

# Operation Concept and Mode Selection Design of Public Parking Lot

Ge Yan<sup>1,\*</sup>

<sup>1</sup> Department of Transportation, Chongqing Jiaotong University, CO 40074, China

\* Corresponding author: Ge Yan (Email: 3219144034@qq.com)

**Abstract:** With the continuous improvement of urban economic development and modernization, the number of motor vehicles has shown a sharp increase in recent years. At the same time, the construction of public parking lots is very backward, and parking spaces are seriously insufficient, leading to increasingly serious problems, such as urban traffic congestion and insufficient parking spaces. The management mode of public parking lot is backward, which is not conducive to the improvement of parking efficiency and may have a negative impact on traffic. This paper mainly analyzes the difference in the management concept of public parking places for social vehicles, and then investigates and analyzes the reasons for poor management and lagging construction of public parking places, and puts forward suggestions to improve the current public parking places.

**Keywords:** Public parking lot, Toll parking lot, Free parking lot, Business philosophy, Mode selection.

## 1. Introduction

Due to the rapid development of motor vehicles, not only the road load is seriously aggravated, but also traffic congestion and other problems are caused. At the same time, the parking facilities are not enough, and the problems of disorderly parking and illegal parking also follow. Due to the chaos of public parking places, the charging cannot be combined with the local actual situation. The areas without charging can be parked at will and used as their own parking spaces. On the contrary, the charging in some areas is outrageous, resulting in few parked vehicles, which seriously occupies and wastes social resources. In addition, the state has clearly stipulated the policies of "increasing parking fee policy, giving full play to the role of price leverage" and "improving the construction and development environment of public parking facilities". Therefore, it is of great significance to select and design the management concept and mode of public vehicle parking places for the effective use of social resources, the promotion of smooth traffic and the promotion of economic development.

With the increasing attention to public car parks in urban social car associations, domestic and foreign experts and scholars are gradually deepening their research on public car parks, and relevant research results are constantly proposed. Wang Li ying[1] Identifies loopholes in the operational management of public car parks in mainstream cities in China. Six personal perspectives are put forward to enable public car parks to achieve maximum efficiency within a limited space. Zheng Shi yuan[2] The planning of the rate and scale of public car parks, and the establishment of a parking rate optimisation model. Huang Wei[3] et al. optimised the scale of public car park supply by considering the competition between public car parks. Dai Ji feng et al.[4] The study investigated and made recommendations on important technical issues such as the classification and functional layout of parking facilities in the planning stage, the construction and management of public car parks in the operation stage, and the dominant position of the market.

Foreign research on public parking has been involved for a

long time and has been successful in many Western countries. Foreign scholars have found many ways to manage public parking operations. For example, parking fees when public parking management companies and private parking management companies co-exist is discussed by Tsai[5] Button[6] Button uses neoclassical economic methods and economic analysis to model the game of 'optimal' and 'sub-optimal' parking charges.

## 2. Public Car Parks Status of Operation and Problems

### 2.1. Free public car parks lead to management confusion

As mentioned above, the current free public car parks are very confusing. The purpose of the free car parks is to allow car owners to park for a short period of time, but at present not only is there no parking space available, but traffic is also very chaotic, with illegal parking and scuffles between cars being a common occurrence. What's more, the free parking spaces funded by the government are not profitable at all, resulting in no one being willing to manage them, and parking recklessly, occupying the streets and parking too densely is a common occurrence.

Therefore changes must be made accordingly, and as they are funded by the government, there are no other excessive costs. The government could have contracted out those free car parks or free parking spaces on the streets to individuals and let them run them independently. This would not only increase the government's revenue and not waste social resources. And individuals only need to pay a portion of the cost to get the right to operate the car park, if the operation is good income is very considerable. In this way, social resources are put to good use, and with management, parking spaces will no longer be occupied for as long as before, and will not be as chaotic as before.

### 2.2. Uneven geographical distribution of car park construction scale

With the rapid development in recent years, cars have

become more and more common, and the same parking spaces have become more and more tight. The government has indeed taken practical action to build many new public car parks every year, which has indeed alleviated the problem of parking difficulties, but it has not really taken into account the actual situation of each place.

In this regard, when building new public car parks in the future, full consideration should be given to the local parking demand, not just adding more car parks without considering the real actual demand. For areas with a shortage of parking spaces and a high demand for parking, the number of parking spaces can be increased appropriately or the number of car parks can be increased, while for places with a relatively small demand for parking, the amount of parking spaces can be reduced appropriately and more space can be used elsewhere.

### 2.3. Backward management system for public car park operation

There are obvious shortcomings in the current parking management structure of public car parks and in guiding the operational trade activities between parking demanders and car park suppliers, in order to facilitate the continuous improvement of the public car park system. However, the improvement may involve many parts and can very well start with one hair and move the whole body, so it is necessary to determine a detailed route map, carefully analyse the current situation of parking management and achieve the overall optimisation of the public parking operation system. Thus laying a good foundation for future consideration of the choice of car park operation fee model.

### 2.4. Complexity of public car park pricing preparation

The current pricing system has been developed so that people can use it as a starting point for reference. Parking fees will be implemented by dividing areas into three levels of three standards. The aim is to achieve a balance in parking demand through price leverage, but in practice the complexity of costs and the diversity of charges is really unavoidable and something that has to be addressed. The coexistence of various charging prices, especially when the prices are obviously close but vary greatly, may cause dissatisfaction and complaints from the public, and may even lead to questions about the regulations related to parking fees, and finally go back to the relevant government departments to complain. The purpose of the price system is to ensure the stable development of the public parking market, which defeats the original purpose.

## 3. Selection and Optimisation of Public Car Park Models

### 3.1. Parking rates in public car parks

Public parking spaces usually have different utilisation rates during peak and peak periods, with a relatively large difference in utilisation uplands. In order to ensure that parking spaces are utilised and to reduce the number of unused parking spaces, the charging scheme needs to be split over time. Therefore, we need to calculate the base charge for public parking.

Based on  $m$  vehicles,  $n=24h$ , to ensure an average of  $m/n$  vehicle trips per parking space per day, the average parking

time is  $t=1/\mu h$ . By  $P_{24}(t)=(P_0/24!)(\lambda/\mu)^{24}$  and

$$P_0 = \left[ \sum_{j=0}^{24} \frac{1}{j} \left( \frac{\lambda}{\mu} \right)^j \right]^{-1}$$

one can find  $t=1/\mu$ . As  $t=1/\mu$

increases,  $P_{24}(t)$  also increases, and for this reason, one follows the increase of  $P_{24}(t)$  with time  $t$  for  $P_{24}(1/\mu)$ . The corresponding stopping time period is determined by the multiplier, i.e. the time at which the segmental doubling charge is applied. The time slots for segmented billing are:  $2P_{24}(1/\mu)$ ;  $3P_{24}(1/\mu)$ ;  $4P_{24}(1/\mu)$ ;  $5P_{24}(1/\mu)$ ; ..... Thus, a segmented charging scheme can be obtained. The day is divided into five periods: morning peak, morning flat, afternoon peak, afternoon flat and evening peak, and different weights  $\alpha_1, \alpha_2, \alpha_3, \alpha_4$  and  $\alpha_5$  are assigned respectively.

The data obtained from the survey can be calculated to show that the difference in charges between the five periods in public car parks is not too great, but there are indeed areas where it is not reasonable. This may not be so significant in the case of paid public car parks. At most, it is a question of more or less revenue. But for those free car parks that are contracted out to individuals in the future, it provides a price worth taking into account. If you don't have a very reasonable price, it will have a significant impact on your profitability.

### 3.2. Choice of parking fee models for public car parks

The most direct relationship between how well a public car park operates and how badly it is run is the car park charges. This is not only related to whether the car park can operate normally, but also a consideration of the cost of travel. From the perspective of domestic and international parking fee models, I have four suggestions for public parking fee models.

#### 3.2.1. Differentiated fee model

The principle of differential pricing is that the price charged on working days is higher than the price charged on non-working days, the price charged during the day is higher than the price charged at night, the price charged for small private cars is higher than the price charged for large trucks, the price charged during traffic congestion is higher than the price charged during smooth traffic flow, etc.

This model is indeed very practical, but it is not applicable to all cities, because some cities are not particularly developed economically, there are not particularly many vehicles and even many public car parks are not parked, so the division into peak and non-peak hours and weekdays and non-weekdays is only applicable to some cities, if all of them are used, it may cause a waste of social resources in public car parks.

#### 3.2.2. Progressive settlement model

The progressive billing strategy is based on the length of time a social vehicle is parked and sets a differential rate. This means that the parking fee increases continuously as the parking time becomes longer. The aim is to limit vehicle parking over a long period of time, thereby increasing the turnover of parking spaces. Both large cities such as Shanghai and other smaller cities are beginning to use this charging model gradually.

#### 3.2.3. Free mode for a limited time

This model is designed to encourage car owners to park for as short a time as possible and give up their spaces to people who need them more urgently, thus increasing the turnover of parking spaces and not taking up too much of the community's

resources.

### 3.2.4. Hourly rate model

This charging model is suitable for those who have been using the public car park for some time. It is certainly very uneconomical to charge according to the previous charging model, so it is recommended to choose the packaged time.

Public car parks in some locations in some cities do offer packaged hours, especially those where spaces are usually vacant, and this model is really worth trying.

### 3.2.5. Factors influencing the charging model

Not all of these charging models are applicable in all cities, and there are several main factors influencing the choice of model for charging through the survey. The first is the environmental factor, which is the perceived environmental conditions in which the city is located, the most significant of which are road congestion and the level of public transport. There is a positive relationship between road congestion and the amount of parking. If public transport is well developed, the opposite is true: less driving. The relationship between car parking charges and the two is the same. The next factor is the market. The high cost of parking services will lead to confusion in the charging model, the level of parking demand and supply will determine the level of the model, and the difficulty of parking will influence the judgement and choice of the car owner on the charging model. In addition, the parker's factor, the first is the length of parking, parking time is too long to reduce the turnover rate of parking spaces, resulting in parking difficulties, in this case the charging model needs to make corresponding changes to guide owners not to park too long. The price of parking is then tolerated. The sensitivity of car owners to charges is now gradually decreasing and tolerance is increasing, so the charging model in Chongqing needs to be changed accordingly to accommodate this change in tolerance. Finally, there is the government factor. The management level of a car park determines the upper and lower limits of the charging model, so the charging model must match the specific management level of a car park. Government policies and regulations must be reasonable, and whatever the car park, the charging model must meet the requirements of government policies and regulations before it can be used.

Regardless of the public car park, a combination of these models must be used to maximise the benefits of car park charges.

## 3.3. Car park parking operation model options

### 3.3.1. Choice of operating models for private enterprises in public car parks

General open-air parking investment scale is not too big, but if it is a three-dimensional type and so on public parking investment is larger, want to achieve the recovery period generally to 8 years or more, if added to other costs may be more than 13 years, but the general real estate only need about 2 years, now the public parking revenue in the city construction is not particularly advantageous, so must choose the right business model, the following proposed three operation mode for public parking reference.

#### (1). Government investment-commissioning model

This model means that the car park is funded by the government, and after the car park is completed, the car park is given to a private company to operate and manage by way of a signed contract as the person in charge of the car

park project. However, there is no free lunch in the world, and the operator of the car park must hand over all the proceeds to the government, and the government will give part of the proceeds to the operator according to the contract signed. There are several features of this model for public car parks.

(1) See results in the short term.

(2) Significant government funding is required.

(3) Because the car park is not directly managed by the government, it may make control inadequate.

(4) It is a little too costly for the city to operate and may not be as efficient to manage.

(5) Suitable for small cities where public car parks are beginning to be built.

#### (2). Government-enterprise investment and business model

This mode of operation involves transferring the right to operate and use state land to the asset management department without compensation, and the asset management department and the private enterprise using the asset as a link between the two to set up a company together, first leasing the right to use the land to the asset management department, and then financing it with the private enterprise. When operating, the revenue obtained must first offset the cost of financing, and after all costs are accounted for, the final revenue is then distributed in proportion to the investment to ensure fairness. For public car parks this model has the following characteristics.

(1) It is a joint-stock company with the government and private enterprises forming the main body of investment.

(2) The government does not require capital investment for the construction of public car parks.

(3) Both the government and the private enterprise profit together, but the private enterprise has to bear the initial risk.

(4) The cost of land saved can significantly reduce the cost of urban investment enterprises.

(5) The cooperation between government and enterprises is conducive to the future progressive advancement of the public parking market in the future.

#### (3). Separate investment business model for enterprises

This business model refers to a proven business model for public car parks that allows private companies to be the sole owner of a public car park, fully funded and completely independent. The model has several features.

(1) The Government no longer needs to invest in the project, easing the financial pressure.

(2) Private enterprises operate independently on their own, making the operation of public car parks more scientific.

(3) The solution to problems can be more flexible and free from government constraints.

(4) Private enterprises may charge fees indiscriminately in pursuit of profit, making them unreasonable.

(5) Companies often locate their car parks in the city centre, which may cause traffic problems.

At present, although public car parks are developing rapidly and present a flourishing scene, they are still in their infancy. Investment funds are lacking, land is insufficient and parking problems are becoming more and more prominent and acute. Therefore, I propose to divide the development of public car parks into three stages from now to later, namely the preliminary stage, the rectification stage and the full-scale

industrialisation stage, corresponding to the use of different approaches in different periods.

**Table 1.** operation mode selection of public parking lot

<b>Business model/phase type</b>	<b>Preliminary stage</b>	<b>Rectification phase</b>	<b>Full industrialisation phase</b>
<b>Government investment-commissioning model</b>	Primary mode	Secondary mode	Assist mode
<b>Government-enterprise investment and business model</b>	Secondary mode	Primary mode	Secondary mode
<b>Business model with separate investment</b>	Assist mode	Assist mode	Primary mode

Although public car parks are currently gaining momentum, they are still in the early stages of public parking operations. A good market environment is essential if the car park is to reach the final stage of full industrialisation. So it is necessary for the government to make changes and play a leading role. As the government continues to pay attention, the introduction of various preferential policies is inevitable, prompting the car park to formalise. However, at present, the parking business itself is a public welfare industry with a long payback period and little profit, so the government must take the lead in subsidising the current car parks and has the responsibility to formulate corresponding management regulations and incentives, so as to guide and promote the construction of car parks. The government should also support the construction of new car parks in terms of taxation, so as to increase the enthusiasm of the private sector to operate the car parks, and drive the reform of the car park market through its own guiding role, thus laying a solid foundation for the final full-scale industrialisation.

**3.3.2. Private business model options for public car parks**

The three business models above are all ways of cooperation between the government and larger private enterprises, but at present and even in the future the main body operating the car park is still the majority of individuals, so the following three options for future private business models of public car parks are described.

(1). Government delegation to private operators

Many individuals in the initial stage of operating public car parks, is a lack of funds, contacts, and relationships, so I suggest that in the initial stage of the car park operation to choose the government authorized operation, the municipal government will entrust the car park to the private operation, the private need to operate and manage the car park but all the earnings need to be paid to get part of the profit. This will largely reduce your financial pressure and lay the foundation for your future business expansion, and you won't have to bear any business risk, it's all borne by the government. However, the government's mandate focuses on management improvements to the car park, and although there will be profits, they are not as high as one would expect, and the government will usually add a large number of clauses to the terms and conditions for the trustee to make management improvements, which is, frankly, for management reasons rather than for profit. The operator therefore has less decision making power over the operation and even less independence over the financial management. Therefore this type of business is only recommended for operators who are new to car park operations and have weak financial resources.

(2). Individual contracting

When the individual is more mature or has sufficient funds, priority can be given to contracting. A contract is signed with a company to run the business on its own, at its own risk and with its own profit and loss. The purpose of contracting is the

purpose of the car park operator: to achieve the project's profit target. The advantages are clear: the operator has greater operational discretion over the operation of the car park, can decide on a business strategy based on the specifics of the market, and does not need to surrender the proceeds of the benefit, so can obtain greater profits than if it were authorised. However, at the same time, the operator must comply with the relevant contractual agreements, and if there are any breaches or problems, these risks must be borne by him or her, and sometimes they are very high. However, in general, it is much more profitable to operate a car park under contract than to operate under a government mandate. So I personally feel that this is the mid-term stage of private car park operation, and also to lay the foundation for self-employment in the future.

(3). Self-employed

Personally, I think the purpose of privately run car parks is to reach the final stage of self-employment. Self-employment originally meant that the producer would run his own product, whereas self-employment in the case of public car parks means that the private sector would run its own car park. This requires a lot of capital to invest and support, and the return on investment is relatively the greatest. Self-employment has the greatest autonomy and the flexibility to adjust the business situation at any time according to consumer groups and seasons. It is possible to provide the most suitable price and quality of service for the area, taking into account the owners' needs. If the operation to the later stage can completely build their own brand and team, if possible to do the entire Chongqing city chain or even the national chain, as long as the business philosophy and the correct way are achievable. And self-operated in is a wider choice of aspects, not necessarily confined to the urban area, the future goal can be put on top of the township, the main goal of the current car park in the urban area more but other areas of the car park in the future must be a new hot spot. Of course, there are also problems with independent management, first of all, the need to use too much money, the need for their own strength or long-term accumulation, followed by this kind of business risk is also the biggest, once the wrong step the end result may be a loss of money, so must be well planned. Finally, because the business is their own investment so many places must exist irregularities, these are the future independent business needs to pay attention to. But there is one thing that can't be denied, in the future of Chongqing private operation of public parking, independent operation must be the ultimate goal of private operation, only to achieve independent operation to achieve the maximum revenue of the car park.

A revenue analysis chart was made for the three approaches to privately operated car parks.

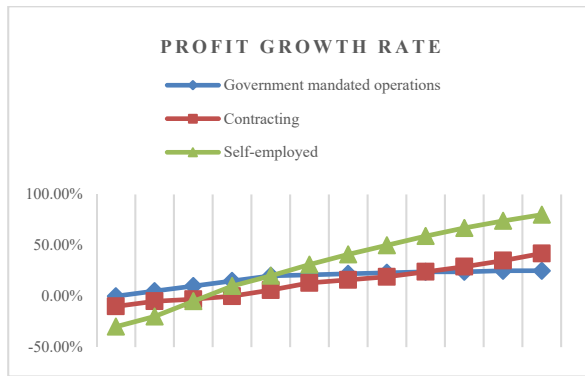


Figure 1. profit growth rate

## 4. Conclusion

With the rapid development of motor vehicles, the supply of public parking facilities is far outstripping the increase in the number of motor vehicles, and parking difficulties will become an increasingly common problem in cities. Combined with the actual situation of the city, the scientific and effective management and operation of the existing public car parks will maximise the effectiveness of the limited space of the public car parks and maximise the revenue. Actively promote

the healthy and orderly development of car parks, so that they can embark on the road of industrialisation.

## References

- [1] Y. Wang, "Analysis and countermeasures of public parking management in large and medium-sized cities, "[J]. Journal of Liaoning Police College,2011,13(03):55-58.
- [2] S. Y. Zheng, "Parking fee and scale optimization in public car parks with incomplete information," [J]. Journal of Transportation Engineering, 2010, 10(05):81-89.
- [3] W Huang, D Chen, X H Li, "A scale optimization model for public car parks considering competitive relationships, "[J]. Traffic and Transportation(AcademicEdition),2015(01):34-37.
- [4] J F Dai, J F Wang, Y Zhang, "Reflections on the economic attributes of public car parks, "[J]. Urban Transportation, 2017, 15(04):80-83.
- [5] F T Jyh, "Chih-Peng Chu, Economic analysis of collecting parking fees by a private firm," Transportation Research Part A: Policy and Practice, Volume 40, Issue 8,2006.
- [6] B Kenneth, "The political economy of parking charges in the "first" and "second-best" worlds," Transport Policy, Volume 13, Issue 6,2016,Pages 470-478.