed to moving traffic.

Physical characteristics of perpendicular parking (angle 90°) are as follows:

- Maximises the parking spaces per unit of street length (one car per 2.5 metres of kerb);
- Takes more roadway width than other orientations;
- The length of perpendicular parking spaces ranges from approximately 4.5 to 5.5 m.
- Parking events result in intermittent intrusion (manoeuvring/friction) of up to 7 m into the roadway (about 2 traffic lanes) beyond the parking zone itself. A minimum of 6 m clearance is necessary between the marked parking space and any obstacle to allow for manoeuvres;
- These widths (friction and clearance) are narrower if backing into parking is the norm.

Angled parking falls between the extremes of perpendicular and parallel parking on each of these factors (kerb length per vehicle, space length, width of friction zone), with the specifics depending on the angle and on whether reverse or a nose first is used.

Angled and perpendicular parking spaces should always be marked. This is to provide guidance to motorists and enables a ban on the use of such spaces by large vehicles that would extend into traffic lanes.

Fig. 34: *Sibiu.* © Armin Wagner

Overhang of vehicles over the kerb must be taken into account in the design of these orientations. Collisions with kerbside plantings, trees and street furniture will occur if the street kerb is less than 0.75 m from such objects. Wheel stops may be needed.

Reverse-in angled parking (also called back-in angled parking), in which motorists back into the spaces, is superior in many ways to having vehicles enter angled spaces nose first [16]:

- Enhances safety, especially for bicycle users, by giving motorists exiting such spaces a much clearer view of the traffic stream they are trying to enter;
- Re-entering traffic from this orientation is much easier than backing out into moving traffic;
- Loading and unloading from the back of the vehicle can take place far from moving traffic and protected by parked vehicles.

Signage, education and enforcement effort will usually be needed to reduce cases of motorists entering nose first from the opposite side of the street.

Reverse-in perpendicular parking has similar advantages.

- Slightly reduces the friction zone compared with nose-in perpendicular parking.

[16] Bike Walk Montana, 'Back-in Angle Parking', http://www.co.silverbow.mt.us/DocumentCenter/Home/View/2889 (pdf).

- Unfortunately, is more difficult to establish a norm or a requirement than for angled spaces. While the orientation of angled spaces can make it obvious that reversing in is expected, this is not the case with perpendicular parking.
- Reversing into perpendicular parking is the norm in some countries, notably Singapore.

Let us compare the space-efficiency of different orientations for on-street parking. Which orientations provide the most parking spaces for the least consumption of space?

- ***Surprisingly perhaps, the total AREAS in the street consumed per car by parallel parking and perpendicular parking are similar.***

Table 8: Parking orientation and street area consumed (for three sets of dimension standards)

India (via ITDP street design guide)	Parallel	45 degrees	90 degrees
Parking space width (m)	2.0	2.5	2.5
Kerb length per space (m)	5.5	3.5	2.5
Street width for parking zone (m)	2.0	5.3	5.0
Area for parking (m^2)	11	18.8	12.5
Manoeuvring zone (minimum clearance) (m)	3.0	4.5	7.0
Total street width impacted (parking plus manoeuvring) (m)	**5.0**	**9.8**	**12.0**
Total area (parking plus manoeuvring areas) (m^2)	**27.5**	**34.7**	**30.0**
Singapore LTA 2005			
Parking space width (m)	2.4	2.4	2.4
Kerb length per space (m)	5.4	3.5	2.4
Street width for parking zone (m)	2.4	5.2	4.8
Area for parking (m^2)	13.0	18.3	11.5
Manoeuvring zone (minimum clearance) (m)	3.6	4.2	6.0
Total street width impacted (parking plus manoeuvring) (m)	**6.0**	**9.4**	**10.8**
Total area (parking plus manoeuvring areas) (m^2)	**32.4**	**33.1**	**25.9**
Australia (via City of Sydney)			
Parking space width (m)	2.0	2.5	2.5
Kerb length per space (m)	6.0	3.5	2.5
Street width for parking zone (m)	2.1	5.6	5.4
Area for parking (m^2)	12.6	19.3	13.5
Manoeuvring zone (minimum clearance) (m)	3.0	3.7	5.8
Total street width impacted (parking plus manoeuvring) (m)	**5.1**	**9.3**	**11.2**
Total area (parking plus manoeuvring areas) (m^2)	**30.6**	**32.4**	**28.0**

Note: Where a range is given in sources, the minimum dimensions for medium turnover spaces were chosen.

- The 'winner' depends on the details of local parking space dimension standards (Table 8).
- The angles in between 0 and 90 are less space-efficient than either parallel or perpendicular orientations. This is so whether we take account of just the parking spaces themselves or if we include the manoeuvring/ friction zone.
- For example, using dimensions from the ITDP India's street design manual, parallel parking is most efficient by a small margin. However, if Singapore's standards are used, perpendicular parking is most space efficient. If Australian standards are used, parallel parking is more efficient if only the spaces are counted but perpendicular is most efficient if the manoeuvring zone/minimum clearance is counted.

Do not confuse the issue of areas consumed with the issue of street width taken by parking.

- Street width consumed is usually of more interest from a traffic flow perspective.
- The minimum street widths taken by three orientations area also shown in Table 8.
- From this perspective, parallel parking is much more clearly the winner.

4.5 Parking within service lanes

Including service lanes in the design of major roads can be a strong design option in some circumstances, as explained below. Such designs are sometimes referred to as a multi-way boulevard [17].

In such designs, any parking is usually included within the service lane, not the main roadway. This service lane should be designed as a low-speed environment.

Although it might seem that having a service lane (and parking within it) takes road space unnecessarily, several factors make this option worthy of serious consideration [18]:

- Such designs are suited to roadways that need to play an important traffic role but which must ALSO provide local access and a quality pedestrian environment close to buildings.
- In successful multi-way boulevards both sets of street roles are actually served better than with an undivided single-roadway design.
- The 'loss' of a traffic lane to make way for the service lane is not as significant for traffic as you may think. The capacity of the outermost traffic lane is often low anyway due to friction from parking and other street-side activities, especially if people often walk in this

[17] Jacobs, Allan B., Elizabeth Macdonald, and Yodan Rofe. *The Boulevard Book*. (Cambridge, MA: MIT Press, 2002).

[18] ITDP India, '*Better streets, better cities: a manual for street design in urban India*' (2010), https://www.itdp.org/better-streets-better-cities.

Fig. 35, 36: *Parking in service lanes in Toulouse, France and Ahmedabad, India.*
© Andrea Broaddus – from SUTP on Flickr and Paul Barter

lane. Creating a service lane keeps most of this friction well away from the remaining traffic lanes.
- Service lanes provide an extension of pedestrian space (shared with low-speed vehicles). This works best with parking on the roadway side of the service lane rather than the building side. Such parking serves as a buffer between traffic lanes and the pedestrian-friendly, low-speed environment of the service lane.
- The service lane itself is more easily kept free of encroachments, such as by vendors, than other parts of the pedestrian realm.
- Some cities find that a shift to parallel parking from perpendicular or angled can be difficult to enforce. Containing parallel parking within a service lane is a self-enforcing design.

The minimum width of a service lane depends on the parking orientation. The minimum clearance beyond the parking is:
- 3 to 3.6 m for parallel parking;
- 3 to 3.6 m for 30 degrees;
- 3.5 to 4.2 m for angled parking at 45 degrees;
- 4.5 to 4.8 m for angled parking at 60 degrees;
- 6.0 to 7.0 m for perpendicular parking.

Therefore, parking orientations of more than 45 degrees are not advisable within a service lane because such orientations require wide service lanes that encourage excessive speeds.

4.6 On-street parking and accessibility for people with disabilities

Many jurisdictions do not require wheelchair accessible on-street parking to be provided. Nevertheless, here are some key principles for improving such access.
- Special spaces are most needed for perpendicular or angled parking because, in the absence of specially designated accessible spaces, there will usually be insufficient space for doors to be fully opened and for a wheelchair or scooter to be deployed next to the vehicle.
- Specially designated accessible spaces for wheelchair users are less essential with parallel parking but are still helpful.
- Designated wheelchair accessible parking spaces require attention to detail to ensure they are not impeded by kerbs, street furniture or nearby vehicles.
- Locations for such spaces must also be carefully chosen. Access to kerb ramps is crucial.
- Please consult local representative bodies for people with disabilities on locations and designs. And consult your relevant design and location guidelines.
- Designating on-street parking spaces for people with disabilities is most crucial if parking management is not successfully ensuring sufficient vacancies. In that case, designated spaces are necessary simply to ensure that wheelchair users have access to well-located on-street spaces.

Fig. 37: *Designated wheelchair parking space in Bad Wimpfen.* © Kevin Korffmann

Fig. 38: *Designated wheelchair parking space in Stuttgart.* © Kevin Korffmann

In Chapter 5 we will also discuss parking fees and payment modes for motorists with disabilities.

4.7 Motorcycle on-street parking

There are enormous variations in the numbers of motorcycles (motorised two-wheelers) between different parts of the world. ***Parking for motorcycles should not be ignored even in cities where they play a small role***.

The key questions include:

- Where to locate motorcycle on-street parking space;
- How much space to allocate for these vehicles;
- Whether to mark individual spaces;
- How to design motorcycle parking.

The two most common locations for well-designed motorcycle parking in streets are:

- At kerbside on the roadway side of the street kerb (where most on-street car parking is also located) and arranged with motorcycles perpendicular to the kerb. ***We will call this the 'kerbside option' for on-street motorcycle parking***;
- On the property/building side of the kerb, within clearly designated areas. Most common is to locate it between the main walkway and the kerb (between or near trees, other plantings, street signs, and the other street furniture in this zone). ***Let us call this the 'pavement option' for on-street motorcycle parking***.

Important issues in choosing between these motorcycle parking location options include:

- Either option requires suitable space, whether on the pavement and space on the roadway.
- Safety and comfort for pedestrians must be primary, which should often preclude the pavement option.
- Parking locations must enable suitable places for pedestrians to reach the street to cross it. Even kerbside motorcycle parking can impede pedestrians from crossing the street if suitable gaps are not ensured through markings and design.
- The pavement option is much less desirable in locations where motorcycles would need to ride along or across the pedestrian area to reach the parking.
- Kerbside motorcycle parking is easily integrated with the parallel car parking because perpendicular motorcycle parking takes about the same width (2.5 m).
- In some cities, the kerbside option is unfamiliar and will require strong design and signage to ensure that car users (and others) respect the space reserved for motorcycles.

Motorcycles usually need explicitly designated parking areas on-street:

- Without designated space for motorcycles, conflict often emerges, prompting illegal motorcycle parking elsewhere. Motorcycle users often feel pressure not to park in space that is viewed as for cars only, especially in countries where motorcycle users generally have lower socio-economic status than car users.
- For the pavement option, it is obvious that motorcycle parking areas need to be explicitly marked to prevent nuisance parking by motorcycles.
- If motorcycle space is not explicitly marked at kerbside, then signs and regulations should make it clear that motorcycles are allowed to park in the usual

Fig. 39, 40: *Kerbside and pavement parking for motorcycles in Taipei.* © Paul Barter

parking areas that might otherwise be assumed to be only for larger vehicles.

- If possible, motorcycle parking should be protected from the danger of traffic via kerb extensions or other design elements. Motorcycle users are vulnerable in collisions and entering/exiting kerbside parking exposes motorcycle users.

Fig. 41, 42: *Yogjakarta.* © Manfred Breithaupt

Motorcycle parking is generally much more space efficient than car parking in terms of space used per vehicle or per person. Between about 5 and 10 motorcycles can be parked in a car space, depending on markings and how tightly packed the motorcycles are.

When marking motorcycle parking space, an 'equitable' amount should be allocated relative to cars (unless there is an explicit policy to restrict motorcycle use). This means allocating motorcycle space in proportion to their parking demand, so that motorcycle parking space is generally not noticeably more over-saturated than car parking space.

Fig. 43, 44: *Motorcycle parking can be very space efficient compared with car parking.* © Paul Barter

Should individual motorcycle spaces be marked?

- Individual motorcycle spaces usually need not be marked.
- The outer boundaries of the motorcycle area should be marked using a box 2.5 m wide for perpendicular parking.
- In cities where small motorcycles are common and where pricing practices permit it, unmarked motorcycle allows many more motorcycles to park than with marked spaces.
- At times of high demand, motorcycles can become so tightly packed inserting and extracting them becomes very difficult.
- However, some jurisdictions do mark individual motorcycle spaces. Certain approaches to pricing, such as pay-by-space if applied to motorcycles, would make this necessary.
- Marked motorcycle spaces are typically 2.4 to 2.5 m long and range from 0.8 to 1.5 m in width depending on the most common sizes of local motorcycles.
- Motorcycle spaces are oriented perpendicular to the kerb.

Very large motorcycles should be allowed to park in car spaces but pay the same fee as cars.

4.8 Bicycle on-street parking

Bicycle parking has some things in common with motorcycle parking. For example, bicycle parking should not be ignored even in cities with low levels of bicycle use. Like motorcycle parking, bicycle parking can be very space efficient.

But there are also significant differences:

- Bicycles (even when locked to a fixed object) are vulnerable to theft. Secure bicycle parking is an important influence on the popularity of bicycle use;
- On-street parked bicycles need to be locked to a fixed object or placed under supervision;
- Most on-street bicycle parking requires parking 'stands' (bicycle parking furniture) to be put in place if the bicycles are to be reasonably secure. Where these are not provided, bicycle users will tend to fix their bicycles to available street furniture, which may cause problems for others.
- Enforcement against nuisance bicycle parking can be difficult.
- Bicycle parking demand can reach extremes around busy mass transit stations where intensive management and design efforts are often needed. If demand is high enough, high-capacity bicycle parking construction may become necessary.

A key feature of bicycle parking is its space efficiency relative to cars. Space consumption is slightly lower even than that of small motorcycles:

- Using modern stands, about eight bicycles can be parked in a car parking space;
- Bicycles parked under attendant supervision can be packed in more tightly (with up to about 12 bicycles per car space).

As with motorcycles, the main location options are pavement and kerbside.

Pavement bicycle parking is most common:

- There are many specific options for the location and design for pavement bicycle parking;
- Small clusters of bicycle parking can be squeezed into various locations;
- Take great care not to hinder or cause a hazard to pedestrians, especially those with disabilities, including visual impairments;
- This usually means locating bicycle parking between the main walkway and the kerb. Clearance of 0.6 m from kerb to a parallel bicycle stand is needed.
- On wide pavements clusters of bicycle parking may be oriented perpendicular to the kerb. Otherwise, bicycle stands are usually oriented parallel to the kerb and in a single-file line;
- Kerb extensions often create opportunities for clusters of bicycle parking without impeding pedestrians and other street users.

The kerbside option is less common but is also possible for bicycles:

- Kerbside bicycle parking areas fitted with bicycle stands are known as a 'bicycle corral'. These are increasingly used in cities of high bicycle parking demand;
- Kerb extensions or other barriers may be needed to protect the corral;
- Kerb extensions were mentioned above under the pavement parking option but bicycle corrals and bicycle parking on a kerb extension are actually in similar locations. The difference is the location of the kerb.

Fig. 45, 46: *Pavement bicycle parking in Copenhagen and a kerbside bicycle parking corral in Oxford.*
© Andrea Broaddus from SUTP on Flickr

Other locations, including in medians, are possible but rare and not discussed here.

Locate unsupervised on-street bicycle parking to maximise informal observation by passers-by, shopkeepers and other street users.

Bicycle parking furniture (bicycle stands) come in many forms.

- Avoid installing old-fashioned 'bicycle racks', into which a wheel is inserted. These damage bicycle wheels and have low security;
- Prefer secure "leaning stands". Each such stand can park two bicycles (one either side). These enable a bicycle to have both wheels and frame locked to the stand. Refer to detailed guidance on quality leaning stands and their location, orientation and spacing.
- There are many forms for leaning stands. Standing rings and inverted u-stands are common.

Fig. 47, 48: *Quality bicycle stands in London and Avignon.* © Andrea Broaddus from SUTP on Flickr

Supervised on-street bicycle parking:

- This is a good option at busy locations in cities with high bicycle usage, especially in relatively low-income cities where attendants wages are not prohibitive.
- These need to be of a scale to justify the employment of attendants and therefore require sufficient space and care in their location and demarcation to avoid nuisance to pedestrians.
- Supervised bicycle parking areas (for a small fee) have long been a common feature in busy areas of Chinese cities.

Fig. 49: *Combined supervised motorcycle and bicycle parking in Bangkok.* © Stefan Bakker

4.9 Self-enforcing parking design

'Self-enforcing' parking design makes it obvious how to park and can even make it difficult for motorists to park in any manner except the way that the parking authorities wish. Careful design of parking can therefore reduce the need for active enforcement.

Examples of self-enforcing parking design features include:

- Keeping the entire width of a service lane below 5.5 m makes parallel car parking in the lane the only option, preventing angled or perpendicular parking.
- Bollards can prevent cars from parking on footpaths/pavements/sidewalks. High kerbs should be avoided as a tool for this purpose because they unduly hinder pedestrians, especially children, the aged and people with disabilities.
- Bollards, kerbs, low fences or other physical barriers can deter car parking on bicycle lanes.
- Kerb extensions are a self-enforcing approach to preventing parking too close to minor intersections while also improving pedestrian crossing safety by improving visibility and shortening the crossing distances, and providing space for street trees.
- Parking can be prevented on narrow streets by installing a median barrier or kerb that restricts the right of way to 3 m or so in each direction and prevents vehicles from overtaking. This also discourages stopping by making traffic passage impossible should

Fig. 50: *Example of design that prevent or discourage nuisance parking in a self-enforcing way in San Sebastian, Spain.* © Andrea Broaddus from SUTP on Flickr

a vehicle stop by the kerb. This treatment may need to be complemented by bollards to prevent parking or stopping on the adjacent footway.
- Trees along parking lanes shade parked vehicles, decreasing the temptation in hot climates or seasons for cars to be parked on shaded parts of footways.

However, care is needed to avoid having these features impede other street users, such as wheelchair users.

Design features can also be used to deter stopping for drop-offs and pick-ups:
- Street-side plantings are widely used to this effect in Singapore but this is an option that requires intensive maintenance.
- Fencing along kerbs is sometimes used for the same reason. However, caution is needed in order to avoid endangering pedestrians or unduly restricting pedestrian movements.

4.10 Places and times where traffic is a reason to ban parking

Traffic movement is not always a reason to remove on-street parking.

However, traffic can be a good reason to ban parking at locations where and when traffic capacity is an important priority in road design, where and when traffic capacity is constrained, and where and when the on-street parking is an important factor in the constriction of traffic capacity.

Where traffic flow is not an important role of a street then it usually makes no sense to ban parking there on traffic-flow grounds.

And even on important traffic arteries, it may not make sense to ban parking if the road has much spare capacity.

Intersection capacity is usually the limiting factor for the traffic capacity of the road:
- ***So distinguish between locations close to intersections and mid-block locations*** (street sections more distant from intersections).
- ***Keep parking well away from intersections*** wherever traffic flow is an important goal.
- ***Removing mid-block parking may often make no difference to traffic*** where intersection capacity is the limiting factor constraining traffic capacity, as is often the case.
- ***In cases where mid-block parking does harm capacity, this is often due to poor parking management*** causing double parking and other problems of saturated parking. These can be solved with improved parking management rather than banning parking.

Fig. 51: *In this street in Shenzhen, China, removing this mid-block parking will probably not increase traffic capacity because it is almost certainly the intersections that are the limiting factor.* © Paul Barter

Where congestion is an issue only for certain hours, part-time parking bans are an option:

- ***Peak period parking bans ('clearways') ban kerbside parking only at the times when the traffic in the relevant direction is heavy***. This may be appropriate on roads with an important traffic role, and with spare capacity much of the time, but which become congested during peak traffic periods. Enforcement for clearways often involves towing, since even one illegally parked vehicle can negate the benefits.
- ***Another practice is to ban parking during the day and to only allow it during the quiet overnight hours***. This can be relevant on streets with some traffic importance that run through dense residential or mixed-use areas where night-time residential parking demand is higher than the daytime demand. In Singapore for example, a single yellow line along a kerb indicates that parking is allowed only between 19:00 and 7:00 h.

Traffic speeds are also a key factor in the decision on whether to allow parking.

- On-street parking requires relatively low-speeds unless a significant buffer zone is available.
- Serious safety concerns emerge if on-street parking is allowed on streets on which speeds of 50 km/h or more are expected.
- Despite this, many cities worldwide do have on-street parking on some roadways with speed limits of 50 km/h or even 60 km/h.

4.11 Should on-street parking be completely banned?

Many local traffic managers believe that roads are for circulation and that parking has no place at all on roads or streets. However, the issue is more complex than that and a blanket ban on on-street parking may not be wise.

In the 1920s, a key figure in early parking policy development, Miller McClintock, pushed for a general ban on on-street parking in the USA. He argued that this would force the emergence of commercial off-street parking at efficient prices [19].

Japan's experience (Box 10) suggests that McClintock's idea had merit. However, it is probably now too late for most cities to follow this option and doing so would not be easy. New York City briefly tried to ban on-street overnight parking but this broke down in the 1940s in the face of mass defiance [20]. The city's wide streets invited parking and banning it seemed unreasonable.

There are also arguments against general bans against on-street parking.

- On-street parking is more space-efficient overall than surface off-street parking, since it does not need dedicated aisles or turning areas.
- We saw in Section 4.1 that mid-block on-street parking does not impede traffic flow if intersections are the limiting factor and if the parking is well managed.
- On-street parking is inherently public parking, which is more efficient than private parking. Any area that bans on-street parking will need to make sure it has some public off-street parking available to casual visitors.
- Furthermore, off-street parking always requires driveways, each of which disturbs walkways (sidewalks, pavements, footpaths), endangers pedestrians, and encourages parking across the pedestrian right-of-way.
- Parking in streets can be compatible with various high-quality street design solutions.
- If parking is newly banned after having long been allowed, it may increase the political pressure to increase parking minimums and to subsidise off-street parking. For example, proposals in 2012 to ban parking along a key shopping street in Palembang, Indonesia, prompted the local government to urgently seek ways to create more off-street parking.

[19] Cited by Shoup, *High Cost*, 2005, p. 492-493

[20] See three posts by 'Cap'n Transit' at the *Cap'n Transit Rides Again blog*: 'When overnight curbside parking was illegal' (4 September, 2012), http://capntransit.blogspot.sg/2012/09/when-overnight-curbside-parking-was.html, 'How the overnight parking ban broke down' (10 September, 2012) http://capntransit.blogspot.sg/2012/09/how-overnight-parking-ban-broke-down.html, and 'The right to free parking in 1940s New York' (12 September, 2012) http://capntransit.blogspot.sg/2012/09/the-right-to-free-parking-in-1940s-new.html.

Box 10: Japan's experience with banning on-street parking

Japan's 1957 Parking Law generally banned on-street parking (although there are some 'temporary exemptions, which still operate today). This came as the country faced the beginnings of mass car ownership. Some streets do have parking spaces with parking meters. However, overnight on-street parking is completely banned.

Japan's 'proof-of-parking' law complements the overnight on-street parking ban by making the overnight street parking ban easier to enforce, with no excuses accepted. Traffic police tow vehicles found parked in streets overnight. Conversely, the overnight street parking ban makes it pointless to try to avoid the proof-of-parking rule. Car owners without on-site parking must seek leased parking nearby.

These policies have created a vibrant commercial off-street parking industry, both for residents and for daytime parking. The relative lack of on-street parking problems has allowed Japanese cities to keep their parking minimums at the very low levels they began with in the 1960s and to avoid large scale subsidy of parking supply.

Note that minor streets in Japanese cities are extremely narrow, making the ban seem reasonable. Larger roads are seen as primarily for traffic not parking. However, some parking experts in Japan argue that Japan could allow more parking on appropriate roads, so long as mid-block capacity is not limited.

Fig. 52: *A confusing parking sign in Washington, D.C.*
© Manfred Breithaupt

4.12 Communicate and guide: signage and markings

Motorists need easy-to-find and easy-to-understand information to guide them to the appropriate parking options.

Most traditional parking communication and guidance take the form of road markings, kerb markings and signage.

Every local government must convey crucial parking regulation messages to motorists in the streets to indicate parking behaviour that is desired, allowed or prohibited. Signage and road markings are the key tools.

Confusing or misleading signage or markings hinder enforcement, make it unpopular, and can even lead to court challenges.

We saw in the section above that good design can often make the desired parking behaviour clear. But in most cases further communication is also needed.

'***Positive' parking signage shows explicitly where parking is allowed and under what conditions. 'Negative' parking signage and markings show where or when parking is forbidden***, possibly with exemptions:

- In areas or streets with intensive parking management both positive and negative parking signs and markings are common, since parking regulations can be complex, with detailed local variations in such areas so that it is necessary to be extremely clear and explicit.
- In areas or streets without intensive parking management (see Section 3.3), simple negative parking signage and markings are often sufficient.

Parking signage sometimes conveys the boundaries of special parking zones in which certain rules apply, such as residential parking permit zones.

Street marking and kerb markings are most often used to convey the following messages:

- Marked spaces to indicate proper positioning and orientation when parking;
- No parking anytime;
- No parking at certain times (*e.g.* peak periods; daytime only; night time only, etc.);
- No parking or stopping;
- No parking between this point and corner/ intersection;
- Boundaries of marked spaces for individual vehicles;
- Eligibility restrictions (such as spaces reserved for people with disabilities).

Street markings are sometimes used to convey other messages, such as price. For example, in Singapore white space markings and yellow markings convey which of the two possible on-street prices applies. However, this hampers price setting flexibility.

Street signage most often conveys the following parking messages:

- No parking anytime;
- No parking at certain times (*e.g.* peak periods; daytime only; night time only, etc.);
- No parking or stopping;
- No parking between this point and corner/ intersection;
- Time limits;
- Times when parking is allowed or not-allowed;
- Vehicle types allowed to be parked;
- Eligibility restrictions (such as resident permit holders only, etc.);
- Tow-away zones (locations where illegal parking attracts this severe consequence);
- Pricing information (price levels, pricing hours, etc.).

Effective communication through signage and markings is not easy and is too often taken too lightly. Local ad-hoc efforts to design signage are often ineffective. Standardisation at a national level can help. Seeking professional help is often advisable.

Some key issues in keeping signage clear:

- Keep signs as simple as possible. This applies especially to signs that must be noted while driving or from a distance. But simplicity is important for all signs;
- Check and test signs for any ambiguity;
- Use standardised symbols;
- If signs include words, use very plain language;
- Focus on actions not information. In other words, signs should focus on the actions that are required or prohibited. Avoid information-only signs which are often not necessary and only cause confusion;
- Beware of incremental emergence of complexity in signs over time (as regulations are modified);
- Avoid proliferation of signs, leading to street clutter and distraction from the key messages;
- Beware of the incremental appearance of such clutter over time.
- If signs and markings have become complicated and easily misunderstood, consider simplifying the regulations!

These situations are especially prone to complex signage:

- Part-time parking bans;
- Eligibility restrictions;
- Eligibility restrictions that apply part-time!
- Complicated pricing schemes;
- Cases where multiple languages must be used.

Signage and markings must communicate at their relevant decision points:

- Signage and markings seek to influence motorist decisions;
- Each such sign or marking must therefore be located and designed to have its impact at the place and time that the relevant decision is about to be made.
- For example, signs or marking to indicate if parking is allowed (and when) must be in places to be noticed by motorists as they drive along searching for parking. They must be large and simple enough to be comprehended while driving.
- Messages intended to be read after the vehicle is parked, such as pricing details, must be located where they can be noted at this decision point.

Standards and guidelines from higher levels of government can greatly ease the task of planning signage and markings.

- National or state/province governments have more capacity and legal authority to establish standards.
- However, these are only helpful if they are well thought out and of high-quality. Always apply such standards with care and attention to local detail, not blindly.

- It would be unfortunate, inefficient, confusing and low-quality to have every municipality designing its own version of every sign and marking.
- Standards on signage also reduce costs by enabling larger scale production by specialised suppliers.

If your country lacks such a high-quality set of standards on parking signage and markings, or if your specific needs are not in the standard, then you may be able to refer the standards of another nation that has a good set of standards.

Parking guidance for motorists is another important form of parking communication.

- Parking guidance refers to efforts to communicate to motorists where to find parking.
- At its simplest, parking guidance can just mean static signs pointing motorists towards off-street parking options or towards streets that tend to have less crowded parking. Even such simple guidance can help nudge motorists to less obvious parking options.
- Parking guidance can also mean real-time digital signage highlighting vacancies in nearby parking options. Similar messages can also be conveyed via smartphone apps and such like.

Parking guidance helps smooth and spread the utilisation of the parking supply— both on- and off-street. By expanding motorists' flexibility and their willingness to exercise a parking location choice, parking guidance helps increase the effectiveness of various parking management tools.

Fig. 53: *Electronic parking guidance in Beijing.* © Carlosfelipe Pardo from SUTP on Flickr

Until recently, most parking guidance has alerted motorists to off-street parking options. Digital parking guidance signs directing motorists to off-street parking are now common in many cities throughout Europe, Japan, and even in China's large cities, among others.

Guidance methods can also provide directions to alternative on-street parking opportunities. This is an under-used role for parking guidance.

Recently, on-street parking availability has become part of some parking guidance systems, especially via smart phone apps or vehicle GPS.

Fig. 54: *Paris.* © Andrea Broaddus

Fig. 55: *Copenhagen.* © Andrea Broaddus

5. Management Tools for Rationing On-Street Parking

On-street parking in busy areas needs to be rationed to avoid a chaotic free-for-all (see Box 11).

The main options for rationing the use of public on-street parking are:

- time limits;
- preferential or reserved access (permits); and
- pricing.

Surveys and problem analysis must preceed decisions on rationing tools (see Chapter 7). Different tools may be suited to different locations or problems. Sometimes, a combination of these options are used.

For many areas (particularly in business districts) pricing is the main recommended approach and much attention in this chapter is devoted to pricing.

Nevertheless, there is also some guidance at the end of the chapter on alternatives to pricing, such as time limits.

5.1 Introduction to pricing on-street parking

Wherever on-street parking faces high demand so that management is needed, parking fees should be considered.

Among the approaches to rationing on-street parking, pricing is, by far, the most efficient, flexible and powerful.

The key reason to use on-street parking fees is for its power and versatility as a parking management tool.

The pricing of on-street parking was tried first over 80 years ago in Oklahoma City in the USA. The sole aim then was to deter local employees (who arrive early) from occupying prime spaces in front of retail shops [21]. Neither cost recovery nor revenue were objectives, they were merely a by-product.

Pricing on-street parking is a parking management tool that is available to cities with all levels of parking management capacity, whether weak or strong.

Box 11: Unmanaged on-street parking is a common-property resource

On-street parking is a good example of a 'common-property resource'. This means that its management problems are akin to those of a common pasture shared by many graziers run livestock.

If it is unmanaged on-street parking is an open-access common property resource like a pasture open to all livestock owners with no restrictions.

As with a common pasture, there is a high risk that open-access on-street parking in busy parts of towns will be over-used. Access needs to be rationed and managed somehow.

Pricing is an efficient, powerful and flexible way to ration but communities often want alternatives due to widespread aversion to pricing.

Such alternatives include:

- Time limits, which are the most common parking rationing alternative to pricing.
- Restricting access to certain groups (such as resident-only zones)
- Giving certain groups preferential access (such as via resident permits) to parking that may be rationed in another way for the general public.

Less common for public on-street parking are:

- Community discussion and norms in small communities (such as unwritten agreements on how to park in private streets within small clusters of housing). But this won't work for on-street parking open to the public.
- Individual ownership of parking spaces. This is common in certain situations, such as inside condominiums in some countries. These individual owners sometimes lease spaces others. But this is not a feasible approach for on-street parking.

[21] USA Federal Highway Administration (FHWA), 'Contemporary Approaches to Parking Pricing: A PRIMER' (2012), http://ops.fhwa.dot.gov/publications/fhwahop12026/sec_2.htm, p.3

Fig. 56: *Munich.* © Andrea Broaddus

Key advantages of pricing parking include:

- Pricing rations demand more powerfully and efficiently than alternative approaches.
- Parking pricing can be used to deliberately nudge parking behaviour in useful directions, such as shifting all-day employee parking away from shopping streets.
- Fees help cover costs of managing the parking management system. This contrasts with non-pricing approaches to managing parking, such as time limits, which impose net costs. On-street parking fees (together with fines) may even yield a revenue surplus.
- Pricing can potentially introduce market-responsiveness. This helps make the parking system more attuned to variations in local conditions. It also sends market signals that prompt solutions to problems.

Table 9 provides a more detailed and theoretical outline of various possible purposes of pricing and highlights their relevance (or lack of relevance) for on-street parking. All have some connection but it is the final two rows that are most crucial for on-street parking management.

Table 9: Purposes of pricing and their relevance for on-street parking

Purpose of pricing	Explanation	Relevance for on-street parking
Private markets and profit maximisation	Business pricing strategies seek profit but are constrained by competition. Market-responsive prices provide feedback between user demand and supply decisions.	***This is not directly relevant for on-street parking***. However, on-street prices might be set to not undermine off-street parking businesses (see below) and/or to mimic the responsiveness of market prices if this serves parking management goals (see below).
Revenue raising	Governments legitimately need revenue. Taxes on incomes, goods or services are key sources of revenue. User fees are also legitimate revenue sources linked with provision of a service but fees can be perceived as hidden taxes if not strongly linked to clear objectives.	***Perceiving on-street parking fees as hidden taxes that are primarily about raising revenue is harmful to the public acceptance of parking fees***. However, this problem may be eased if parking revenue is used to fund local benefits, such as street improvements, bicycle share schemes, or local public transport.
Cost recovery	Covering costs is an important purpose of pricing for both market goods and non-market goods. Conflict may emerge with other goals of pricing (such as rationing) if laws limit government user fees to cost recovery alone.	***A narrow focus on cost can undermine support for on-street parking pricing*** because on-street parking does not require much new investment. It does have opportunity cost but most people ignore this, so they do not see cost recovery as reason for on-street pricing.
To avoid the undercutting of private businesses by public sector suppliers	When both the private sector and government provide a service, the public sector is sometimes expected to avoid setting prices that would unfairly undercut private business in the same industry.	***Free or under-priced on-street parking undermines off-street parking as a business***. Unfortunately, this is a reason governments feel they must intervene in parking supply (with parking requirements for example) **). Pricing for parking management goals should help avoid this problem.
To ration demand (as a policy or management tool)	Fee levels for non-market goods can be used explicitly to regulate demand. Deliberate variations in prices can be used to influence consumer choices in various desired ways.	***Managing on-street parking demand (its level, its timing and its location) is the most helpful goal to set for on-street parking pricing***. In other words, parking management, should be the key goal.
For market-responsiveness (even without business involvement)	This can come about when prices of non-market goods are used as a management tool (see above). It can also be achieved by basing prices on a relevant objective criterion or via the creation of a market process (such as a cap-and-trade market in pollution abatement policy).	***'Demand-responsive' or 'performance' prices can introduce market-responsiveness into on-street parking prices and demand***. This usually involves setting prices using a target range for occupancy rates (typically 70 to 85 %).

**) This argument can be found for example in Paul Barter, 'Off-Street Parking Policy without Parking Requirements: a Need for Market Fostering and Regulation?', *Transport Reviews*, 30 (5), (2010) 571-588. http://dx.doi.org/10.1080/01441640903216958.

5.2 Phase out informal fee collection and criminal involvement

An alarming obstacle to reform of parking fee systems in some cities with weak parking management systems is entrenched informal collection of fees. However, this phenomenon shows that the alternative to an effective formal pricing system is often NOT free-of-charge parking.

Informal fee collection often emerges when formal parking pricing is absent or inadequate but where parking demand is high.

- In many such cases, informal fee collection activities are illegal but are tolerated. This is the case, for example, in various Latin American cities, including Bogota where all on-street fees are informal, and most Mexican cities.
- In some cases, informal fee collection is regulated to some extent, such as in Buenos Aires [22].
- In some cases criminal activity is just below the surface of an official fee collection system. This is the case in many Indonesian cities with their unusual system of outsourcing fee collection to individuals, not companies [23].
- In others, an apparently normal outsourcing arrangement has been captured and corrupted. This is allegedly the case for various parking fee contracts in Indian and Chinese cities [24].

[22] Ríos Flores *et al., Practical Guidebook*

[23] Paul Barter, 'Gangsters" in Indonesian parking', May 2012, http://www.reinventingparking.org/2012/05/gangsters-in-indonesian-parking.html

[24] See for example, Wang Xiaodong, 'Parking fees short in Beijing', China Daily, 6 Jan. 2015, http://usa.chinadaily.com.cn/china/2015-01/06/content_19246442.htm

Fig. 57, 58: *Semi-formal parking fee collectors in Jakarta and Palembang, Indonesia.* © Paul Barter

In such places it becomes extremely difficult to use on-street fees effectively as an instrument of parking management.

Such cities urgently need reform of their on-street fee collection arrangements. This can be challenging but it must be done:

- Formidable vested interests can be an obstacle to reform of such fee collection systems. Reportedly, Jakarta's first attempt to install parking meters was halted after they were smashed up by thugs. In 2005, ITDP reported that 'interests' behind parking attendants were a strong force against change in Yogyakarta's Malioboro district [25].
- Nevertheless, with determination, a much improved parking pricing system is possible. Examples of cities where formal pricing systems have been introduced despite these obstacles include: Mexico City and its new ecoParq system; Medellin, Colombia; Bandung, Indonesia (with recent installation of parking meters); Chennai, India.
- In many cases, informal attendants are not to be a serious obstacle. They simply shift away from areas with new formal pricing systems. However, pricing mechanisms in such contexts need to be resilient in the face of possible sabotage efforts.
- In some cases, it may be necessary to engage with incumbent informal fee collectors and bring them into a more robust and cleaner system. For example, proposals for reform in Palembang, Indonesia (currently on hold) would have brought parking attendants and some of their 'protectors' into formal employment in a new, clean system.
- Corruption in formal-sector fee contracting arrangements requires an improved procurement system (as part of stronger parking management generally). This may not be easy but it is possible, especially with support at high levels and from the general public.

5.3 Make pricing as acceptable as possible

Motorists tend to be dismayed when any kind of rationing becomes necessary if they have become accustomed to unregulated parking. ***On-street parking pricing seems to attract more opposition than other rationing methods***:

- Increasing parking fees is felt as a direct loss by motorists, especially if not clearly linked with a popular rationale.
- Introducing fees when parking had previously been free-of-charge seems especially painful. San Francisco and Seattle have had little difficulty moving to demand-responsive pricing in areas that already had pricing but have faced fierce resistance to extensions of pricing to new areas and new times (such as Sundays and the evenings) [26].
- Complaints often emerge that pricing is inequitable and hurts the poor (see below).
- User fees for public services have been associated with a trend towards reduced taxpayer funding of important services needed by low-income people. Parking pricing is sometimes portrayed as similar.
- Opposition to pricing sometimes taps sentiment that government-provided services should always be provided at prices below cost.
- Claims of unfairness may be heard if nearby areas remain free (regardless of whether such areas need pricing).
- And, of course, all fees levied by government face special political scrutiny compared with other prices (such as private sector market prices). Government-imposed prices are vulnerable to populist agitation and on-street parking is no exception.

Pricing deserves a strong defence even on equity grounds:

- On-street parking fees not less equitable than other prices, such as the price of vehicles or clothes or food.
- In fact, in most low-income and middle-income countries, cars are owned mainly by households with above average incomes. In such societies, cars are in fact luxury goods and parking fees imposed on car users are much fairer than food or clothing prices.
- The alternatives to pricing are, in some ways, less equitable than pricing.

[25] ITDP, 'Pedestrianisation in Yogyakarta: Transforming the Malioboro One Step at a Time', (1 Dec. 2005) https://www.itdp.org/pedestrianization-in-yogyakarta-transforming-the-maliboro-one-step-at-a-time

[26] Paul Barter, 'Seattle's street parking pricing gets a little smarter. Is it smart enough?', Reinventing Parking website, 5 Aug. 2014, http://www.reinventingparking.org/2014/08/seattle-street-parking-pricing-gets.html

Box 12: Should cities try to avoid having an on-street parking pricing surplus in order to ease public unhappiness over pricing?

This sounds tempting as a way to avoid a public backlash. Unfortunately, it is not consistent with making parking management the primary purpose of on-street parking fees, which is crucial to success as well as to making pricing more acceptable.

Let us see why:

- The surplus is influenced mainly by the efficiency of fee collection and the levels of the fees.
- No one wants fee collection should be made inefficient just to avoid surplus.
- Of course, many might say set fees low! But fees set to avoid a surplus (so fees only just cover parking management costs) are highly unlikely to just happen to be right for achieving good parking management.
- There are various approaches to setting the fees (see Section 5.5). The best of these should be applied because they have the intended results, not to hit any revenue target (either high or low).
- A well-run parking pricing system in an area of high parking demand will usually have a surplus.

There are various ways to ease opposition to on-street parking pricing:

- ***Central to making on-street parking pricing more acceptable is to make sure that its primary purpose is parking management***. This must be constantly repeated and must be more than rhetoric.
- ***Make sure that visible improvements in street conditions result*** from the introduction of pricing or from any significant pricing reform. Pricing will be seen as a failure if a timid price rise means that parking is still saturated and chaotic even after the change.
- ***Make sure that conditions improve for key stakeholder groups that can veto change***. Local residents, local businesses, and local property owners are typically the most influential groups. Some unhappiness from motorists may not matter if these key local groups are happy.
- ***Devote any revenue surplus to popular purposes within the locality (not across the whole city)***. There are various ways to achieve this. "Parking benefit districts" are one example (used in some USA cities). Mexico City's EcoParq pricing is using such tactics (see Box 13 [27]). Giving some of the surplus to local charities has also been suggested [28]. General revenue may be an efficient and often pro-poor use of revenue, but it is usually politically poisonous.

- Weak parking management, with no parking fees, can lead to street chaos, road danger, and congestion. These impacts fall heavily on disadvantaged groups. They also prompt policies which divert excessive taxpayer money to subsidised parking and road expansion, which benefit high-income motorists.
- Time limits may seem a more equitable way to ration but in areas with high parking demand, time limits do not prevent parking saturation and its negative impacts. Attempts to ration by shortening these time limits will result in new complaints of unfairness if fines for overstaying increase.
- Access restrictions may seem appealing but often benefit privileged car-owning residents of expensive inner areas at the expense of others.

Box 13: Easing opposition via revenue allocation in Mexico City

The EcoParq pricing initiative allocates 30% of the revenue to public space improvements chosen by the community through the Public Space Authority. For example, of the estimated USD 492,000 monthly meter income for Colonia Condesa, USD 150,000 is allocated to providing quality accessible sidewalks, improving local parks, rejuvenating the lighting, and so on.

[27] Ríos Flores *et al.*, *Practical Guidebook*, p. 88

[28] Donald Shoup, 'THE ACCESS ALMANAC: Making Parking Meters Popular', *Access Magazine*, Fall 2014, http://www.accessmagazine.org/articles/fall-2014/access-almanac-making-parking-meters-popular

- ***Work to reduce corruption and eliminate 'leakage' (theft)***. Building trust in the fees system is crucial to making pricing better accepted. Contracts with private sector suppliers and/or operators of the pricing system must be as beyond reproach as possible. Prevent informal fee collection or dishonest contractors from capturing parking surpluses. Avoid allowing a big businesses monopoly to capture (or be seen to capture) the parking surplus.
- ***Base price adjustments on clear and objective criteria that are strongly linked with popular parking management objectives***. Such adjustments have a better chance of public acceptance than price adjustments that seem arbitrary and are difficult to defend.
- ***Make regular small price adjustments*** (at least once per year) not large ones less often.
- ***Enhance access to cheaper parking options***. This does not necessarily mean new supply. It may just mean making existing parking options easier to reach and choose. Examples include opening up private parking to the public or improving guidance for finding alternatives. It can mean lowering the price for under-used parking that does not face saturation. It can mean encouraging valet parking businesses. Improving the walking environment also helps motorists to access cheaper parking options.
- ***Enhance other mobility options***. This does not mean they need to be perfect. But some improvement can ease the unhappiness a little, especially if well-timed to coincide with the introduction of pricing or a price change.

Fig. 59, 60: *Visibly improved conditions in the street are crucial for pricing changes to gain acceptance; Examples from Taipei and from Makati in Metro Manila.* © Paul Barter

If parking prices are not strongly linked with parking management goals, it is easy to slide into a vicious cycle of under-pricing, weak parking management, and an assumption that the fees are for revenue. This is much worse for public acceptance of fees than higher fees with clear parking management goals would be:

- Parking revenue often becomes politicised. As discussed above and in Section 6.3.
- Unfortunately, unless parking fees are based on explicit parking management goals, it is easy to forget the original purpose of the pricing.

- Such fees are not likely to be regularly updated. Inflation or increasing parking demand may then erode their effectiveness at easing parking saturation on busy streets.
- But if parking fees have no clear parking management purpose, then they will come to be seen as primarily about revenue.
- Even local authorities themselves may come to believe this and forget the original purpose of the fees. They then justify small fee rises in terms of revenue [29].
- This is an awful mistake. Being seen as a kind of tax, with revenue as a key goal, is disastrous for public support of parking pricing. Once this perception takes hold then renewed efforts to really use fees for parking management purposes will be met with great suspicion.

We have seen repeatedly in this section that the acceptability of on-street parking pricing depends on making sure that the purpose of pricing is parking management, not revenue.

[29] USA Federal Highway Administration, *Parking Pricing Primer*, p. 4

5.4 Pricing mechanisms and payment methods

There are many possible mechanisms for collecting fees for on-street parking (and even more options for off-street parking). There is currently no clear-cut answer on which is best and this is an issue that is seeing rapid technological developments in this area. Nevertheless, this section provides some guidance on making a choice among the pricing mechanism options.

There are two main dimensions to discuss here.

- ***Pricing mechanisms*** are the different ways parking fee payments are physically organised, such as via attendants, in-street parking meters, pre-paid coupons, mobile phones or in-vehicle parking meters.
- ***Payment methods*** are the various ways in which the money transfer for the payment is handled. The choices include cash (coins, notes or both), credit cards and debit cards, stored value cards, payment through a mobile telecoms carrier, mobile wallets, etc.

A number of key considerations are important when choosing both pricing mechanisms and payment methods (Table 10).

Table 10: Key considerations for choosing pricing mechanisms and payment methods *)

Key considerations	Comments
Overall costs (capital and operating combined)	**Tolerable costs depend in part on price levels. Low-priced parking requires a low cost mechanism to avoid a deficit.**
Capital cost	The up-front capital investment required to establish the system and to regularly renew it. Pricing mechanisms that require significant infrastructure to be installed in the streets will typically have high capital costs.
Operating cost	Includes costs to the operator or city to keep the system running smoothly and for each transaction. Labour costs may dominate operating costs for labour intensive methods. Ease of maintenance is also an important dimension of operating costs.
Transaction costs	The cost of each transaction can have a large influence on operating costs in high-demand, short-duration parking situations. Be especially wary of flat fees per transaction (as with most credit/debit card transactions for example). These are especially a problem when parking fees are low.

Key considerations	Comments
Convenience for users	**Public acceptance of pricing is heavily influenced by the convenience and ease of making payment. This can be broken down into several dimensions:**
Convenient mode of payment	For example, meters that accept only low denomination coins will quickly become inconvenient over time as prices are adjusted. Excessively complex procedures or long walks to/from pay-display meters will irritate users and lead to mistakes.
Options for payment mode	Convenience is often enhanced by offering a range of payment options (such as cash, credit/debit card, and mobile-phone-based payment options) for each parking event.
Lack of a need to predict length of stay	With only a few exceptions, most on-street parking payment mechanisms require users to predict the length of stay and pay for that time.
Ability to extend parking sessions	Even if users must initially predict their length of stay and pre-pay, many value being enabled (and allowed) to later extend the parking session, especially if this can be done without returning to the vehicle.
Convenience for diverse users	Most cities must cater to motorcycles as well as larger vehicles. Motorists with disabilities, if charged, also need suitable easy-to-use payment options.
Ease of price adjustments	To be compatible with modern best-practice parking management, a pricing mechanism requires easily adjustable fee levels. This includes the ability to set different fees for different locations and for different times of the day and week.
Ease of enforcement/integration with enforcement	The costs and efficiency of enforcement of the pricing system can be heavily influenced by the choice of pricing mechanism. For example, 'pay-by-plate' mechanisms (both meter-based and mobile) involve the capture of license plate information and enable very effective use of License Plate Recognition (LPR) in enforcement.
Ease of central data collection	Many modern digital pricing mechanisms enable easy and cost-effective collection of a stream of parking usage data with both operator and local government (if different). This data on occupancies, durations, and payments is invaluable for parking management decision-making.
Trustworthiness (resists theft/leakage)	Mechanisms vary enormously in their ability to resist or deter leakage/corruption and their vulnerability to theft. Minimising these is crucial to successful pricing.
Robustness/reliability	A strong payment mechanism obviously needs to stand up to various conditions and remain working reliably despite challenging circumstances, such as harsh weather, vandalism, power failures, computing failures, and operator or user errors.
Suitability for motorcycles	In many cities, pricing mechanisms need to be well-suited to motorcycles, not just larger, enclosed vehicles. Mechanisms that require the display of a paper ticket can be problematic for motorcycle users (although not impossible).

*) These are adapted and extended from those listed in Todd Litman, 'Parking management best practices' (Chicago: American Planning Association, 2006).

Table 11 provides a list of the common pricing mechanism options for on-street parking and briefly highlights their key strengths and weaknesses.

A surprising theme here is that even cities with poorly developed parking management should consider leap-frogging to an advanced pricing mechanism.

- Some of the most up-to-date approaches, including digital mobile mechanisms, are also relatively low-cost and surprisingly simple to adopt, while offering dramatic advantages.
- This presents an opportunity for local governments where parking reform is currently held back by weak pricing mechanisms, such as attendants issuing paper tickets.
- There are risks too of course but it is striking that, as cities in Asia, Africa, eastern Europe and Latin America upgrade their parking pricing mechanisms, some are now choosing surprisingly 'cutting-edge', high-technology options.

Table 11: The main pricing mechanism options, with strengths and weaknesses (don't forget to refer to 'key considerations' Table 10).

Pricing Mechanisms	Description	Strengths	Weaknesses	Example cities and other comments
Displayed pass or permit (usually monthly or annual)	Eligible motorists buy paper or windscreen sticker permit to park in small zone. Casual parking banned or via other payment options.	Low cost	Sometimes prone to fraud; Serves narrow range of rationing goals; Permit-only areas limit public parking.	Common for dense residential areas (preferential parking usually primary, not rationing goals served by pricing).
Valet (usually cash)	Pay an attendant who parks the car elsewhere. Usually a private-sector initiative.	Can ease extreme parking problems at busiest times and places. Low capital cost.	Not a general approach to parking payments; High operation costs.	Very common in restaurant or entertainment areas with localised parking problems.
Attendants: cash payment and paper tickets	Attendant seeks flat or time-based fee on arrival or departure. (In theory) issues ticket on arrival.	Simple; Very low capital cost; Convenient for motorist; No need to predict duration.	Very high leakage risk; Very labour intensive; Time-based fees problematic so often prompts flat fees per arrival (undermines parking management).	Most cities in Indonesia; Dhaka (flat fee); Parts of Beijing, other Chinese cities, some cities in India (time-based fees).

Pricing Mechanisms	Description	Strengths	Weaknesses	Example cities and other comments
Pre-purchased coupons (tear, pierce or scratch then display)	Buy coupons from various retailers. Indicate starting time on correct value coupon and display to prove payment for a period of parking.	Low capital cost; Low-tech (although anti-counterfeiting effort needed).	Motorist error; Must predict duration; No data stream; Minor cheating (indicate arrival later than actual); Enforcement cost; Counterfeiting.	Singapore; some cities in Brazil, Malaysia, Ireland.
Mechanical single-space meters	Invented in 1930s; Accept only coins.	Familiarity (in some cities).	High capital/operating cost; No data stream; Coin-only; Must predict duration; Hard to change prices.	Many cities, especially in North America.
Electronic single-space meters (first generation)	Electronic meter but less sophisticated than 'smart' meters below.	Improved reliability over mechanical meters; Electronic monitoring, recording of repair and collection.	High costs; Must predict duration. Limited payment methods (usually coin only).	Common in North America.
Electronic single-space or two-space meters (e-card payment)	Electronic meter but less sophisticated than 'smart' meters below. Contactless stored-value smart card payment.	High reliability; Low leakage; Theft proof.	High capital cost; medium operating costs; Must predict duration; Limited payment methods (e-card only).	Hong Kong/Guangzhou
Multi-space pay-and-display meters (basic electronic)	Walk to meter, pay for expected duration, return to vehicle and display receipt. Usually coins only.	Moderate capital and operating costs (one meter per 6–12 spaces).	High enforcement costs for pay-and-display. Must predict duration; Limited payment methods. Poorly suited to motorcycles.	Common in Malaysia, Australasia, North America (rapidly being replaced by modern meters).
Digital mechanisms (all those below)	Digital capture of transaction and parking data. Many use purely digital proof-of-payment. All enable digital payment modes (credit/debit cards and mobile payments of various kinds). Many are cashless.	Rich data stream; Usually real-time, two-way data exchange with a control centre. Several digital mechanisms often coexist, giving motorists options. User can be notified by sms before time expires.	See below. Beware of payment modes with a significant fixed cost per transaction.	See below for strengths and weaknesses of specific digital options and example cities.
Digital permit (monthly or annual)	Eligible motorists buy permit to park in small zone. Proof of permit usually via RFID or license plate in system.	Low cost; Efficient enforcement.	Serves narrow range of rationing goals; Permit-only areas limit public parking.	Many cities; Singapore 'season passes' use RFID; Becoming dominant permit approach.
Attendants and digital handhelds (pay on arrival)	Pay attendant fee for expected duration and display ticket. May allow multiple payment modes.	Motorist convenience; Lower leakage than non-digital attendant options; Data stream.	Labour-intensive; Must predict duration.	Makati in Metro Manila; Medellin, Colombia; parts of Delhi, India; Seoul.

Pricing Mechanisms	Description	Strengths	Weaknesses	Example cities and other comments
Attendants and digital hand-helds (pay later)	Attendant issues tickets on frequent rounds and fixes to vehicle. Pay online or through local retailers.	Motorist convenience; No need to predict duration; Low leakage; Data stream.	Very labour intensive.	Taipei
Smart (digital) single-space meters	Sensor detects vehicle in space; Multiple payment options including cash.	Convenient; Can integrate with other digital options to allow extend-by-phone, etc. Easy price adjustment.	High capital and operating costs.	San Francisco (SFPark); Tokyo
Smart (digital) multi-space pay-and-display meters (6 – 12 spaces per meter)	***Several variations below***. Walk to meter, pay for expected duration, return and display receipt on/in vehicle; Multiple payment modes.	Robust; Easy price adjustment. Sometimes allows top-up and extend via any meter or phone.	High enforcement costs. Moderate capital and operating costs (high compared with low-infrastructure options below); Poorly suited to motorcycles.	Common in Europe and increasingly in North America
Smart multi-space meters with Pay-by-Space	No need to return with receipt. Parking space number is entered at meter and registered as paid for relevant period.	As above. But easier enforcement. Often allows top-up and extend via any meter or phone.	Requires spaces to be marked and numbered; Must enter space number (prone to user error).	Various OECD cities
Smart multi-space with Pay-by-License	No need to return with receipt. Vehicle license number is entered at meter and registered as paid for relevant period.	As above; Easy LPR enforcement; Often allows top-up and extend via any meter or phone; Integrates well with discounts and permits.	Privacy concerns; Users must remember their license plate number. Relatively new.	Increasingly common in OECD; Mexico City's ecoParq; Chennai
Pay-by-Phone:	***Several variations below***. Each can register either a parking space number, small parking zone number or the vehicle license plate number.	Often used as a complement to digital meters; Low additional capital costs; Eases enforcement, especially if licence-plates used. Discounts and permit integration; Easy extension of time paid. Suits motorcycles.	Prior registration usually; Capital cost savings only if street infrastructure removed; May need alternatives for certain users; Extra complexity in enforcement if combined with pay-and-display.	High and growing percentage of on-street parking payments in OECD countries; Surging in middle-income countries.
Pay-by-phone call	Call automated phone line and enter details including space or zone and desired time.	As above	Significant cost per transaction.	Shenzhen; various OECD cities.
Pay-by-sms	Send text with space, zone or license plate number and desired time.	As above; Convenient payment can be via mobile phone bill.	Significant fixed cost per transaction.	Dubai; Sharjah; and many others.
Pay-by-smart-phone-app	Pre-register payment account and license plate. When parking use app to register location and desired time.	As above; Convenient; Very low transaction costs.	Need other options until smart phone penetration almost universal.	Shenzhen, Tel Aviv and many others. Need alternatives for non-locals and late adopters.

Pricing Mechanisms	Description	Strengths	Weaknesses	Example cities and other comments
In-vehicle meters	Device displayed in vehicle is loaded with pre-paid credits or linked with payment account. Manual activation is usual.	Low-moderate capital costs; Low operating and transaction costs; Convenient. Pay exactly for time used; Near-field communication enables integration with enforcement.	Usually need to retain alternatives for non-locals and others.	Many OECD cities; Tel Aviv.
Global Positioning System (GPS)-based ('pay-by-sky')	GPS tracks device installed in vehicle, detects parking events, calculates fees for billing or deduction. May include in-vehicle display.	Very convenient for motorist; Low-medium capital costs; Low operating, transaction costs; Pay exactly for time used; Excellent integration with enforcement, discounts and permits.	Privacy concerns (design can protect privacy but worries are difficult to allay); Usually need to retain alternatives for non-locals and others.	Singapore in future possibly.

Fig. 61, 62, 63, 64: *Examples of non-digital on-street parking pricing mechanisms: Attendant with cash payments and paper tickets in Beijing (top left); Pre-purchased tear-and-display coupons in Singapore (top right); Mechanical single-space meters (bottom left); Multi-space pay-and-display meters (basic electronic) (bottom right).*

Fig. 65, 66: *Parking fee collector, Thimphu, Bhutan.* © Manfred Breithaupt

If your city does not have widespread parking meters, consider leapfrogging straight to low-cost mobile digital options and avoid parking meter investments completely:

- Even though many cities in the West now see pay-by-phone for a large proportion of on-street parking transactions, almost all have faced pressure to retain their in-street parking meter infrastructure as well.
- However, not having parking meters may now actually be an important advantage for many cities in low-income and middle-income countries.
- Having not yet made any large investments parking payments infrastructure, many such cities may be able to avoid the need to ever install payment infrastructure in the streets.

Fig. 67: *Examples of modern digital on-street parking pricing mechanisms: Smart (digital) single-space meter in San Francisco.* © Carlos Gomez on Flickr

Fig. 68: *Smart (digital) multi-space meter in Ann Arbor.* © Dwight Burdette via Wikimedia Commons

Fig. 69: *Pay-by-Phone in Washington DC.* © Paul Barter

Fig. 70: *In-vehicle meter.* © Eliavnl via Wikipedia

- For example, Shenzhen, China is now piloting on-street parking pricing with pay-by-phone approaches as the only options.
- In Tel Aviv, Israel the only options to pay for on-street parking are pay-by-phone (two companies) and in-vehicle meter (one company).
- Pay-by-phone is also well-suited to motorcycles which will be important in many cities.

Most digital options in Table 11 have a range of options for the payment methods, such as using credit/debit card merchants or mobile wallets, etc. The strengths and weaknesses of common parking payment method options are outlined in Table 12.

Best practice for cities without extensive existing parking meter investments currently looks something like this:

- pay-by-phone with pay-by-sms and pay-by-app options;
- possibly supplemented by in-vehicle meters;
- making sure to capture license plate details for integration with LPR-based enforcement;
- and using a mobile wallet approach to payments to keep transaction costs low.

If parking meters are seen as essential (perhaps due to resistance to mobile-only payments in places accustomed to being able to use cash at a meter), then current best practice seems to be:

- multi-space digital meters;
- in pay-by-plate mode;
- supplemented by pay-by-phone options with license-plate information;
- with mobile wallet-based payments encouraged.

Table 12: Payment methods and their strengths and weaknesses

Payment method	Strengths	Weaknesses
Cash (coins)	Familiar	Inconvenient for users if the only option, as on older meters, especially as parking prices rise.
Cash (notes)	Convenient	Costly to enable meters
Telecom provider's mobile phone bill (used for some pay-by-phone implementations).	Easy integration with pay-by-phone-call or pay-by-sms. Avoids need for additional mobile wallet or credit/debit card details.	Telecom providers usually take a large commission.
Credit card/debit card readers in parking meters.	Convenient; High penetration of cards, at least in OECD.	Significant fixed cost per payment undermines revenue from large numbers of small payments.
Mobile phone payment linked to credit/debit card.	Convenient	Same fixed cost problem as above.
Stored value smart card (Near Field Communications NFC).	Low transaction costs (fixed fees imposed on top-ups not small parking payments); Useful if high penetration of cards for other reasons (such as public transport).	Main disadvantage is distribution of cards to users and hassle of topping up.
Mobile wallets for payment from stored value accounts via mobile phones (app or tap-to-pay at smart meter) (Near Field Comms).	Low fixed costs per parking transaction. Like stored value cards, the operator fee is attached to the larger top-up transactions not the small parking transactions.	Low penetration/familiarity for now in most cities (but may change quickly).

5.5 How to set parking prices

Price setting is an issue on which it is especially important to make parking management goals the focus of the decisions. This section canvasses possible approaches to price setting then looks in more detail at the option with the strongest claim to serving parking management objectives.

Price setting options have widened in recent years.

- Price adjustments are becoming much easier to implement for many cities, as they adopt modern digital pricing mechanisms and payment methods (see the previous section).
- Not only can price adjustments be more frequent, but it is more feasible to consider setting different prices for different places and even for different times of the day and week.
- The ability to collect parking data regularly (or in real time) at a low cost makes it more feasible than ever to base price setting decisions on objective parking conditions, such as occupancy targets.

The decision to price at all is as important as having a precise price-setting criterion.

- Pricing is extremely effective at managing parking demand. San Francisco's SFPark project trial found for example that on-street parking conditions on Sundays were drastically improved by extending the usual meter operations to that day [30].
- However, prices that are not updated regularly may lose their effectiveness.
- As noted in Section 5.3, without frequent updates based on parking management goals (at least to some

[30] San Francisco Municipal Transportation Agency (SFMTA), 'SFpark Pilot Evaluation: A summary of the SFMTA's evaluation of the SFpark pilot project' (June 2014), p. 16. Via http://sfpark.org/about-the-project/pilot-evaluation and http://sfpark.org/wp-content/uploads/2014/06/SFpark_Eval_Summary_2014.pdf.

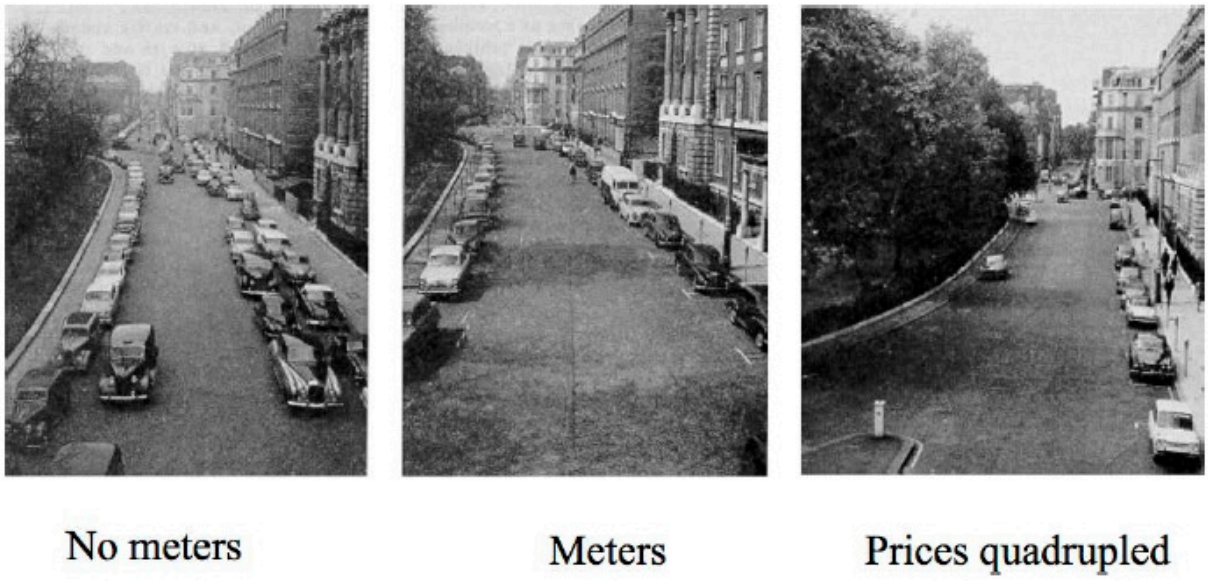

Fig. 71a, b, c: *Grosvenor Square in London.* © TRL

extent), a vicious cycle of under-pricing, weak parking management and a growing suspicion that fees are merely for revenue not parking management. The 'political judgment' approach in Table 13 reflects this syndrome.

Setting prices is best done using an objective criterion based on observable variables.

- *Ad hoc* choices will be prone to undue political influence.
- It is better to have a political debate about choosing the right criterion than to encourage politicking over particular price adjustments.
- Public respect for price adjustments is improved if they are based on very clear and objective evidence-based criteria. A scientific price adjustment is easier to justify than an administrative decision.
- The objective criterion that is chosen should be closely linked with key parking management goals.
- ***A growing consensus says that preventing on-street parking saturation is the best parking management goal to link with on-street parking price setting***. The relevant objective price-setting criterion is to target an efficient level (in a range) for occupancy or vacancy (= the percentage of spaces that are occupied or vacant).

Table 13 outlines often-debated price setting approaches and presents their main strengths and weaknesses. The options are arranged roughly in order of usefulness, with the least useful options at the top. ***Note that only the last option in Table 13, "occupancy targeting with simple zones" is recommended***.

Table 13: Approaches to price setting for on-street parking

Criterion	Description	Examples, Strengths and Weaknesses
Political judgement (with focus on revenue in price debates)	If prices are not adjusted regularly enough, their parking management benefits erode gradually. After some time, the management purposes of fees even get forgotten. Parking fees come to be seen as a 'tax' with revenue as their sole purpose. In this context, even modest rises have high political cost.	***Examples***: Very many cities worldwide. For example, Indonesian cities and most USA cities. For example, in 2011 Boston, USA, raised the on-street parking price for the first time in 25 years, from USD 1/hour to 1.25, justifying it purely in terms of revenue[1]). ***Strengths***: none ***Weaknesses***: *Ad hoc*. Hampers efforts to gain support for pricing as a parking management tool. Revenue goal is futile because revenue as objective guarantees public hostility to price rises, so prices fall behind inflation, eroding parking management benefits. Effort to avoid political backlash fails since parking management is seen as a failure and pricing becomes ever more unpopular.
Fuel price benchmark	Involves linking parking fees to fuel prices. This seems to be an ill-conceived populist policy aimed at restraining local governments from raising prices 'too much'.	***Examples***: European national rules sometimes link parking fees to fuel prices (for a maximum price). Budapest is an example[2]. ***Strengths***: None ***Weaknesses***: Arbitrary. Not linked with management objectives. Encourages belief that parking must not be too expensive. Provides no guidance for where/when to price and at what levels.
Traffic speeds/congestion (to serve traffic reduction goals)	Implies setting on-street parking prices higher in areas that are the key destinations of congested traffic flows. Also implies setting peak-time parking prices to match traffic peak times.	***Examples***: Delhi briefly proposed higher parking fees during traffic peak-hours. A Bangalore proposal suggested zones based on traffic conditions. ***Strengths***: May help complement other demand-management policies to limit traffic congestion. ***Weaknesses***: Untested. Ignores parking saturation issues; Potentially objective but difficult to implement as a clear criterion (rather than a goal). On-street parking and its prices not closely linked with metropolitan traffic flows. If on-street prices rise automatically if traffic speed targets are not met, they might keep rising without notable impact on regional traffic speeds.
Turnover (short durations)	Aims to ensure that convenient on-street parking spaces 'turn over' frequently (usually so that they will be used by shoppers not all-day parking). In other words, the aim is short parking durations.	***Examples***: Many cities. ***Strengths***: Keeping on-street durations short is relevant for retail areas, serving the interests of retailers. ***Weaknesses***: Not clear what level of turnover to target. Even if a turnover criterion is met, saturated parking can cause problems. Turnover data can be misleading in some circumstances. Turnover not easily measured without digital pricing mechanisms.
Public transport fares as benchmark	Involves linking parking fees to the price of a primary alternative to driving, public transport. If public transport fares rise, so do city-centre parking fees, avoiding an increase in the attractiveness of driving to the city centre.	***Examples***: European local governments often link parking fees to the cost of a transit ticket (usually to set a minimum price)[3]. Budapest is an example[4]. ***Strengths***: May slightly deter future populist attempts to lower city-centre parking prices. Prevents public transport fare increases from encouraging car use. ***Weaknesses***: Arbitrary – not obvious how parking prices should compare with public transport. May not prevent saturation. Suitable primarily for city centre parking. Defines only a minimum price. No guidance for where to price or pricing hours.

Criterion	Description	Examples, Strengths and Weaknesses
Intensity of development	Parking price zones (usually concentric) based on urban development intensity (or past growth of management).	***Examples***: Seoul and various cities in Europe and China. ***Strengths***: Serves traffic mitigation goals and the need to ration on-street parking more intensively in busiest areas. Tends to match local expectations of where different policies should apply. ***Weaknesses***: Decisions on zone boundaries and prices are both arbitrary. No guidance for pricing hours.
Land values	Base parking prices on some percentage of nearby average land values. Based on the idea that parking pressure is highest in areas of highest land values/ rents. Also alludes to the idea that parking should pay its share of land rent.	***Examples***: Proposed in India's national urban transport strategy. Proposed for Ahmedabad. ***Strengths***: Simple. Sends a helpful message about the value of parking. Parking pressure may correlate roughly with land values. ***Weaknesses***: Untested. Proposals so far make parking an arbitrary (and low) proportion of estimated land prices. Insufficient evidence that on-street parking pressure correlates closely with land rents. Some low-land-price areas may have saturated on-street parking. No guidance for pricing hours.
On-street prices higher than off-street	Takes nearby off-street parking prices (or an average of such prices) as a minimum benchmark and sets on-street prices a certain amount or percentage higher. Aims to discourage cruising for on-street parking and encourage use of off-street parking, which otherwise is often under-used.	***Examples***: Medellin[5]; Beijing; Frankfurt-am-Main ***Strengths***: Probably simple to implement. Widely advocated[6]. Provides market-responsiveness if off-street parking has market-influenced prices. Should encourage off-street parking use and discourage cruising for on-street parking. Is in line with the fact that most motorists value on-street parking more than off-street. ***Weaknesses***: Limited evidence. Danger it may prompt control of off-street prices. Off-street parking often under-priced due to other policies. Problems if off-street prices are not responsive enough. Does short-term on-street need to be pricier than short-term off-street, or is it adequate if on-street price for 6 hours or more is higher than the daily off-street price aimed at employees?
Precise occupancy targeting with tiny zones	Price setting based on a relatively narrow target range for the average on-street parking occupancy (such as 70 to 90 %). Frequent price adjustments (monthly for example). Prices can change for any street section and any part of the day in which average occupancy over the previous survey period falls outside the target range.	***Examples***: Los Angeles (in Express Park trial areas); San Francisco (in SFPark[7] trial areas). See also Table 14. ***Strengths***: Highly targeted at the most important on-street parking management objective (preventing saturation). Tiny zones enable price-sensitive motorists to use their parking location choice to avoid high parking fees. Effective at reducing parking saturation and its ill effects. Makes on-street parking prices very responsive to changing conditions. ***Weaknesses***: High precision in space and such frequent price adjustments may not be necessary to achieve most goals. Tried so far only in high-income cities. Problems conveying detailed price information to motorists. Requires high capacities in data-collection, management analysis and price adjustment.

Criterion	Description	Examples, Strengths and Weaknesses
Non-systematic occupancy targeting	An approximation of occupancy targeting emerges if: a. avoiding saturation is an important consideration in price setting (with or without an explicit occupancy target range); and b. there is a willingness to have different prices for specific locations or streets with high parking pressure.	***Examples***: Vancouver, several Boroughs in London[8], many places in Australia, various cities in Hungary, Taipei (almost systematic – see Table 14). Many cities that seem to use another criterion in this table may, in practice, use occupancy in this way. ***Strengths***: Widespread. Reaps some benefits of occupancy targeting (to the extent that occupancy does influence prices). May provide first steps towards systematic occupancy targeting. ***Weaknesses***: Not sufficiently objective if actual price setting is a judgement by officials (potentially influenced by other issues besides avoiding saturation). Therefore, difficult to defend price changes. Risk of sliding back to 'political judgement' approach.
Occupancy targeting with simple zones	Price setting is based on a target range for the average on-street parking occupancy (or vacancy) rate. Price zones are not tiny (covering several streets or blocks but usually not more than about 1 km across). Price adjustments regular but usually much less often than monthly. Certain examples have some time-of-day pricing but most have a single price for all priced hours.	***Examples***: central Auckland; central Calgary[9]; Rotterdam; Seattle[10]; possibly Budapest. See also Table 14. ***Strengths***: Well targeted at the most important on-street parking management objective (preventing saturation). Reduces the incidence of on-street parking saturation (and its ill effects such as illegal parking, double parking, and cruising for parking); Makes on-street parking prices responsive to changing local conditions; Simpler price information to motorists than the tiny-zone option above; Does not stretch data management and implementation capacity; Suited to incremental introduction and improvement. ***Weaknesses***: Small areas and short periods of severe parking saturation can emerge if parking demand is not uniform within each zone and across the day. [*However, this can be addressed by incremental improvements, such as splitting zones or adding time-of-day pricing as needed, as was done in Seattle's Chinatown.*] Zones that are too big often cut off the motorist option of avoiding high prices by parking a little further then walking.

(Footnotes of Table 13)

[1] USA Federal Highway Administration, *Parking Pricing Primer*
[2] Paul Barter, '*Is Budapest in the demand-responsive parking pricing club*?', Reinventing Parking website, June 2014, http://www.reinventingparking.org/2014/06/is-budapest-in-demand-responsive.html
[3] ITDP China, *Parking Management Guide*
[4] Barter, *Budapest*
[5] Ríos Flores *et al.*, *Practical Guidebook*, p. 74
[6] T. de Wit (Ed.), 'Parking Policies and the Effects on Economy and Mobility, Report on COST Action 342, European Cooperation in the Field of Scientific and Technical Research, (8 Feb. 2006), pp. 22 and 80 via http://www.europeanparking.eu/cms/Media/COST%20Action%20342%20final%20report[1].pdf,
[7] San Francisco Municipal Transportation Agency (SFMTA), 'SFPark Pilot Evaluation' (June 2014), http://sfpark.org/about-the-project/pilot-evaluation
[8] Kodransky and Hermann, *Europe's Parking U-Turn*, p. 43
[9] Barter, *Calgary's on-street parking pricing*
[10] Barter, *Seattle's street parking pricing*

The option 'occupancy targeting with simple zones' is the best choice for many cities.

Notice that serious use of almost any measurable criterion for price setting requires a willingness to make regular price adjustments as conditions change and to set different prices in different places.

- Most of the criteria above vary from place to place.
- Some vary with the time of day and day of the week.
- Differential prices are now much easier to achieve with digital pricing mechanisms than with older mechanisms.

Occupancy targeting is increasingly seen as the best approach to setting on-street prices:

- It is well targeted at the on-street parking management objective that is most important (once basic order is established): reducing the incidence of on-street saturation.
- There is increasing understanding and awareness of the importance of preventing on-street parking from becoming saturated. Saturated on-street parking causes many problems including illegal parking, double-parking, and extra parking search traffic (see Section 2.4).
- Keeping average occupancy well below a certain level has been demonstrated empirically to reduce the amount of time that parking is saturated, thereby greatly reducing the negative effects of saturated parking. For on-street parking, this level is about 85 % occupancy.
- Problems caused by saturated on-street parking also fuel the (often false) perception of parking shortage. This prompts various wasteful parking efforts and investments and many misguided parking policy efforts, including excessive minimum parking requirements [31].
- Other approaches to setting prices will not necessarily tame on-street parking saturation, nor its negative side-effects. This risks having pricing being seen as a failure (even if there is success on other parking management goals, such as high turnover, good use of off-street parking and orderly physical parking arrangements).
- Parking occupancy is increasingly easy and cheap to measure (see Section 7.3).
- Experience has confirmed that price adjustments can and do ease saturation and that incremental adjustments can bring occupancies within the desired range and generally keep them there in a fairly reliable way.
- Occupancy that is neither 'too full' nor 'too empty' is a simple and intuitive criterion that is easily explained to the public.
- Adjusting prices based on an occupancy criterion adds a useful degree of responsiveness in on-street parking prices to changing parking supply-and-demand conditions.

[31] See Litman, *Parking management*

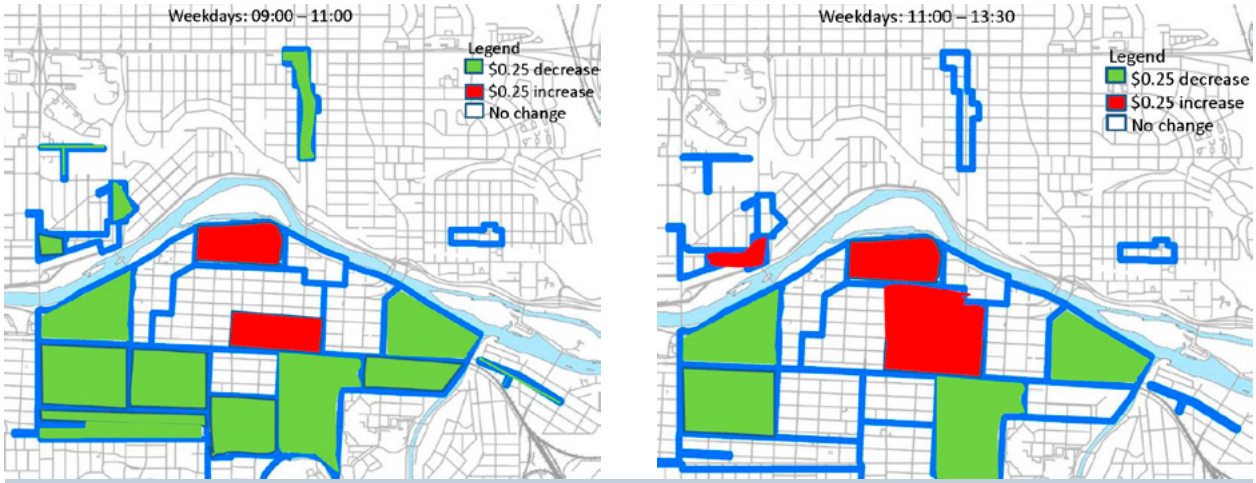

Fig. 72a, b: *Maps of 2014 price adjustments for morning and midday periods under Calgary's on-street price-setting approach that uses occupancy-targeting and simple zones.* © http://www.calgaryparking.com

Box 14: Steps to implement 'occupancy targeting with simple zones' for on-street price-setting

1. Carry out a detailed occupancy survey of the relevant area.
2. Create initial pricing zones using 'occupancy maps' of the area for every hour of the day.
   - Possible zone boundaries are locations with sharp occupancy gradients that persist for hours.
   - Based on these possible boundaries, as well as 'natural' boundaries (rivers, expressways, etc.), define initial price zones of no less than 200 m by 200 m and no more than about 2 km by 2 km.
   - Each zone should now have relative uniform patterns of daily occupancy within the zone.
3. Set the initial pricing hours (these can vary from zone to zone).
   - If the area already had priced on-street parking, then initial hours will be the same as before.
   - If the area had no pricing previously, then parking should initially remain free-of-charge at times when surveyed occupancies in the zone were lower than the target range.
   - Subsequent price adjustments will extend pricing to earlier, later, or even overnight, only when surveyed occupancies in a zone at those times become higher than the target range.
4. Define weekdays and weekends (to have separate sets of prices).
   - Certain days of the week have distinct occupancy patterns (weekdays and weekends).
   - A two day weekend may be further divided if each day has very different demand patterns.
5. Set the initial price levels.
   - If the area already has pricing, then initial price levels should be the existing prices.
   - If the area had no pricing, then choose a modest initial price for the whole area. This should be zero if saturated parking only occurs in certain zones initially. But if saturated parking is widespread, then the initial modest price should not be zero.
6. Schedule regular price reviews based on regular reviews of occupancy data:
   - Decide on a modest increment by which prices can adjust in price reviews.
   - For each zone, adjust the price downwards (or upwards) if occupancies during the relevant priced hours fall below (or above) the target range. Otherwise keep the price constant.
   - Initially have several frequent reviews (such as once every three months). After most prices stabilise further adjustments can be less frequent (such as once per year).
7. Be prepared to modify zone boundaries as needed if occupancy patterns in part of a zone become substantially different from the rest of the zone.
8. Similarly, be prepared to adjust pricing hours if periods outside the priced hours are found to consistently have occupancies higher than the upper end of the target range.

To add differential prices based on the time-of-day

If certain zones have large variations in occupancy during different parts of the daily pricing period, then differentiated prices based on the time-of-day may be needed.

- The initial time periods for differential time-of-day pricing (if any) should be based primarily on consistent time-based patterns in the occupancy survey results.
- Each zone might get different prices for morning, the hours around lunch, mid-afternoon, evening, and overnight, for example.
- Unlike the pricing hours, the beginnings/ends of these periods should NOT vary from zone to zone.
- Subsequent price reviews now allow for different prices for each zone AND each period of the day.

An ad-hoc approximation of occupancy targeting often emerges incrementally:

- A non-systematic form of 'occupancy targeting' is actually already common (see Table 14).
- Most such cases start with something like the 'political judgement' approach (the first one described in Table 13) or free-of-charge parking. This means a uniform price (perhaps zero) applies across a wide area and has rarely been adjusted in the past.
- Busy areas with serious parking saturation problems (under the prevailing price) will typically face a series of studies seeking parking management solutions.
- These are usually carried by parking consultants or in-house parking professionals who often suggest raising parking prices in ONLY the most-saturated locations. This reflects the growing view among parking professionals that it makes no sense to set prices that result in either overly full or overly empty parking.
- A series of localised price rises aimed at easing localised on-street parking saturation can come to approximate the effects of a more systematic occupancy targeting approach.
- However, this is still an *ad hoc* use of occupancy rather than systematic and explicit occupancy targeting. Price setting decisions are not explicitly tied to an objective occupancy criterion but are made as an administrative decision or by elected officials and are potentially influenced by many other considerations besides occupancy.

Table 14 presents examples of metropolitan areas where one or more local governments make significant use of occupancy targeting:

- Some use occupancy targeting with tiny zones;
- Several make explicit use of occupancy targeting with simple zones;
- And many of the places mentioned in Table 14 appear to be approaching occupancy targeting in an *ad hoc* way, as just discussed above.

Box 15: Incremental improvement of occupancy-targeting with simple zones: Seattle's Chinatown

Seattle has occupancy targeting with simple zones for its on-street parking price adjustments. The target occupancy target range is 70 to 85 percent.

Experience in Seattle's Chinatown illustrates that incremental improvements will often be needed under this approach. It became necessary to split the zone into two and to add time-of-day price variations.

The Chinatown area was a single zone when pricing was extended into the evenings (from 17:00 to 20:00 h) in 2011. The new evening price was initially the same as the daytime prices (USD 2.50).

This extension was noisily opposed by local business owners (especially restaurants), many of whom claimed large drops in business. Seattle Department of Transportation (SDOT) held a review and in February 2013, the Mayor announced changes:

1. The price zone was split into Chinatown-ID Core (the busiest part of the restaurant area of Chinatown) and Chinatown Periphery.
2. A time-of-day price difference was introduced between daytime and evening for the core area. This was the first such time-of-day price differentiation under Seattle's price setting system. In the 2014 price review, Chinatown-ID core has a daytime price of USD 3/hour (8:00–17:00 h) and an evening rate of USD 1.50/hour.
3. The evening price for the periphery of Chinatown returned to zero.

The initial Chinatown price zone had been too big and too diverse in its evening occupancy patterns (especially in the evenings). Dividing the zone into two solved that problem.

The other problem was that, even in the core, the daytime price was too high for the evening. Time-of-day price differentiation, with a lower evening price for the core, solved that problem.

The results can be seen in the most recent survey results (after the changes of 2013).

- Chinatown-ID Core 19:00 h occupancy was 77 % in 2014. This is within the targeted range with the new USD 1.50 evening price.
- Chinatown Periphery 19:00 h occupancy was 70 % in 2014. This is almost in the 'too low' occupancy range even with a price of zero.

Price setting for overnight on-street parking can follow similar approaches (suitably modified):

- Preventing congestion impacts of full parking is not as crucial for overnight parking as for daytime parking.
- Nevertheless, trying to stop overnight on-street parking from becoming overly saturated is a very useful goal.
- Occupancy targets can be relevant for price adjustments for overnight casual parking. If there is already pricing for daytime parking then adding a price for overnight casual parking should be a relatively simple matter. Price adjustments for this casual overnight price can be based on the relevant occupancy rates (in the depths of the night).
- In cities with residential on-street parking permits, occupancies may not be the best basis for permit price adjustments.
- Instead, the number of permits should be limited (so that they do not exceed the capacity available). The price of these permits should be made responsive to the demand for permits (from eligible buyers). If a waiting list for permits emerges in an area, then the price of permits in that area should rise slightly at the next price review.

Table 14: Examples of occupancy targets for on-street parking price-setting

Locations	Type of occupancy targeting used in price setting	Details/Comments
Amsterdam	Non-systematic with simple zones	Inner Amsterdam has priced on-street parking with simple zones. Occupancy is said to be the main criterion for these zones and their prices. Some zones have distinct pricing hours.
Budapest	Possibly systematic with simple zones	The average occupancy for an area needs to be 70 % or more for on-street parking charging to be allowed. Parking areas are said to be categorised according to saturation: below 70 %, 70–80 %, above 90 %. It is not clear how systematic the process is but these categories seem to guide the level of the "multiplier" (of the public transport fare) that yields the parking fee for each zone. Occupancy also influences zone boundary adjustments.
Dublin	Non-systematic with simple zones.	Dublin's parking price zones are labelled Very high demand zone (Yellow), High demand zone (Red), High demand zone – Sundays (White), Medium demand zone (Green), Low demand zone (Orange) and Suburban villages (Blue). Although prices have not been adjusted since 2008, these labels suggest that occupancy is a factor in zone boundaries and price-setting.
Taipei[1]	Semi-systematic with simple zones	Price setting uses an explicit occupancy target (50–80 %). Deviations of occupancy from this range trigger price adjustment proposals (for both on-street and off-street parking). But these are subject to political negotiation and approval. Nevertheless, prices are now highest in high-demand locations and lower in lower demand areas. Price reviews take place every 6 months.
Vancouver	Possibly systematic but with small zones	The map of parking prices in Vancouver, Canada, shows price variations on a fine scale or with very small zones[2]. These prices are set on the basis of observed parking demand (presumably with an occupancy target behind the scenes).
Waverly (and various other local authorities in Australia)	Non-systematic but strongly influenced by occupancy	This municipality in Sydney's inner east has parking meter rates that vary depending on the time and location (sometimes over short distances). Stated policy allows for fees to be set 'to maximise or optimise the use of/demand for the asset/facility. These come under the Council's "pricing principle E" in which the "price charged for this product/service is set by reference to market prices". [3]

Locations	Type of occupancy targeting used in price setting	Details/Comments
Auckland[4]	Systematic with simple zones and some simple time-of-day pricing	Since 2013, central Auckland has had three price zones. Price can rise or fall every 3, 6 or 12 months (depending on location) based on a target of 70–90 % occupancy. Peak prices can potentially be applied to parts of the day in zones that need this. Time limits were removed in these zones.
Calgary[5]	Systematic with simple zones and time-of-day pricing	Since 2014, annual review of on-street prices using data from digital payments systems. Price per hour rise or drop by USD 0.25 per year in zones where occupancy is outside the target 50–80 % range. Price zones usually about 500 m by 500 m in size. Time-of-day pricing periods are: Weekdays: 09:00–11:00; 11:00–13:30; 13:30–15:30; and 15:30–18:00; and Saturdays 9:00–18:00.
Redwood City	Systematic with simple zones	Redwood City (on the San Francisco peninsula) began targeting occupancy of 85 % via price setting in 2005. Prices in each zone are adjusted at least annually in twenty-five cent intervals. Data is based on occupancy surveys.
Rotterdam	Systematic with simple (but small) zones and some time-of-day pricing.	Has had a demand-based parking pricing approach since 1999. Yearly price adjustments based on targeting 60 to 80 % occupancies. Small zones (prices seem to vary on quite a fine scale). The adjustment procedure was modified slightly in 2012 as frequent small adjustments were judged not to be necessary.
Seattle[6]	Systematic with simple zones (and beginnings of time-of-day pricing)	The occupancy target is 70 to 85 %. Initially zones were quite large and there was no time-of-day price differences. Incremental improvement in 2014 included splitting a zone and introducing limited time-of-day price differentiation (see Box 15).
Los Angeles (Express Park trial areas)[7]	Systematic and precise with tiny zones, frequent price adjustments and time-of-day pricing	LA Express Park™ is a demonstration project in parts of Los Angeles. Tiny zones (block faces) have prices adjusted every 4 to 6 weeks based on target occupancy of 70–90 % and continuous data from wireless sensors. Different prices depending on the time-of-day (four periods: Morning – Mon-Fri before 11:00, Midday – Mon-Fri 11:00 to 16:00, Evening – Mon-Fri after 16:00, Saturday all hours).
San Francisco (SFPark trial areas)	Systematic and precise with tiny zones, frequent price adjustments and time-of-day pricing	San Francisco's SFPark trial of demand-responsive parking pricing uses an occupancy target of 60–80 %. Initially used data from in-pavement sensors. Now uses data from pricing system calibrated with surveys. Has tiny zones so that prices can differ from street block to street block. Time of day periods: morning, midday and afternoon. The official evaluation and various other studies [8] have broadly confirmed the success of the programme, although there is much debate about detailed implications [9].

(Footnotes of Table 14)

[1] Barter, *Parking Policy in Asian Cities*, p. 35

[2] Alan Durning, 'There's a Place for Us', Sightline Daily (27 September 2013) via http://daily.sightline.org/2013/09/27/theres-a-place-for-us (Post 14 in his series 'Parking? Lots!')

[3] Waverly City Council's parking policies via http://www.waverley.nsw.gov.au/__data/assets/pdf_file/0009/2241/Pricing_Policy_Fees_and_Charges_revised_24_June_2013_Final_adopted_18_June_2013.pdf

[4] 'Matt L.', 'AT Confirms City Centre Parking Changes', 19 September 2012, Auckland Transport Blog, http://transportblog.co.nz/2012/09/19/at-confirms-city-centre-parking-changes

[5] Barter, *Calgary's on-street parking pricing*

[6] Barter, *Seattle's street parking pricing*

[7] LA Express Park, 'LA Express Park Meter Rate Changes for 5 May 2014', http://www.laexpresspark.org/la-express-park-meter-rate-changes-for-may-5-2014

[8] Such as Adam Millard-Ball, Rachel R. Weinberger and Robert C. Hampshire, 'Is the curb 80 % full or 20 % empty? Assessing the impacts of San Francisco's parking pricing experiment', *Transportation Research Part A: Policy and Practice* 63 (May 2014), 76-92, http://people.ucsc.edu/~adammb/publications/Millard-Ball_Weinberger_Hampshire_2014_Assessing_the_impacts_SFPark.pdf

[9] For example, see http://www.citylab.com/cityfixer/2014/06/does-san-franciscos-smart-parking-system-reduce-cruising-for-a-space/373351.

Unfortunately, existing laws, regulations, administrative procedures or outdated pricing mechanisms may restrict your price-setting options in the short or medium term.

- If local laws define parking fees as user fees and place limits on user fee surpluses (for example, they may only cover costs) this will severely constrain the price-setting options.
- Many price-setting approaches will be difficult to implement if parking prices are set by a vote of local politicians for example.
- It is also a problem if prices are fixed by a higher level of government (state/province or national). This may become a problem in Germany for example, where the Federal Government sets the maximum on-street price that any city may charge (currently EUR 3 per hour).
- Outdated pricing mechanisms, such as non-digital meters, make regular price adjustments or price variations in space and time both difficult and expensive. Mechanical meters that only accept low-denomination coins make it difficult to raise prices beyond a certain point.

What can you do to cope with such constraints on price setting?

- The inability to set optimal prices will usually force the use of less efficient parking management tools such as time-limits.
- It would be better to push for reform of laws or administrative constraints that prevent optimal price-setting.
- Upgrade your pricing mechanisms if these are the obstacle to better price setting.

5.6 Price schemes

The level of prices (or price-setting) was discussed above. This section now looks at price schemes with respect to time. For example, some cities adopt prices that escalate so that the price for later hours is higher than the first or second.

Price per unit of time, not by arrival

- Parking pricing as a parking management tool requires charges to be levied according to parking duration (per unit of time).
- Avoid a flat price per parking event, regardless of duration (see Box 16).
- Instead, set a duration-based price (a price per hour or per minute or per 30 minutes or per day or such like).

Avoid monthly or yearly subscriptions for street parking across wide areas

- In other words, permits paid for on a monthly or yearly basis should allow parking only within restricted areas.
- Cities where parking fees are seen as for revenue (not management) sometimes propose 'subscriptions' for

Box 16: Problems with fees that are levied per parking event (and not per unit of time)

In many cities with poorly developed parking management systems, on-street parking prices are one-off payments, regardless of how long the vehicle parks. For example, there are flat, non-duration-based parking fees in Dhaka in Bangladesh and most Indonesian cities.

The one-off fee is usually handed to an attendant on departure or arrival, depending on local custom. This is also a common feature of informal fee collection.

This simplest of pricing schemes is not compatible with using pricing for parking management:

- Non-duration-based fees cannot discourage long duration parking (one of the most common on-street parking management objectives).
- It is also unfair if 15 minutes of parking, taking a valuable space only briefly, has the same fee as 8 hours of parking that hogs a space that could have benefited many others during that time.
- Non-duration-based fees make price increases very difficult. There is a limit to how expensive we can make short-time parking. This places a low upper limit on the price for all durations, since all durations cost the same.
- Non-duration-based fees undermine the demand management value of price rises, because any politically conceivable non-duration-based price will be cheap for long-duration parking.
- The level of non-duration-based fees cannot be set using any useful objective performance criterion.

parking (yearly payment to park anywhere in the city).

- Several Indonesian cities have such 'subscriptions' to reduce leakage from attendant-based fee collection.
- This throws away the parking management on-street pricing.
- However, residential parking permits can be charged on a monthly or yearly basis. They should not allow parking anywhere except near the registered home.

Keep price-per-unit-of-time price schemes simple

- Most on-street parking price schemes involve a simple price per hour (or other unit of time). This is almost always the best option.
- However, some cities adopt complex schemes such as:
  - Varying parking prices depending on the length of stay (such as a higher fee per hour for a third and fourth hours than for the first and second);
  - Offering an initial period for free, such as 30 minutes or an hour;
  - These both offer cheap parking to short-stay visitors while deterring long-durations.
- These complex schemes are well-intentioned but should generally be avoided:
  - Complex schemes generally involve *ad hoc* judgements that cannot easily be based on objective measurement of conditions.
  - Simplicity in communicating the price is important. Complex schemes add to potential confusion and frustration.
  - Such schemes will quickly become confusing if combined with other forms of price differentiation. They would therefore be an obstacle to introducing occupancy-based price-setting using zones (as discussed in the previous section).

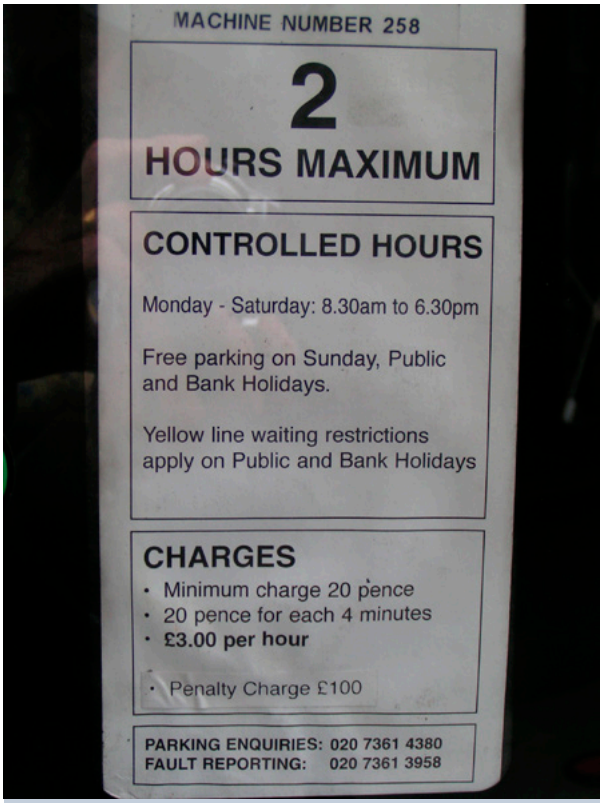

Fig. 73: *London.* © Manfred Breithaupt

5.7 Private sector participation in on-street parking pricing

Private sector participation in on-street parking pricing can range from limited to profound:

- ***Limited***: such as basic procurement of equipment or specific services, while handling the overall operations of the fee collection system in-house (such as in the 'parking authority'). San Francisco is an example, despite its ambitious SFPark programme;
- ***Profound***: the most extreme long-term concessions with a private company to manage the entire on-street parking system over a long period. The government is usually paid a large up-front fee. The contract may even provide for wide-ranging autonomy for the company to make investments and to set prices and management policies. Chicago is an example that has been widely criticised;
- ***Between these extremes***: Various approaches to private sector participation in on-street parking pricing fall between the extremes above. Most of these involve contracts of several years for private operations of parts or all of the on-street fee collection using contracts. They vary in the extent of private investments in the pricing infrastructure. It is these options are the focus of this section.

Please refer to Section 2.6 for broad advice on involving the private sector.

Recall the warning to avoid options that undermine the local government's ability to manage parking for the

public interest with a focus on key parking management objectives.

- On-street parking management is fundamentally a government function.
- Therefore, avoid long-term concessions that hand too much ownership and autonomy over on-street parking to a private corporation even if the up-front fee is temptingly large.

Avoid exclusive contracts with specific vendors or payment systems wherever possible:

- Exclusive contracts with a single fee-collection operator are no longer necessary.
- Several new mobile and digital pricing mechanisms can run in parallel with each other and in parallel with fixed parking meter infrastructure. On-street parking fee collection is no longer a natural monopoly. Tel Aviv, for example, has three different on-street parking fee collection operators running in competition with each other.
- Competition among operators should help keep costs low and reduce the risk of corruption.
- Avoiding exclusive contracts allows benchmarking comparisons among operators and provides information for future rounds of contracting.

Be wary of unsolicited proposals from the private sector. Instead, choose private sector providers by competitive tender:

- Instead, make a strong effort to decide in advance what the municipality requires from the fee collection system and the technical and service features that are needed. These requirements should rest on a solid foundation of strong parking management capacity. The local government must establish relevant capacities or seek professional help to handle private contracting in a robust and professional way.
- Such capacities include: the ability to negotiate and craft a fair contract that specifies the rights and obligations of both contractor and government and which includes suitable options in the event of a failure to deliver (by either side); the ability to monitor the contract, including operational checks; robust audit systems to minimise leakage and corruption risks.

Avoid contracts reached only by negotiation:

- Non-competitive approaches, such as negotiated contracts, put a high information burden on local

Box 17: Revenue sharing between government and operator is an important question for parking fee collection contracts

It highlights the importance of local government capacity and enabling competition rather than using negotiated contracts.

Competitive tendering can make the operator's revenues an object of competition in the bidding process. If the process is clean and truly competitive, this should ensure cost effectiveness and fairness.

Non-exclusive operator contracts should offer further pressure to keep operator costs low.

If a negotiated contract is necessary for some reason, there are several options for revenue sharing:

- Fixed percentage to each party (such as 50–50 or 60–40): This is simple but gives the contractor an incentive to under-report revenue. Shares proposes by contractors often lack an empirical basis.
- Fixed payment (from contractor to city) is also simple and makes under-reporting of revenue irrelevant. But it runs the risk that contractor profits may be too high.
- Other (better) options have become possible with digital mobile payment options with rich data on transactions. Mobile payment contractors can be primarily paid by the customers (not the city) based on a fee per transaction handled. This should reduce public suspicion and put a healthy focus on keeping transaction costs low (including via the use of mobile wallets).

If the fixed percentage shares option is chosen then every case needs to be assessed on its merits:

- Contrary to some operator claims, there is no 'standard industry practice' on the percentages that should go to the operator and to local government.
- The city side needs baseline studies and ongoing monitoring to estimate expected revenue.
- Without this, the city is negotiating blind. And in ongoing contracts, the contractors may be tempted to present misleading information.
- Even with such data, the risk of corruption remains high with negotiated contracts.

government and require strong data capture and analysis capacity.
- Deciding on revenue sharing becomes especially difficult (Box 17).
- Robust competitive tendering reduces this information asymmetry problem because keeping the operator share of revenue to a cost-effective level should be one of the objects of competition in tenders.
- Negotiated contracts increase the risk of corruption. EcoParq in Mexico City, for example, has faced concerns over the lack of transparency of its negotiated contracts [32].

5.8 Time limits

A time limit is a regulation forbidding vehicles from remaining parked on the street in a specific space (or set of spaces or a whole area) for more than a specified time, such as 15 minutes or one, two, three or four hours.

Many local governments find time limits politically attractive. Time limits of one or several hours seem to offer a parking management tool that avoids the political difficulty of pricing.

The most common purpose for time limits is parking turnover. This has several contexts:

- Very short-term drop-off/pickup places (with a limit of <10 minutes);
- Short-term zones for loading/unloading or quick errands (with 15 to 30 minute limits);
- Shopping streets/districts (with one to three hour limits usually) where the aim is to serve the interests of retail/dining/entertainment businesses in the area by discouraging employee parking in convenient on-street spaces which are better used by shorter-term visitors, assumed mostly to be customers.

Time limits can be used to discourage some kinds of spillover parking:

- Such as commuter parking spillover into residential streets around commercial areas;
- And park-and-ride parking near mass transit stations;
- Using time limits of 3 or 4 hours typically;
- With residential permit holders usually exempted;
- Such limits aim to accommodate most parking by friends, relatives and tradespeople while still deterring commuter parking.

Fig. 74: *Park and Ride in Bangalore.* © Manfred Breithaupt

However, we will see below that there can be serious problems with time limits. Time limits only serve certain tasks. They are often ineffective, especially when parking demand is high. Without strong (and expensive) enforcement, compliance is typically low. Time limits prompt many commuters to simply move their vehicle every few hours, which wastes time, generates pointless traffic, and serves no useful parking management purpose.

There are several mechanisms for imposing time limits. All include signposting the time limit.

- ***Most common, and simplest for motorists, is to put the onus on enforcement*** to deter overstaying by monitoring and detection. Motorists just park and later try to leave on time.
- ***Another approach requires motorists to use a 'parking disc'*** (Figures 75, 76). This is a cardboard clock-face disc on which the motorist displays the time that parking commences. It is an offense to not display a disc (usually on front windshield or side window), to indicate a false arrival time, to return and change

[32] See Karla Casillas Bermudez, 'Parquimetros, negocio de una sola empresa en el DF', El Universal (21 Oct. 2013), http://www.eluniversal.com.mx/ciudad-metropoli/2013/impreso/parquimetros-negocio-de-una-sola-empresa-en-el-df-119441.html (in Spanish)

Fig. 75, 76: *Part-time time limits (some combined with pricing) in a Melbourne street and a 'parking disc' displaying time of arrival near Stockholm.* © Paul Barter and Holger. Ellgaard via Wikimedia Commons

it, or to stay beyond allowed time. Parking discs are commonly used in Western Europe [33] but are gradually falling out of favour.

- ***Time limits can also be integrated with pricing (Box 18).*** For example, a maximum allowable payment can be made to correspond with the time limit and extending the payment can be prohibited or prevented. Digital payment mechanisms (especially pay-by-plate options) can also facilitate easier enforcement of such time limits.

Even if time limits yield good turnover, parking saturation can emerge and cause problems:

- Even if turnover goals are met and compliance is good, high demand can cause high occupancies. Every time a vehicle departs another quickly takes its place.
- So, time limits for free-of-charge on-street parking do not prevent the negative impacts of parking saturation (such as parking search traffic, illegal parking and double parking – Section 2.4).
- Shortening the time limit may help a little by deterring or shifting some parking to other options. However, busy streets quickly reach a limit beyond which shortening of time limits causes worse problems.
- For example, shopping street time limits of one hour or less make shopping visits inconvenient, fail to support retail businesses, risk causing motorist frustration, require expensive enforcement and risk provoking a backlash.

Difficulty and expense of enforcement is a major shortcoming of time limits:

- Compliance with time limits is usually low. Various studies show 40 to 60% of vehicles typically overstay free-of-charge time limits [34].
- Especially inefficient are traditional low-tech approaches such as marking tyres with chalk and returning later to write a hand-written violation notice if necessary. This is labour intensive and cannot prevent motorists from simply moving their

[33] Rye, *Parking Management*

[34] Rachel Weinberger, J. Kaehny, and M. Rufo, 'U.S. Parking Policies: An Overview of Management Strategies', Report for the Institute for Transportation and Development Policy (ITDP) (23 Feb 2010), p. 26. https://www.itdp.org/u-s-parking-policies-an-overview-of-management-strategies

Box 18: If on-street parking is priced, is it useful to have time limits as well?

There are reasons to say no:

- Time limits achieve no additional purpose if pricing alone prevents saturation (Section 5.5).
- In that case, time limits needlessly reduce people's choices over how long to stay.
- In any case, combining time limits with pricing means losing their political advantage as an alternative to pricing.
- The combination creates a complex and confusing set of regulations and signs. Experience shows that many motorists misunderstand and believe they can pay to extend their parking session.

However, some see solid reasons to say yes to time limits together with pricing:

- in practice, on-street pricing often fails to meet its potential to eradicate saturated parking (especially at the busiest places and the busiest times).
- So the thinking is that time limits should at least promote turnover and deter long-term parking in prime locations.
- Furthermore, because many people disagree with using pricing alone to ration parking, combining pricing with time limits allows prices to be more moderate than they would otherwise need to be.

Pro-pricing opponents of time limits answer that:

- Such prices are not efficient. Even with time limits, high occupancies still occur at busy times and places and will cause the usual problems.
- It is a pity that excessive faith in the power of the time limits prompts local governments to avoid the task of getting the prices right.
- Better to get the prices right and forget time limits.

vehicles slightly, or to another space nearby, to defeat the enforcement.

- Modern digital enforcement, often with license plate recognition (LPR) (see Section 6.4) is much more efficient but enforcement officers must still make frequent rounds.
- Digital enforcement tools enable more effective time limits that apply to parking in a whole area, so that moving a vehicle a short distance does not 'reset the clock' on a time limit.
- Although time limits are usually less unpopular than pricing, their enforcement can be unpopular, with claims of over-zealousness and pleas that 'I was only a few minutes late'.
- An exception is time limits that are integrated with digital pricing mechanisms or with in-street sensors. These can enable more efficient well-targeted enforcement.

A verdict on time limits:

- Time limits suit very short-term parking in loading or drop-off zones.
- Time limits can also achieve adequate turnover where demand is relatively low (for example, if shifting long-stay parking away from prime parking is the main goal and is enough to prevent saturated parking).
- They are politically easier than pricing, which makes them tempting for governments.
- However, they are costly and unpopular to enforce. Compliance is typically poor.
- Cities with weak parking management capacities should be especially cautious about time limits.
- If parking demand is high, time limits cannot prevent saturation and all its side-effects.
- Time limits often supplement pricing but add little benefit if the pricing scheme is efficient.
- Time limits lack most of the other benefits of pricing, such as dampening demand and sending useful market signals to other actors.

5.9 Restricted or preferential access (permits)

Another common approach to rationing on-street parking is to give preference to certain favoured groups.

Exercise caution before adopting this strategy.

- This approach tends to address the problem from the point of view of the favoured group, while inconveniencing those outside this group.
- It requires a broad consensus that the favoured group really has a stronger claim to the parking in question than anyone else.
- Such a consensus is rarely universal but implementation of this approach will reinforce the claims of the favoured group.
- Giving preference to certain groups can become complex and administratively problematic.
- Restricting access to on-street parking reduces the proportion of parking that is open to the general public. This erodes the efficiency and flexibility that public parking lends to the parking system.

Restricted versus preferential access:

- Restricted access means ONLY the favoured group may park. An example, is a resident-only zone, where only residents' vehicles with a residential permit may park.
- Preferential access involves giving a favoured group special treatment. This can involve exemptions from pricing or time limits or other regulations that apply to the general public.
- Both restricted access and preferential access is achieved via permits systems.
- Each can be applied full time or part time.
- A common hybrid is to restrict access part time and to have preferential access for the rest of the time. For example, a street section might be restricted to residential permit parking at night but to allow public parking with residential permit holders exempt from pricing or time limits (preferential access) in the daytime.

Groups that are often given preferential treatment via on-street permits include:

- Wheelchair users and certain other groups of people with disabilities. The person with the disability may be issued a permit as driver or as passenger. The displayed permits are sometimes called 'placards'.
- Local residents.
- Visitors to residents in permit-only zones. This may take the form of a limited number of visitor tickets each year, to be used by visitors or tradespeople. Carers or other regular visitors may be given another category of visitor permits to enable regular parking on a preferential basis.
- Local business owners are sometimes eligible to purchase local parking permits to park vehicles near their business, usually on an annual or monthly payment basis.

Fig. 77, 78: *Parking restricted to permit holders only – full-time in Seoul and part-time in Singapore.* © Paul Barter

An unusual case that does not involve permits is the system in some cities that allows businesses to pay to reserve specific on-street spaces:

- For example, in Kuala Lumpur it is possible for businesses to permanently reserve on street parking in front of their shop.
- In Singapore, businesses may pay to temporarily reserve on-street parking to receive a specific bulky delivery or to accommodate a heavy waste bin (or 'skip').

Municipalities with weak parking management capacity or governance weaknesses should be very cautious about the use of on-street permits.

- Notice above how complexity can easily emerge as pleas are heard for additional groups to be given preferential parking treatment.
- Administering permits systems can also be complex.
- If demand for permits is high, then the permits need to be rationed by some means, such as a lottery, a waiting list or by pricing. This involves further conflict and complexity.
- It can be tempting to issue too many permits for an area but then the system will fail in its key goal of rationing parking demand because the result is saturated parking and widespread conflict and anger.
- Permits systems that offer a large advantage to the favoured group create a strong temptation for fraud or petty corruption.
- The reinforcement of a sense of entitlement to parking by the favoured group can also become a problem into the future. This group will not easily accept any future reduction in their parking privileges.

These problems suggest a need to be cautious. Nevertheless, many cities will need to at least have special permits for the vehicles of people with disabilities. Many older urban areas will face strong demands from residents to establish a system of residential permits.

Guidelines for residential permits:

- Each residential permit must be specific to a small area close to home. It must not enable preferential parking across a large area. This would undermine parking management.
- Avoid selling more residential permits than there are on-street spaces in the relevant zone.
- ***Price residential permits efficiently***:
  - Do not allow a long waiting list to develop.
  - If all permits sell out, then increase the price of permits for the next round and repeat until demand drops below the supply.
  - If demand for permits does not exceed supply, then residential permits should be priced at some modest discount compared with hourly parking. However, this should be framed, if possible, as a privilege not as a right.
  - Avoid thinking of residential permits as exempting residents from paying. Instead see them as a convenience for regulars, enabling them to pay on an annual basis.
  - Residential permits for preferential access must be complemented by efficient pricing of casual parking to prevent saturation. This serves the desire of residents to be able to find a space close to home when they return. This makes restricted access option unnecessary (see below).
- ***Resident-only zones are tempting but problematic:***
  - Restricted access residents permits (residents only zones) are tempting because they seem to promise strong protection from parking by 'outsiders'.
  - But they reduce public parking. On-street parking that is open to the public is much more efficient and likely to be well-used across the day and week. [*However, in some European cities reducing the supply of parking available to commuters and casual visitors is actually an aim of these 'blue zones', for traffic limitation reasons.*]
  - Such zones create problems for legitimate visitors to the area, including visitors to residents. This may then prompt complex solutions such as special visitor tickets.

Fig. 79: *Residential parking scheme in Toulouse/France.*
© Andrea Broaddus

- ***Be careful over eligibility.***
  - Eligibility should focus on older housing stock built without parking.
  - Consider making homes with off-street parking ineligible (as in Amsterdam [35]).
  - Make residents of all new buildings ineligible. This should help enable reform of parking minimums. If new housing is then built with little parking, it would need to be marketed to households with low levels of car ownership or with a willingness to pay to lease off-street parking nearby.
  - Avoid having too large a financial advantage for permit holders relative to others who park regularly in the area.
  - Consider imposing limits on the number of permits per household (for example, one per household) to limit misuse.

For disabled parking permits the primary aim should be to enable access to suitable parking spaces designed for people with disabilities and in convenient locations. Allowing free-of-charge parking for disabled parking permit holders should not be the focus (see below). Exemption from payment should be restricted to people whose disability makes it too difficult to make payment.

Avoid offering special exemptions from parking fees (even for motorists with disabilities):

- It is tempting to exempt certain classes of motorists from parking fees but this is almost always a mistake. Such exemptions are an invitation to fraud and abuse of the privilege.
- A controversial and common example is the widespread practice of exempting motorists with disabilities from parking fees [36]. This usually involves the display of a 'disabled parking permit' or 'disabled parking placard'.
  - In certain cities, such as Los Angeles, around 25 % of vehicles parked in paid areas park free of charge by displaying a placard. Many of these involve placards obtained by fraud, use of someone else's placard, and other forms of placard abuse.
  - Rampant abuse of the placard system blocks up spaces that are really needed by motorists with disabilities.
  - Vehicles displaying such placards tend to park for much longer durations than those who must pay.
  - Such rampant fraud seriously undermines occupancy-targeted price setting, since a large proportion of vehicles parking do so for free and don't care about the price.
  - Even without the rampant fraud, free parking for motorists with disabilities is a poorly targeted way to help. It fails to help people with the most serious disabilities nor disabled people with low incomes, since most such people cannot drive or cannot afford a car.
- It is best to avoid or abolish such exemptions. Waiving parking fees for a whole category of motorists results in fraud and does not target those who need the help most.

[35] Kodransky and Hermann, *Europe's Parking U-Turn*

[36] Michael Manville and Jonathan A. Williams, 'The Price Doesn't Matter If You Don't Have to Pay: Legal Exemptions and Market-Priced Parking', *Journal of Planning Education and Research*, vol. 32 no. 3 (2012), 289-304. http://jpe.sagepub.com/content/32/3/289.abstract?etoc

- Instead, if members of a group of motorists need special financial help, find more direct ways of offering help in a more targeted way.

Fig. 80: *Seoul.* © Paranee Pihakaendr

6. Enforce Effectively, Efficiently and Fairly

Ineffective enforcement is a common obstacle to good on-street parking management.

Efficient enforcement focuses on achieving an acceptable level of compliance with parking rules. These rules must be clear and aligned with parking management objectives. They need clarity about which violations are most serious. Good enforcement is consistent and persistent. It must be as fair and as free of corruption as possible.

Parking enforcement is best carried out by a dedicated force of parking wardens, whose focus is parking. Such wardens always do better at this than traffic police, who have other priorities. However, traffic police can still act against major violations that endanger others or hinder important right of way.

6.1 Goals of enforcement

Enforcement goals should be integrated with parking management goals. Compliance with parking rules is important primarily because this serves parking management goals.

This focus should also guide the allocation of enforcement effort, guiding enforcement resources to places and times that contribute most to parking management goals.

Enforcement raises revenue through fines but this should be seen as merely incidental, not as a goal of enforcement. Ideally, this revenue should not influence enforcement policy choices. Unfortunately, in practice, revenue from fines often does influence enforcement goals. This, or even the suspicion of it, greatly complicates the politics of parking enforcement. See more in Section 6.8.

Two broad types of violation are interrelated and both are important:

1) ***parking at a place or time that parking is not allowed; and***
2) ***parking at a legal space but failing to follow the associated rules, such as a time limit or payment of fees or an eligibility restriction.***

Unfortunately, different agencies are often responsible for each type. This can be a problem.

- It sometimes means that enforcement against minor violations in legal spaces is more efficient than enforcement against outright illegal parking.
- This is the reverse of the proper priorities. On-street parking management requires enforcement to strongly deter outright illegal parking.

On-street parking pricing is dependent on good enforcement. This goes beyond compliance with fee payment rules within legal spaces. Fees cannot work effectively as a parking management tool if there is rampant illegal parking outside the legitimate spaces. Note that pricing can also help enable enforcement (see Sections 6.4 and 6.8).

Enforcement must aim to achieve 'good enough' compliance. Motorists should expect to be penalised if they park illegally or fail to pay meter fees. But perfect compliance is not possible. How good is 'good enough' depends on the wider parking management context and goals.

6.2 Common enforcement problems

Cities with weak parking management generally also have weak enforcement. In such cities, disruptive illegal parking can be so rampant that it is difficult to imagine gaining control.

Quietly efficient enforcement in thousands of cities around the world is not newsworthy and attracts little attention. This is a good thing but it contributes to low levels of awareness that parking enforcement often works very well.

Parking enforcement attracts two contradictory kinds of complaint:

- that it is failing to prevent widespread nuisance parking and non-compliance;
- claims that it is 'over-zealous' (for example, too many citations and excessive fines).

We will see however that improvements to enforcement can (paradoxically) reduce both kinds of complaint.

Fig. 81, 82: *Parking enforcement problems in Shenzhen and Dhaka.* © Paul Barter

Specific shortcomings of enforcement commonly include:

- underfunded and under-resourced enforcement efforts;
- enforcement handled by traffic police, for whom parking is a low priority;
- effort undermined because revenue from fines goes to a level of government or agency other than that doing the enforcement;
- unreliable vehicle registries hinder efficient issuing of fines through postal services, forcing more costly and drastic actions such as towing or immobilisation;
- outdated technologies and mechanisms for detecting violations and for taking action;
- parking enforcement employees with low social status relative to many motorists, and therefore easily intimidated into not taking action;
- a lack of clear unambiguous parking signage and markings;
- so much illegal parking that it would seem unreasonable to suddenly enforce consistently;
- a political fear of enforcing strongly, even when the tools are available;
- petty corruption in the streets by enforcement officers;
- weak oversight of private enforcement contractors, allowing extortionate activities by some;
- a lack of transparency and public trust over where fine revenues go.

Improvements can be achieved even in cities facing all of these problems.

6.3 Making enforcement less unpopular

Enforcement is never popular but this chapter will highlight how to reduce the unpopularity and the unfriendliness of enforcement as much as possible.

It would be wonderful if every motorist always parked responsibly without any need for enforcement or fines.

Good design and communication does help a little (see Chapter 4). But there will always be some need for negative consequences to deter illegal parking. Can this be made less unpleasant without losing effectiveness?

Lax enforcement is NOT the answer:

- Weak enforcement is no path to popularity. Local authorities often hold back on enforcement for fear of a political backlash from motorists. This is a mistake and a trap.
- ***Lax enforcement may seem popular at first but leads to rampant illegal and anti-social on-street parking***. These consequences are also unpopular.
- ***Lax enforcement also inevitably means inconsistent enforcement***. Paradoxically, this can lead to complaints about overzealous enforcement while illegal parking remains rampant.
- ***Occasional enforcement operations are counter-productive***. If strict enforcement is only occasional then motorists who habitually park illegally may assume that their actions are tolerated. They will see any sudden clampdown as unreasonable and unjust.

- It is much better to consistently and efficiently deter illegal parking.

Focus more on fostering good behaviour, less on penalties:

- ***This does not mean having no penalties. It is about the emphasis in enforcement effort and public communications about it:***
- The majority of motorists wish to do the right thing and appreciate an emphasis on fostering desired parking behaviour, rather than on penalising violations;
- Constantly repeat the message that enforcement is to support parking management goals;
- Each parking rule has its purpose, which can be communicated whenever possible;
- Ideally, fines and warnings should come with tips for how to avoid the same mistake again;
- Encourage enforcement officers to see their role as helping people to do the right thing, rather than mainly about punishing those who do the wrong thing;
- Some cities and community groups have experimented with 'positive parking tickets' in which a note of praise or thanks is given to motorists who have parked well. These are usually part of a stunt rather than a routine thing. Nevertheless, such publicity exercises do send the right message that the ultimate goal of enforcement is good parking behaviour.

Target habitual violators and be gentle with first timers

- Studies of parking violations typically show that a surprisingly large proportion of illegal parking is by a relatively small group who do so habitually.
- ***Achieving changes in the behaviour of such habitual violators (or scoff-laws) should therefore make a large difference***. In Singapore, for example, fines for second and subsequent parking offences are now double the first-offence fine.
- ***The converse of this is treating first-offences in a generous way***. A majority of motorists generally want to comply with the rules (so long as these are seen as reasonable). Many of the violations by this large group are likely mistakes, resulting from inattention or confusion over the rules. We do not really know which violations are truly accidental but we can assume that most first offences are mistakes and not intentional.
- Issuing only warnings for first-offence parking violations.

Graduated fines combine the targeting of habitual violators and kindness to first offenders. This idea, being popularised by Donald Shoup [37]:

- Issue warnings (or modest fines) for first offences.
- Impose the usual fine on second violations.
- Escalate to painful fines for third offences and so on (within three years say).
- Reduce the perception that enforcement officers are eager to catch people making simple mistakes.

Another way to target habitual violators involves using the demerit point system for motorists. For example in Singapore, certain serious parking violations result in demerit points. Habitual parking offenders put their driver's license at risk.

These options all require an efficient vehicle register. Most also require digital enforcement equipment. Unfortunately, many low-income and middle-income cities do not yet have such a reliable vehicle registration system.

Appeal for support from stakeholders who benefit from enforcement:

- Certain kinds of obnoxious illegal parking disproportionately harm certain groups. These groups should be encouraged to speak up against the dangerous and inconsiderate parking that harms them and in support of better enforcement. Examples include the following.

[37] Donald Shoup, 'Graduated Parking Fines', *Access magazine*, 37 (Fall 2010), 41. Via http://www.uctc.net/access/37/access37_parking_fines.pdf

Box 19: Enforcement yields revenue but should not be for the purpose of revenue

Many motorists believe that the purpose of parking enforcement is to generate local government revenue.

Unfortunately, many local authorities do little to refute this perception. Some do seem to see parking fines as an important source of revenue.

This is a serious mistake. See Section 6.8.

- Associations of blind people, people with mobility impairments and elderly people often participate in campaigns for stricter enforcement against parking on pavements/sidewalks and across pedestrian crossings.
- Schools and their parent associations often support enhanced enforcement against nuisance parking and stopping near school entrances.

Make sure penalties are proportionate:

- ***To be accepted as fair, parking penalties must reflect the severity of offences.***
- This requires public education to improve understanding of why certain kinds of illegal parking are indeed serious.
- Penalties for making a mistake with payment or overstaying a few minutes must be much lower than for dangerous parking acts, such as blocking a walkway or pedestrian crossing.

If the status quo is rampant illegal parking, then use the severity of violations as a guide to the phasing in of better enforcement.

- Early steps should target acts that are viewed as a menace by important segments of the community.
- It is easier to get public support for zero tolerance of highly dangerous forms of illegal parking than for violations that are widely seen as minor.

Box 20: Income-based parking fines?

Proportionality can also be about the ability to pay.

A common objection to parking (and other traffic) fines is that they are regressive, hurting low-income motorists badly while seeming insignificant for high-income people.

For many decades, a number of northern and central European countries, most notably Finland, impose "day fines" for many violations. This means that fines, such as for speeding, are proportional to the daily income of the offender. Police officers can access the income tax database when imposing on-the-spot traffic fines. This system does not seem to be used for routine parking fines. Perhaps it should?

This approach requires sophisticated capacities and reliable vehicle and taxpayer databases.

Time each stage of the process of tightening enforcement to match improvements in parking management that yield visible improvements in parking conditions. If parking supply is being increased, then enforcement tightening steps can be timed to coincide with openings of new facilities.

Enable appeals against mistaken or unfair enforcement

- Some enforcement mistakes are inevitable.
- ***Unjust or mistaken fines cause indignation and bad publicity for such cases undermines public support for parking enforcement.***
- Every city needs a user-friendly system for appeals against mistaken or unfair parking enforcement.
- Enabling recourse is important to reduce the number of cases that go to the courts.
- Do not worry that a convenient appeals process will encourage too many appeals. The majority of appeals will be clear cut and dealt with quickly. Reject obviously invalid appeals to discourage frivolous appeals.
- But if there is any doubt about the validity of the fine, then it probably should be waived. If enforcement is efficient then these cases will be a small proportion. For the sake of public perceptions of enforcement, it is better to waive some fines that should have been imposed than to generate widespread ill will by contesting appeals against uncertain cases.

6.4 Detecting violations

The basis of good enforcement is reliable and consistent detection of violations of the rules.

Low-technology detection of violations involves simple visual observation of parking locations and payment (such as display of a valid ticket receipt or coupon or a paid-up meter).

- This can be effective but low technology approaches are labour intensive, which limits enforcement capacity.
- Such detection is also problematic for enforcing time limits. For example, marking tyre then returning at the appropriate time is time consuming, unreliable and cannot easily prevent small vehicle shifts to remain parked in the area, against the spirit of the rule.

Most local governments could benefit from improved enforcement technologies:

- License Plate Recognition (LPR), which often goes together with modern digital 'pay-by-plate' pricing mechanisms, both via mobile phone or smart parking meters;
- Parking Sensors for enforcing time limits, overstaying in a paid space, and even for preventing illegal parking at certain sensitive locations;
- Hand-Held Citation Devices speed the process of taking action on a violation and recording evidence. Most integrate digitally with relevant databases and include tools to enhance detection;
- Smart parking meters able to detect overstay or non-payment violations;

Fig. 83: *Seoul.* © Manfred Breithaupt

Fig. 84: *Seoul.* © Jeroen Buis

- Van-mounted monitoring (equipped with license plate readers) as used in Amsterdam;
- CCTV cameras in certain high-violation locations, with or without LPR, as used in Seoul and Singapore for example to detect and deter illegal parking at hotspots for violations.

These approaches greatly increase efficiency and speed of enforcement activities to enable more comprehensive coverage and to enable better focused effort by enforcement officers.

6.5 Deciding on enforcement locations, hours and intensity

Trial and error plays a role in constantly improving enforcement priorities. This requires monitoring of parking data (see Chapter 7) and paying attention to complaints (mapping them for example).

Enforcement can be costly, so focus the effort where and when it is most beneficial.

- The effort devoted to any particular location and time period should depend on the extent to which the problem undermines parking management goals.
- Parking management goals also inform choices about the level of compliance or the incidence of violations that is acceptable at each place and time;
- Don't forget that safety is a key parking management goal, so have low tolerance for violations that endanger others;
- Locations and times at which obstructive illegal parking is common must also be a priority but the intensity of effort will depend on the traffic function

Box 21: Very short-duration parking poses special enforcement challenges:

- Locations with a high incidence of illegal stopping or very short-duration illegal parking events often require intensive enforcement (or tools such as CCTV).
- Otherwise, drivers stopping for short periods will assume that the chance of getting caught is small.
- If short-duration parking at a particular location does not cause serious problems then it does not warrant such expensive enforcement effort. Consider legalising it and managing it appropriately.

of the street, the level of the hazard created by the illegal parking, and whether it undermines parking management tools, such as pricing.

Parking durations influence the frequency of enforcement that is needed:

- Areas with mostly all-day parking may need only one daily round by wardens (at a random time).
- Areas with much short duration parking will require more frequent passes.

Deciding the timing or hours of enforcement involves at least the following issues:

- Times for enforcement against pricing system violations need to match pricing hours;
- Enforcement against other kinds of illegal parking may have no clearly defined hours (and certainly no publicly announced hours) but intensity should match the times at which each kind of violation causes most problems.
- But a total absence of enforcement for long predictable periods may lead to habitual illegal parking, so a certain amount of random enforcement may still be required in such periods.

6.6 Taking action against violations

This topic is about imposing consequences on the motorist after a parking violation is detected.

Vehicle owner (not driver) liability is necessary:

- The registered owner of each vehicle must be made legally responsible for its parking violations even when there is no evidence of who was driving.
- This is the case in all countries with effective parking management. Without this, enforcement is extremely difficult.
- Until 2006, the law in Tokyo held only the driver responsible. This made it impractical for traffic police to issue parking violations because they had to wait for a driver to return. As a result, illegal parking was rampant. Conditions improved greatly in 2006 when owners were made responsible for parking violations when the driver is not identified.

A reliable vehicle register is essential for efficient action:

- By far the most common consequence imposed on motorists for parking violations is payment of a fine. Fines can only be efficiently imposed if a notice can be attached to the vehicle (often referred to as a 'parking ticket') or sent to the owner by mail.
- ***For fines to be imposed via notices requires a reliable vehicle registry with up-to-date home addresses. Without this, there is no way to follow up on unpaid fines***. Some places have a vehicle registry but fail to keep it up-to-date. In such cases, a large proportion of parking fines will never be paid. Obviously this undermines enforcement.
- Parking violation notices can be low-tech or high-tech. In the past, hand-written notices attached to vehicles were the norm. Today, an increasing number of local authorities issue fine notices using digital handheld equipment or generate mailed notices automatically, based on License Plate Recognition (LPR) evidence (usually with human checking).

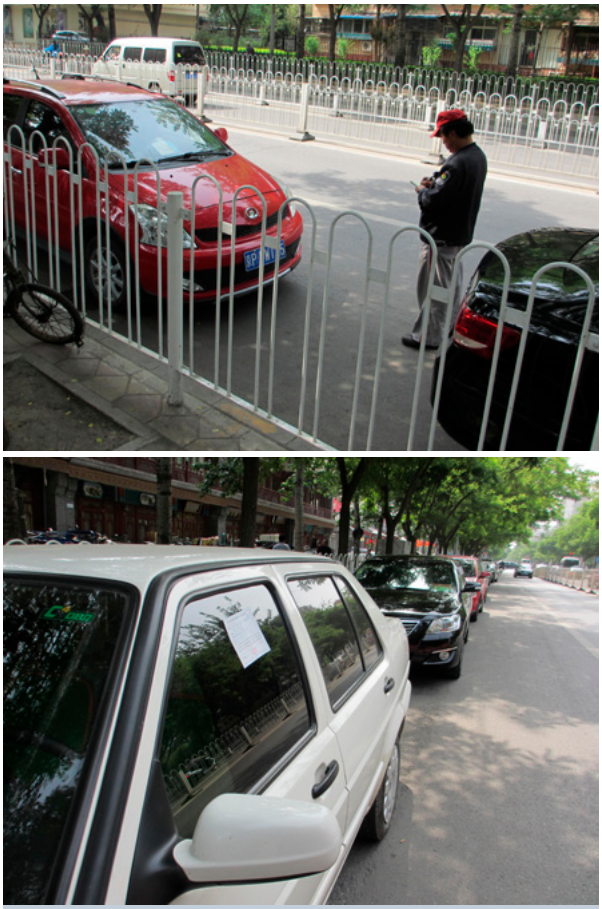

Fig. 85, 86: *Handwritten violation notices affixed to a vehicle (with photographic evidence and follow-up by post) in Beijing.* © Paul Barter

Besides fines, other actions taken in contexts of a good vehicle register include:

- Deducting demerit points on a driver's or owner's driving licence is sometimes imposed for serious violations or repeat offenders.
- ***Another important possibility is the issuing of a formal warning***, as mentioned above. Issuing these in the street requires digital equipment and a good database of violations accessible to enforcement officers. For such warnings to be issued by mail would also require a reliable registry of vehicles.
- ***Removal (towing) or immobilising vehicles is not necessary for most parking violations if there is a reliable vehicle registration system***. However, even with an efficient vehicle register there are situations in which these drastic actions are appropriate.
  - ❖ Removal is suited to serious obstructive parking where it is essential that the vehicle be removed. For example, towing is a common enforcement method against illegal parking on bus lanes, clearways and for most illegal parking on major roads where traffic flow is a high priority.
  - ❖ Immobilising a vehicle may be necessary when a vehicle is found to have unpaid fines, vehicle taxes, invalid registration, or is not roadworthy. Immobilisation is achieved using a wheel clamp (or 'wheel boot' or 'parking boot').

Fig. 87, 88: *An example of immobilisation in Singapore.* © Paul Barter

Fig. 89: *Wheel clamp on a car in London.* © Manfred Breithaup

Many places lack reliable vehicle registration records linked with home addresses. In some cases, the register at a higher level of government cannot be used by local government. If there is no reliable vehicle registration database, then getting one is a key priority.

When there is no reliable vehicle register the actions that can be taken against illegal parking violations are limited and problematic:

- ***Immobilising the vehicle*** with a wheel clamp and imposing a release fee or fine; or
- ***Removing the vehicle*** (by towing for cars and other large vehicles, by loading onto a truck for two-wheelers and non-motorised vehicles) and imposing a release fee or fine
- Less common (and less effective) consequences in cities without an efficient vehicle register and where towing and clamping are not possible include:
  - Attaching a prominent (and often difficult-to-remove) sticker to the vehicle;
  - Attaching a difficult-to-remove disposable attachment of some kind that does not immobilise or hamper the vehicle but which is prominent and which can only be easily removed by the local authority upon payment of a fee. For example, wardens the Subang Jaya Municipal Council (MPSJ) in Malaysia attach a yellow tag to the side mirrors of double parked vehicles. Council staff remove the tags when the motorists present proof of payment of the relevant fine.

Nevertheless, improved parking management is possible even if towing or clamping are the only serious options available. For example, even Mexico City's ecoParq pricing system, which uses relatively advanced parking meters, relies on vehicle immobilisation as the main consequence of violations, with towing as a last resort [38]. However, this does make enforcement much more costly than it should be.

Box 22: Parking Activism in Lviv/Ukraine

In Lviv/Ukraine, the group "Daite Proti" (Let's pass) is using big stickers to remind car drivers that sidewalk and cycling paths belong to pedestrians and cyclists. Activists are putting the stickers on wind-screens of illegally parked cars to shame the drivers. Other campaigns include putting an old fridge with number plate on a sidewalk (asking publicly with huge media attention whether we would accepts this, as we accept cars on sidewalks) as well as the installation of bollards to prevent illegal parking. The funds for bollards are raised through crowd-funding and matched by public funds. More on: http://www.trotuar.lviv.ua

6.7 Enable enforcement with suitable legal and institutional arrangements

Enforcement requires a suitable institutional basis to be efficient, effective, and with priorities aligned properly with wider parking management goals.

Enforcement actions obviously need to be properly sanctioned under the law. This may seem obvious but it is sometimes neglected, opening a door to legal challenges which undermine parking management and can cause large losses.

This section highlights several important issues on the legal and institutional foundations for parking enforcement.

[38] Ríos Flores *et al.*, *Practical Guidebook*, p. 71

Make parking infringements an administrative matter:

- This refers to imposing consequences for parking violations in a simple manner without tying up the law courts (unless absolutely necessary). Exactly how this is achieved varies, depending on details of each legal and administrative system.
- Sometimes it means parking violations are 'decriminalised' by becoming an 'administrative' or a 'fiscal' matter rather than a criminal one. Examples include the UK, the Netherlands, Spain, Singapore, Malaysia and the Philippines.
- ***This reform does not mean that parking enforcement is not important***. In fact, it enables parking enforcement to be carried out more intensively, as necessary.

Enforcement is best as a local or metropolitan government responsibility:

- In many places, the traffic police have responsibility for all parking enforcement. This often means that national or state level governments are responsible.
- ***It is better to empower local or metropolitan government to carry out most parking enforcement, so long as capacity exists or can be created.***
- Higher levels of government lack enough interest in effective local enforcement.
- The parking enforcement priorities of traffic police or higher levels of government are often focused on traffic flow or on revenue rather than effective local parking management.
- They often fail to tackle parking problems that are of local concern.
- In the UK in 1991, local governments were empowered to apply to handle their own on-street parking enforcement rather than the police. Most have taken this up. Similar reforms have happened in the Netherlands and Spain.

Ideally, enforcement responsibility matches the level at which on-street pricing and other aspects of parking management are handled.

- Revenue from enforcement should remain in the jurisdiction that handles the enforcement.
- Local people are more likely to support parking enforcement and pricing when they have a say and when the revenue stays local [39].
- In fact, most aspects of on-street parking management are ideally the responsibility of a single agency (including regulation-setting, price setting and collection, enforcement).

Consider involving the private sector (but beware potential pitfalls):

- Outsourcing parking enforcement to private sector contractors under competitive bidding has unleashed improvements for many cities. However, there seems to be no clear-cut correlation between this action and successful on-street parking enforcement.
- Singapore and Tokyo and many cities in Europe, delegate to private actors all or part of the parking warden role (detecting violations and initiating action). In Tokyo, the shift from police enforcement to private enforcement took place in 2006 and is seen as a success. Many cities, including Ahmedabad, India, use private contractors for removal of errant vehicles.
- However, inadequate contracts and poor oversight of contractors can lead to problems, such as weak enforcement, overly zealous or even fraudulent enforcement.
- Such problems undermine public support for parking management.
- In Shenzhen, China, for example, scandals over private parking enforcement contractors were a factor in its abandoning of on-street parking pricing in the 2000s. This undermined the city's parking management for many years.

6.8 Revenue and how to pay for enforcement

Is revenue a valid purpose of parking enforcement? How should the level of fines be set? How should enforcement effort be paid for? These are the main questions addressed in this section.

Enforcement revenue raises dilemmas that need to be handled with care.

- Fines are an important part of deterring undesirable parking behaviour.

[39] E. Calthrop, 'Institutional issues in on-street parking', in *Barriers to Sustainable Transport: Institutions, Regulation and Sustainability*, ed. P. Rietveld and R.R. Stough (London and New York: Spon Press, 2005), 130-142.

- Fines do bring in revenue. With good parking management, this exceeds the costs of enforcement, to achieve a modest surplus.
- Enforcement needs to be paid for.
- Sometimes a local government may be tempted to tackle a budget problem via parking enforcement revenue.
- However, this can stir public anger.

Enforcement cannot be a cash cow so don't try to make it one:

- For both practical and political reasons, it is foolish to aim for high enforcement revenue (see Box 23).
- Making revenue the focus of enforcement decisions does not actually yield more than making parking management the focus. But a focus on revenue is politically risky.
- Public anxiety over enforcement revenue is usually exaggerated but is a potent force that must be soothed.
- It is better to make enforcement choices based on what is best for parking management.
- Many municipalities would do well to sacrifice some enforcement revenue by adopting suggestions in Section 6.3 aimed at making enforcement less unpopular.

Strike a good balance between fines and enforcement intensity:

- A little thought reveals (see Table 15) that we should not rely too much on either high fines alone (with low intensity of effort) or high intensity of effort alone (with low fines).
  - ❖ High fines and low intensity make for enforcement that is seen as a lottery and unfair. Motorists who are fined feel outraged when so many others 'get away with it'. And wardens may face

Box 23: Why making revenue the focus of parking enforcement usually backfires

Imagine a municipality that has efficient enforcement in support of good parking management. If such a city tries to make revenue the focus of parking enforcement:

- It could increase the price of parking fines and it could raise the intensity of parking enforcement but both would quickly face diminishing returns;
  - ➢ Increased fines and increased enforcement intensity will result in increased compliance;
  - ➢ Intensive enforcement has costs. At some point these costs exceed the revenue.
- These efforts would be deeply unpopular. Enforcement had been good enough. So there will be little visible improvement. And most of the extra violations detected will be minor ones by otherwise law-abiding people.
- So any such effort to increase revenue will yield little additional surplus but will certainly create a large public backlash.

What about a municipality with weak enforcement and a weak parking management system?

- Such a city could increase its revenue from both parking fees and fines by improving its enforcement.
- But public support will be low if the proposal is justified as a revenue raising exercise!
- The city is unlikely to be able to improve enforcement as much as it would if the goal was efficient parking management.
- A revenue-focused effort will probably actually yield LESS revenue surplus than one focused properly on parking management goals.

Table 15: Enforcement intensity versus the level of fines

		Fine levels	
		Cheap	Expensive
Enforcement intensity	***Low***	Unacceptably low compliance	Fines become an unfair lottery and source of corruption
	High	Fines treated as price of parking	Overkill (high compliance but at excessive cost)

a significant temptation to ignore violations in return for small inducements.
  - ❖ Conversely, low fines and high intensity make it highly likely a violation will attract a fine. But this does not eliminate violations because many motorists will just treat very low fines as akin to a price to be paid routinely, rather than as a penalty.
  - ❖ Between the extremes, in the centre of Table 15, cities must find a suitable mix of fine levels and enforcement intensity that achieves good-enough compliance results for each particular context.
- This suitable mix has enforcement intensity calibrated to achieve required levels of compliance (which varies from street to street as discussed in Section 6.5) and moderate fines (although matched to the seriousness of the violation).
- These moderate fines will be:
  - ❖ high enough that motorists will not treat them as a price
  - ❖ but not so high that they prompt petty corruption among parking wardens
- Finding this sweet spot for the price level of fines and the intensity enforcement requires a certain amount of trial and error with a willingness to make adjustments.

Strike a good balance between enforcement revenue and pricing revenue:

- Many cities over-use time limits or have inefficient pricing mechanisms or have prices that are too low to effectively ration the on-street demand. These tend to result in high levels of violations and fines but low revenue from fees.
- For enforcement in priced parking zones we must also find the right balance between revenue from pricing and revenue from enforcement (fines).
- It would be better to see more revenue from fees and less from fines, especially fines associated with payment mistakes or overstaying a time limit (assuming most people want to do the right thing). This would make for a more friendly parking management system.
- For many municipalities, a shift towards optimal pricing and improved pricing methods, should result in a healthy reduction in enforcement surpluses balanced by an increase in parking fee surpluses.

Enforcement must pay for itself?

- ***There is no principle that says that enforcement effort must cover its own costs*** although it commonly does so.
- Ideally, on-street parking management overall will provide a surplus to the local government. This can be thought of as partial payment of land rent for the on-street spaces.
- ***The combination of parking fees revenue and enforcement-related revenue should cover the costs of the whole on-street parking management effort.***
- This is useful to keep in mind because new pricing mechanism choices and price-setting reforms should have the benefit of increasing compliance. This may lower the enforcement revenue surplus but should be welcomed for improving parking management outcomes.

Corruption is always a risk in parking enforcement systems. There are tactics to minimise it but no easy answers if corruption is a widespread problem. Success often depends on a strong anti-corruption push in wider society.

Some of the following efforts to reduce leakage and corruption in enforcement can help.

- Adopt of digital enforcement tools, especially automated ones, such as LPR;
- Rotate wardens among districts;
- Avoid excessively punitive levels for fines since this expands the temptation for motorists to seek a lower, corrupt payment to a warden instead of the fine;
- Pair each warden with another person, as in Mexico City's ecoParq, where enforcement officers are paired with a female police officer ('for security') and both are rotated regularly from zone to zone to reduce corruption.

6.9 What to do if illegal parking is totally out of control

There is rampant illegal parking in many cities in countries with rapidly rising vehicle ownership. Motorists often claim that parking shortages are so severe they have no choice but to park illegally. This often makes the authorities reluctant to enforce the rules.

This section suggests ways for enforcement to help, even in the face of a dire parking 'crisis' in which effective

enforcement is believed to be impossible. Not only can enforcement help in such situations, it is crucial.

The following steps can begin to help even in the worst crisis:

1. First begin calibrated enforcement to ensure habitual illegal parking carries a cost;
2. At the same time, enforce strongly against really obnoxious and dangerous parking;
3. Then gradually enhance enforcement intensity as parking management improves.

These steps assume that some basic parking management capacity and institutions are in place so that delineation of where parking is legal and where it is illegal has already been done. If not, then such basics need to happen first to make these steps possible (see Chapters 3 and 4).

1. First begin calibrated enforcement to ensure habitual illegal parking carries a cost

In extreme cases, the authorities sometimes give up on enforcement in response to pleas that 'we have no choice'. They may turn to supply as the supposed answer.

In this situation, even habitual or routine illegal parking carries no risk of a fine. An obvious first step is to begin enforcement at a low intensity. The average cost (in fines) of habitually parking illegally should at least match the average cost of legal parking in the same area. If the area has no priced parking, at least habitual illegal parking must have a small risk of a fine.

This calibrated enforcement can also be seen as a way of 'tolerating' illegal parking for a period, while efforts are made to ease the larger problem.

Giving habitual illegal parking a price (in effect) should begin to help in several ways:

- it should slightly increase the willingness to pay for legal parking;
- and give motorists a bigger incentive to seek legal parking (some of which may be private and currently under-used even when public parking is saturated);
- the added willingness to pay should also stimulate some new supply via shared parking arrangements and maybe even commercial parking.

These goals should be communicated to motorists and the community to avoid a backlash. Without such communication, getting an occasional fine will seem arbitrary to motorists.

2. At the same time, enforce strictly against really obnoxious and dangerous parking

The step above applies to moderate forms of illegal parking that are not deemed too serious.

However, really seriously obnoxious parking that endangers others or seriously hinders important movements, such as bus lanes, must be deterred much more quickly. So, intensive enforcement should commence against these practices. Rampant dangerous parking cannot be tolerated, even in the short term in a crisis.

Again, to avoid a motorist backlash, this step needs to be explained. The kinds of parking in this category need to be clearly identified as obnoxious.

3. Gradually enhance enforcement intensity along with other management improvements

Later, enforcement can be tightened step-by-step as wider parking management improves. Habitual illegal parking should gradually become much costlier than legal parking.

Each step up in enforcement intensity can be timed to coincide with relevant improvements, such as new parking supply, public transport enhancements, better conditions for pedestrian and cyclists, parking pricing, and such like.

At some point, compliance will reach a good enough level and enforcement effort can stabilise.

7. Collect Key Parking Data and Use it Wisely

Ad hoc parking management decisions based on first impressions rather than on solid information are common. Public pressure for action is often driven by casual impressions. This is especially likely in cities with weak parking management.

But first impressions can be misleading, as we saw in Section 2.5.

So it is important to take the collection and analysis of parking data seriously and to use it to better inform parking debates and to guide parking management choices.

Even though comprehensive and detailed parking studies are usually outsourced to consulting companies with the relevant expertise, ***local authority parking management teams need the capacity to collect and analyse routine but important parking data***. They need to do this to inform the essential day-to-day parking management effort.

With limited resources for data collection, survey efforts need to be low-cost and focused on the really key information most relevant for decisions and actions.

Fortunately, even simple surveys with simple analysis can be very useful.

7.1 Types of parking data

Parking professionals focus mainly on three kinds of parking data that can play a role in parking management [40]. These are:

1. ***Data on parking supply (inventories);***
2. ***Data on how fully occupied parking is (occupancy data) and on illegal parking;***
3. ***Data on the parking behaviour of individual vehicles (license plate surveys – usually for the purpose of durations data)***

In addition, other parking-related information includes data on stakeholder views, mode-of-access surveys (to gauge the relative importance of driving/parking in accessing a location), parking user views or experiences, parking choice-making, and parking search traffic.

This chapter will focus mainly on inventories and on occupancy data. The section on license plate surveys will focus on the simplest and most common application: parking durations.

7.2 Parking inventories

Parking supply information is obtained via parking inventories.

There are various reasons to conduct an inventory:

- An inventory is necessary to enable reliable occupancy surveys (see section below). Such surveys count parked vehicles and divide by the number of spaces to calculate the proportion of spaces that are occupied – the occupancy rate. The denominators in occupancy calculations can only come from an inventory.
- Wider aims of inventories are to establish a clear understanding, within a small area, of the numbers of parking spaces and key characteristics relevant to parking management.
- Simple initial steps to improve parking management can proceed without an inventory. But at least a simple inventory is necessary for any serious parking management effort. An inventory provides essential insight on the parking options available.
- Controversy can also prompt an inventory. If parking spaces need to be removed, an inventory helps evaluate the impact on the area's whole parking supply (see Section 4.3).

Careful inventories, especially those that include private off-street parking, often yield surprises. The most common surprise is to find more off-street parking (especially private parking) than had been counted before.

An inventory requires careful preparation. Before going into the field, the team will need:

- a detailed cadastral map with each plot of land and section of street assigned a code;

[40] Terri O'Connor, 'Parking Data Collection and the MTC Parking Demand Model', Presentation to the Metropolitan Transportation Commission (MTC) seminar *Parking 101: Fundamentals of Parking Reform* (25 March 2011) (starts slide 77).

Box 24: Information captured in a detailed parking inventory

Parking inventories typically include a count and mapping of all parking spaces, with the following information recorded:

- Exact location of parking;
- Physical type of parking:
  - on-street, off-street surface, off-street underground, etc.
- Physical features:
  - marked/unmarked
  - orientation of spaces
  - condition
- Number of parking spaces in each facility or section of street:
  - for each vehicle type, if relevant, or in terms of car-equivalent spaces
- Pricing:
  - Price levels applied (at all priced times; for all vehicle or user categories)
  - pricing hours
  - pricing mechanisms
- Eligibility:
  - open to the public
  - restricted to certain users – and, if so, record details
- Hours open (for off-street);
- Restrictions:
  - time limits, loading zones, clearways, bus lanes, etc. and when they apply
- Access points (driveways) and usual direction of approach (if relevant).

A comprehensive inventory may also investigate:

- Ownership of off-street lots and structures;
- Management (contractors and contract types for example) of off-street lots and structures.

- well-designed forms already prepared to enable efficient entry of the relevant information (from the list above, according to local needs);
- digital cameras to visually document each location and enable checking;
- prior permission to enter each site. However, this is not always possible, so inventories will often have some gaps.

Data must be entered into an appropriate database to enable analysis.

- If it exists, the local government Geographical Information Systems (GIS) is the place to enter parking inventory data to enable standardisation and integration with other data on land parcels and streets.
- In the absence of a GIS, simpler database tools can be used for basic parking inventories.

Include illegal parking:

- Inventories have not traditionally included illegal parking.
- However, in places with weak parking management, it may be important to make an inventory of spaces that are illegal but which, in practice, are indeed habitually occupied.
- This would require that data collection forms and the database be slightly adapted. They should enable capture of common illegal parking practices, including parking on walkways, across driveways, double parking, etc.

Inventories are highly local, since each parking space serves a small local area.

- City-wide 'parking deficit' claims based on a city-wide parking inventory would be misleading and unhelpful.
- A metropolitan-wide parking deficit provides no useful information on whether any particular area has enough parking. And they shed no light on local daytime parking problems in specific areas which are a function of motorist visitors to specific areas, and of parking management and travel options, not the overall number of parking spaces relative to vehicles.
- So, even if a large-scale inventory is done, there is no point discussing the aggregate results. Inventory results should be analysed area by area.

7.3 Occupancy data

Parking occupancy refers to the proportion of legal parking spaces that are occupied by vehicles. In other words, ***occupancy = vehicles parked/legal parking spaces***.

Occupancy data thus describes how "full" parking is. The vacancy rate is 100 % minus occupancy.

Saturated parking means that occupancy is very high. Locations with severe illegal parking problems may see occupancy rates well over 150 %.

Fig. 91: *Very high-occupancy ('saturated') on-street parking as here in Palembang, Indonesia causes side-effects including double-parking and parking search traffic.* © Paul Barter

Box 25: Inventories when spaces are not marked and for mixed parking situations

If spaces are not marked counting car spaces means:

- For on-street parking, counting/measuring car-lengths of kerb at which parking is legal (or widths for angled or perpendicular parking).
- For off-street parking, the dimensions of the parking area will need to be recorded.
- Such measurements allow estimates of car parking capacity (for example, dimensions in Section 4.6 can be used).
- Note that it is best to base such capacity calculations on local observations rather than international norms. For example, one car per 5.4 m of kerb is generally a good estimate for parallel parking without markings but not for cities with unusual numbers of small or large cars.

A similar procedure can be used for areas of unmarked parking by any other kind of vehicle.

Unmarked parking and a mix of vehicle types adds further difficulty

Many cities have parking areas (both on-street and off-street) that often accommodate a mix of vehicles.

This creates dilemmas for inventories. Standard techniques tend to assume that cars are predominant or that each major vehicle type will have designated areas.

If each vehicle type has separate and designated lengths of kerb or areas we can simply measure each length of kerb or each separate area as above.

If mixed parking takes place without designated areas for each vehicle types:

- Common practice is to measure car capacity (as above) but to use terms such as 'car-equivalent spaces' or 'car space equivalents' to remind everyone that a mix of vehicles is expected.
- Supplement counts of 'car-equivalent spaces' with observations of how much space is actually used by each kind of vehicle and whether informal allocations of space emerge in actual practice. These may vary from time to time and day to day, so a set of observations over time should be made.

There are important reasons to obtain occupancy data:

- Key decisions in parking management require a clear picture of how parking occupancy varies from place to place and across the week and daytime.
- Parking occupancies can vary greatly even over short distances, between on and off-street parking, and from time period to time period across the day. Such variations are an opening for parking management efforts, which can ease excessive demand at particular places and times by nudging small numbers of motorists to alternative locations and times.
- Full parking causes problems. Section 2.4 explained that high occupancies at on-street parking have a range of nasty side-effects. An occupancy of over 85% is the approximate level at which the negative consequences of on-street saturation escalate.
- Conversely, under-utilised parking is a waste and presents an opportunity for better use or shift to other street uses.
- There is an increasing trend for parking management, including pricing, to adopt a target range of occupancies, typically 70 to 90% or so, as a goal. This trend has increased the focus on monitoring on-street occupancy levels.

Before embarking on an occupancy survey:

- There needs to be at least a basic inventory of legal spaces within the survey area.
- Decide between accumulation, space-by-space or segment-by-segment counts (see below).
- For space-by-space counts or segment-by-segment counts, the survey area must be divided into segments, such as street sections, or sections or levels within an off-street facility.
  - Occupancies can vary over short distances, so segments should be small (for example, 10–20 on-street spaces). Overly large survey segments will miss important local variations.
  - Each segment should include parking with a single set of eligibility and pricing characteristics. For example, do not include priced and free-of-charge parking in the same segment.
  - Short sections of kerb with special restrictions (such as loading zones or spaces reserved for people with disabilities) should have their own short segments.
- The dates for the survey need to be chosen with care.
  - For example, a typical mid-week day is often chosen. Seasons, school holidays and major holidays must be a factor in choosing a 'typical' day.
  - The day of the week with the greatest parking problems is also often surveyed.
  - In comprehensive occupancy surveys, weekends will also need to be surveyed.
  - Counting must be deferred in case of bad weather or results will be misleading.

The actual survey process must be carefully planned:

- Observations are made by human data collectors on foot or in vehicles, using paper forms or using still or video cameras.
- The route to be followed must be planned and followed consistently.
- How much of the day to survey must be decided. From 6am to 10pm may suit many cases, with the 6am sweep able to represent the overnight situation in most cases.
- Choose how often survey sweeps will occur.
  - In high-income countries and in areas with intensively managed parking, 15 minutes is a common choice.
  - Hourly is a common choice for lower-cost occupancy surveys.
  - If resources are very limited, there is still value in an even simpler survey with as few as three or four observations across a day. These would aim to capture peak times, as well as an hour or two before each peak and an hour or two after each peak, if possible. Peak times will depend on the main land uses.

The space-by-space count option:

- Both space-by-space and segment-by-segment counts involve making repeated sweeps through the area to count the vehicles parked in each segment of kerb space.
- Space-by-space counting is possible when all legal spaces are marked.
- This usually means that a single type of vehicles parks in the marked spaces in each segment (such as cars only or motorcycles only).
- Automated real-time occupancy data becomes possible when all spaces are marked and when automatic sensors of some kind are deployed:

- Sources of automated occupancy data include parking space sensors in the ground or in some smart parking meters.
- Digital payments data also provides estimates of occupancy in priced spaces (but calibration with surveys is needed to correct for kerb time that is not paid).
- Automatic sources miss most parking on illegal locations.

- However, manual surveys are still common and are needed to complement automated data.
- Survey forms (Figure 92) or data entry formats for space-by-space occupancy surveys are almost the same as license plate survey forms (Section 7.4).
  - Each parking space has a row on the form, and each parking space is given a unique number (if it has not already been assigned one by the local government).
  - Each sweep of the study area gets a column (for example, the 8am sweep).
  - In the box for each sweep and each space data gatherers must record if the space is empty or occupied by a vehicle (and the vehicle type if diverse types are relevant).
  - Note that despite the similar forms, each sweep and subsequent data entry and analysis is much faster than for license-plate survey because license plate numbers are not recorded or entered.
  - In areas where occupancies are consistently high, observers can be instructed to record empty spaces rather than occupied spaces. This will speed up observations.
  - Each form page should include space to note the presence of illegally parked vehicles in each segment of street and their exact locations.

Date:			Segment code:			Vehicle type:		Illegal parking observations:					Data collector:		
	Times of observations (start times)														
Space codes	18:00	18:15	18:30	18:45	19:00	19:15	19:30	19:45	20:00	20:15	20:30	20:45	21:00	21:15	21:30
21															
22															
23															
24															

Fig. 92: *Part of a possible space-by-space occupancy survey form (in which occupied spaces are indicated by the observer) OR license plate survey (in which license plate numbers are entered by the observer).*

The segment-by-segment count option:

- Segment-by-segment counts are an option even if all spaces are marked.
- But the segment-by-segment approach is necessary when parking spaces are not marked (unless an accumulation count is feasible – see below).
- The basics of a segment-by-segment count form are:
  - Rows in the survey form correspond with particular segments of kerb, each with a unique numerical code.
  - There are columns for legally parked vehicles of various types and columns for illegally parked vehicles of the same types.
  - Each box includes a simple count of each vehicle type.

- If there is mixed parking so that diverse vehicle types may park on the same segment the calculation of occupancy is not straightforward. See below.
- Figure 93 shows an example of a survey form for a segment by segment count in a context with diverse vehicle types [41].
  - Specifics, such as the vehicle categories need to be adapted to suit your local context.
  - Notice that a systemic count of illegal parking is also included in the form.

The accumulation count option may be feasible in some cases:

- This approach involves monitoring vehicles arriving or departing a cordon around each parking segment of interest (or the whole area in a single cordon).
- An accumulation count requires continuous monitoring of every entry and exit of every segment in the survey. This is feasible if there are few segments and few entrances and exits.
- Accumulation counts miss small-scale variations in occupancy within each cordon.
- The basics of an accumulation count include:
  - A baseline count of vehicles already inside the cordon is needed. This is best done at the beginning. If done at the end of the survey there is a risk that the day's observations would be wasted if the baseline count cannot be done for some reason.
  - Every vehicle entering and leaving each access point is counted and the time noted.
  - It is then simple to calculate the accumulation of parked vehicles at each time.
  - Occupancy can then be calculated if the capacity has been measured.

[41] This form was adapted from a sample via http://sti-india-ut-toolkit.adb.org/mod4/se5/003.html (Last updated 2008) in Padeco Co. Ltd., 'Module 4: Guidelines for Parking Measures: Policy and Options', in 'Guidelines and Toolkits for Urban Transport Development in Medium Sized Cities in India' (Manila: Asian Development Bank, 2008).

Date:		Segment code:		Kerb length of segment:		Car equivalent spaces in segment:			Data collector:
	Legally parked				Illegally parked				Other stopping activity (loading, double parking, etc.). Note type and number.
Times	Car or small van (<5.5 m)	Motor-cycle	Truck or van (>5.5 m)	Others	Car or small van	Motor-cycle	Truck or van (>5.5 m)	Others	
12:00									
12:15									
12:30									
12:45									
13:00									
13:15									

Fig. 93: *Part of a possible form for a segment-by-segment occupancy survey for an area with mixed parking and no marked parking spaces; The observer indicates the number of each vehicle type in the relevant boxes.*

- As usual, this is simple if each cordon has only one vehicle type but is more complex for mixed parking (see below).

- When are accumulation counts used?
  - They are most often suited to off-street facilities with limited access points.
  - Can only be used if it is possible to gain access for a complete baseline count of all vehicles inside the cordon.
  - The accumulation approach is also feasible for routine real-time occupancy monitoring of off-street facilities in which entry and exit is reliably monitored via the normal access control system.
  - They provide a more precise picture across time than manual space-by-space or segment-by-segment counts. In most on-street studies, spatial variations are more important to measure than very short-term time variations.

Occupancy calculations for mixed vehicle parking:

- If different vehicle types, such as cars and motorcycles, have separate and designated spaces or areas then it is simple for a space-by-space occupancy count to obtain separate occupancy rates for each vehicle type.
  - In some cases, an informal allocation emerges of separate sections of kerb space for cars, motorcycles and sometimes other kinds of vehicles.
  - If these sections are relatively stable then the capacity estimates and occupancy calculations can proceed as if these sections are formal.
- ***Difficulty arises if vehicles with diverse sizes, such as cars and motorcycles, intermix in less predictable ways, as they do in some cities.***
- This is closely linked with the problem of calculating capacities that was discussed in Section 7.2 for inventories.
- ***The obvious approach is to calculate a 'car-equivalent occupancy'***, although there is currently no widespread or standard method for this situation.
  - Each segment has a parking capacity expressed as car-equivalent spaces (lengths of kerb at least 5.5 m long for example).
  - The occupancy survey then yields a count of all vehicles of all types parked in each segment at the time of each observation sweep.
  - This count is converted into a 'car-equivalents count' to allow calculation of the 'car-equivalent occupancy' which is simply the number of car equivalents divided by the car-equivalent capacity.
  - ***This conversion should not use PCU (passenger car equivalent) values***, which are intended for traffic capacity calculations not parking space consumption.
  - Instead make careful observations of the number of vehicles of each type that can park in a car space under local conditions. For example, if local practice fits 6 motorcycles at full-capacity into a typical parallel car space of 5.5 m (or 5 m perhaps depending on local conditions), then each motorcycle counted should contribute 1/6 towards the 'car-equivalents count'. These assumptions should be stated explicitly when presenting such data.
  - Car-equivalent occupancy data provides useful information and allows simple communication and mapping of the occupancy situation.
  - However, it also glosses over the diversity of vehicle types. Therefore, in mixed parking contexts always present car-equivalent occupancy data together with information on the proportions of vehicle types that were present in each segment. Otherwise, the information on occupancies may be misleading.

Occupancy survey results lend themselves to mapping:

- Mapping occupancies helps guide parking management decision making of course.
- Occupancy maps play an important role in the design of the zones for the 'occupancy targeting with simple zones' approach to price setting (Section 5.5).
- ***Cities should also consider publicising such maps, which might be thought of as 'parking stress maps'.***
  - Such maps may help relevant actors in the city take better account of parking.
  - In the process, these actors may help ease the problem. For example, car-owning households seeking to move house may avoid residential locations with severe night-time parking stress. Valet parking entrepreneurs will spot opportunities in entertainment and restaurant districts with parking stress. And so on.
  - Such maps should help inform public debate over potential parking management efforts and why they are needed at certain places and times and not others.

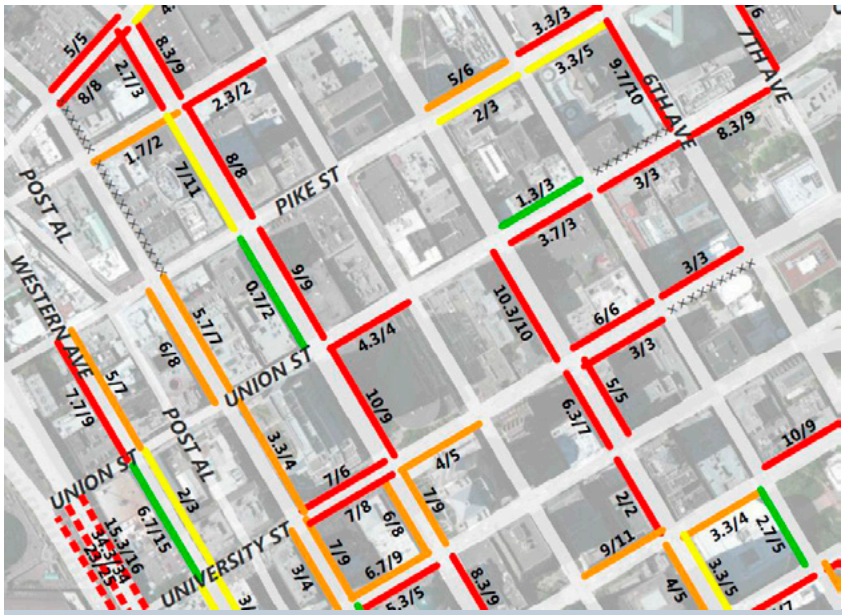

Fig. 94: *Mapped results of an occupancy survey of on-street parking in part of Seattle's commercial core on a weekday in 2013.* © Sightline Institute — Image from a report by Seattle's Department of Transportation is via the Sightline Institute, http://daily.sightline.org/2013/09/27/theres-a-place-for-us

Occupancy measurement when there is rampant illegal parking:

- Standard occupancy survey methods include counts of illegal parking. Illegally parked vehicles are included in the numerator of the occupancy calculation.
  - Occupancy figures well above 100% alert us to both high occupancy in legal spaces AND a problem with illegal parking.
  - However, we cannot assume that high levels of illegal parking will automatically show up as occupancy rates higher than 100%.
  - In certain situations, illegal parking can be significant even when the occupancy in legal spaces is very low. In such cases, a measured occupancy rate of 50% (say) would seem fine and would not automatically flag the illegal parking problem.
- Therefore, if illegal parking is significant then explicit data on illegal parking should always be presented together with occupancy survey results.
- Occupancy rates are only unambiguous if presented together with information on the prevalence of illegal parking.

Can we describe the occupancy of segments that have NO legal parking at all but nevertheless have substantial illegal parking?

- Occasionally, we find street segments that have significant amounts of illegal parking but no legal on-street spaces at all.
- The standard occupancy rate would be infinity!
- Yet, it would be useful to have a measure akin to occupancy to describe progress in parking management at such locations. Such progress might be either by legalising some spaces or by deterring the illegal parking.
- This can be achieved by adapting the approach used on streets with legal unmarked parking. In other words, measure the number of illegally parked vehicles per parking space length (5.5 m say) of kerb space.
- ***This can be called 'occupancy of illegal spaces'.***
- This measure gives numbers equivalent to the occupancy rates that would be obtained if all such kerb parking was legal.
- But be careful not cause confusion with legal space occupancies. Make sure these rates are carefully highlighted as 'occupancy of illegal spaces'. Do not combine these numbers with real occupancy rates. And if

mapped, the occupancies of illegal spaces will need a special colour scheme.
- Despite such risk of confusion, data on occupancy of illegal spaces allows useful comparisons and monitoring of progress in the battle against illegal parking.

7.4 Additional data via license plate data collection

License place surveys are more costly and time consuming than inventories or occupancy surveys. However, they provide more detailed information on parking behaviour.

There are several important reasons to conduct a license plate survey:
- Insight into parking durations is the most important and common reason to do such a survey.
- The related variable of turnover is also often of interest but should not be over-emphasised (see Box 26).
- This kind of survey is also sometimes used to examine the parking behaviour of different groups of parking users, such as local residents, employees in the area, and shoppers. These groups can usually be identified by characteristic patterns of arrival and departure.

Because the standard license plate survey method is resource intensive, it should only be carried out if the data is really needed to make key parking management decisions. The intensity of the survey should be the minimum necessary to answer the relevant questions.

The basic idea of a license plate survey involves multiple observations over the course of a day of each parking space, recording the license plate numbers of the vehicles parked there.
- This enables analysis of which vehicles remain parked between each pair of sweeps.
- It provides a lower and upper bound for the duration (length of time) that each recorded vehicle was parked there.
- The more frequent the observations, the more precise the duration estimates. Some surveys have passes as often as once every 15 minutes. This enables duration estimates that are accurate enough for most purposes.
- For some purposes and if costs need to be kept low, one pass every 2 hours may be sufficient. For example, this would be enough if the objective was to identify how many vehicles remain for longer than 4 hours.
- License plate surveys can raise privacy concerns and it is important to follow protocols to prevent the misuse or theft of potentially identifying parking data. Commonly, only the final four digits of each license plate is recorded. This also speeds up data entry.

Preparations for license plate parking surveys are similar to space-by-space occupancy surveys or segment-by-segment occupancy surveys
- The usual method is to collect the data manually by teams of data collectors on foot, using paper forms. In some cases (if parking orientation allows it) video cameras mounted on vehicles may be practical and

Box 26: Has turnover data been over-emphasized in the past?

Sections 5.5 and 5.8 cast doubt on the past emphasis on turnover as a parking management objective and as a price setting criterion.

Turnover does help stakeholders who need to ensure parking for short-term visitors is available.

But managing with a narrow focus on turnover is often ineffective when demand is high. Achieving high turnover does not necessarily prevent saturated parking and its side-effects.

Turnover monitoring usually requires costly license plate surveys. Digital pricing mechanisms can provide turnover data too but a turnover focus often prompts reliance on time-limits not pricing.

Turnover data can also be misleading in the context of low occupancies. When occupancies are high, the turnover of a space is roughly the inverse of the parking duration. However, with low occupancies, the connection between turnover and durations breaks down.

If reducing the incidence of long-duration parking is a key parking management goal for a street, then it would be better to focus directly on durations data. This is easier to understand and interpret and has a clearer connection with the goal than turnover.

can reduce the labour needed. In either case, data entry will be time consuming.

- Survey forms usually look similar to space-by-space or segment-by segment occupancy forms but with space enough for license plate information to be entered.
- If there are marked spaces, rows in the form represent each space, with columns for each survey sweep of the study area (Figure 92).
- If spaces are not marked, then rows in the survey form will usually represent approximate vehicle spaces. To reduce errors the form may need space to note adjacent landmarks.
- If spaces are not marked AND a mix of vehicle types with diverse sizes are present, then each row in the form will need to match a short section of street between landmarks, and will need enough space to insert the licence plate numbers of all vehicles in that short section. This complicates data entry but is manageable if the street sections are short.

Other (lower cost) license plate or duration data capture can sometimes be used:

- If License Plate Recognition (LPR) technology is part of the enforcement process, it may be possible to 'piggyback' a useful license plate survey on routine enforcement, or on an enforcement routine that is temporarily modified to enable such data collection.
- Sensors and some smart parking meters also routinely yield accurate parking duration information, at least in the legal or priced spaces, without obtaining license plate data.
- Digital pricing mechanisms often provide an ongoing real-time data stream on parking durations (and often license plates if needed for other kinds of analysis) but only during priced hours and only for vehicles complying with the pricing.

Use a time-space perspective on durations to gain insight on how much of a problem long-duration parking may be:

- Parking studies often quote the ***average duration*** for parking at various locations. This can be useful but it hides additional important information.
- For example, on a shopping street an average duration of only 30 minutes might look excellent. Perhaps 20% of vehicles may still be staying for more than 4 hours. However, this long-duration 20% will be occupying a startling proportion of 'space hours' so that at any particular time, a large proportion of the vehicles in parking spaces will be long duration parking. The time-space perspective [42] would reveal this problem.
- ***The time-space perspective reveals the proportion of parking spaces taken by vehicles in different ranges of parking duration.***

[42] Eric C. Bruun and Vukan R. Vuchic, 'Time-Area Concept: Development, Meaning and Application, *Transportation Research Record* 1499 (Washington D.C.: TRB, 1995), 95-104.

Table 16: Time-space perspective on parking durations in on-street parking in central Palembang, Indonesia

	Distribution of parking durations					Distribution of Time-Weighted Durations (percentage of occupied space hours used by each duration)				
Location	≤ 1hr	1≤ 2hr	2≤3hr	3≤4hr	≥4 hr	≤ 1hr	1≤ 2hr	2≤3hr	3≤4hr	≥4 hr
C	82%	7%	4%	2%	5%	42%	11%	9%	6%	**32%**
H1	72%	8%	8%	3%	8%	28%	10%	16%	8%	**39%**
D	72%	12%	2%	0%	14%	26%	13%	3%	0%	**59%**
J1	47%	15%	12%	0%	27%	10%	9%	13%	0%	**68%**
G1	44%	6%	13%	3%	35%	8%	3%	11%	3%	**74%**
L	13%	21%	9%	16%	40%	2%	9%	7%	16%	**67%**

- Start with license plate survey data. Create a table showing (for each segment of street) the frequency of each range of durations. This table shows how many vehicles in each segment park for less than 30 minutes, 30 minutes to one hour, one to two hours, two to three hours, three to four hours, etc.
- Then add another set of columns with the average duration of each duration range. The mid-point of each range is good enough and use a conservative estimate for the average duration of the longest, open-ended range (for example, 5 hours is a conservative estimate for average duration of a 'more than 4 hours' duration range).
- In a further set of columns enter the products of multiplying the number of vehicles in each duration range by the average duration for that range.
- Then in a final set of columns, express these numbers as a percentage of their sum total. These final columns provide the 'time-space' perspective by showing percentages of parking 'space hours' occupied by each duration range.

- In the examples below, notice that long-stay vehicles occupy a significant percentage of the occupied parking 'space hours' even at locations where long-stay vehicles are a rather modest percentage of vehicles recorded (location D is especially striking).

7.5 Other kinds of parking data

In addition to the main kinds of parking data above, some studies include others, such as:

- ***Stakeholder views on the problem*** (what kind, when, where) via interviews, survey, focus groups or workshops;
- ***Surveys of mode of access to an area*** (usually focused on customers, employees). These gauge the relative importance of parking in access to a location. A common finding is that car-based access is less important, that parking supply is less crucial, and that parking management is more beneficial to local businesses than most business people thought;
- ***Parking user surveys*** (often as intercept surveys with various possible objectives);
- ***Parking search traffic observations or surveys***. For example, in a busy area with saturated parking, it may be important to estimate the proportion of vehicles in the traffic flow that are actually searching ('cruising') for parking at different times of the week or daytime. A simple approach is an intercept survey of motorists stopped at traffic signals in the area [43], who can be asked a single question, "Are you looking for parking in this area right now"?

7.6 Evaluating parking management changes or pilots

Parking management initiatives need to be monitored and evaluated against their objectives. Parking data collection and analysis is an important part of this. Good examples include evaluations by ITDP of early Ecoparq pilots in Mexico City and the evaluations in San Francisco of the SFPark pilot.

The evaluation of a parking management change often involves simple before-after comparisons. For small changes with immediate effects, this may be adequate for assessing the impacts of a parking change.

However, for complex initiatives that take time to reach fruition, a before-and-after comparison will often not be adequate and the findings may be misleading.

- Cities are complex, with many variables changing constantly.
- Any particular change in outcomes may be the result of something other than the parking change that we are interested in.
- In other words, confounding variables may interfere with evaluation.

Pilots areas with controls areas are one response to this problem.

- It is best to pilot any significant parking management initiative in a limited pilot area.
- The results in such a pilot area can be compared with events in a matching 'control' area, where the change does not take place.
- The word 'control' here is in the scientific sense, such as a drug investigation in which a control group gets a placebo, not the drug being studied.

[43] Transportation Alternatives, 'No Vacancy: Park Slope's Parking Problem And How to Fix It', (New York City: Transportation Alternatives, Feb. 2007). Via http://transalt.org/sites/default/files/news/reports/novacancy.pdf.

- The most important comparisons are differences between pilot areas and control areas, NOT comparing before and after in the pilot areas.
- Changes in the pilot areas that are absent from the controls or are much more pronounced than in the controls, or in the opposite direction from the controls, are probably the result of the policy change (if the changes are statistically significant).
- Without the control areas we cannot be fully confident that such a change would not have occurred even in the absence of our policies.
- This need for control areas is probably especially important in rapidly changing cities or cities where vehicle ownership and use are increasing quickly. Unfortunately, this kind of careful evaluation is rarely done in such cities.
- The official evaluation of San Francisco's SFPark pilot provides a good example of the use of matched control areas, whose trends can be compared with the pilot areas for the price-setting trial [44].
- Take care that there are no influences of parking management in the control areas. This could emerge if a control area is too close to a pilot area and parking demand is relocated from one area to the other.
- A survey of parking conditions in adjacent areas is necessary to get information about the relocation of parking demand and emerging problems there.

[44] SFMTA, *SFpark Pilot Evaluation*

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Published by
Deutsche Gesellschaft für
Internationale Zusammenarbeit (GIZ) GmbH

Registered offices
GIZ Bonn and Eschborn, Germany

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Design and layout
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Photo credits
Cover photo © Paul Barter, Kathmandu, Nepal

As of
March 2016

GIZ is responsible for the content of this publication.

On behalf of
Federal Ministry for Economic Cooperation and Development (BMZ)
Division Water; Urban development; Transport

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