

Parking allocations and Pricing Strategies of Two-stage Optimization Models for Makung Airport

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Abstract: Increasing private car and residents traveling frequently, the demand for airport parking increasing, parking fee is so cheap cause parking lots to be very congested at the weekend and holidays. This study will applied a two-stage optimization model are applied to evaluate parking pricing strategies, the first stage model is to meet the goal of maximum passengers' number and consider each parking demand distributions of stay length types and airport parking capacity constraints. The second stage model is to minimize costs of the pricing objectives, and to consider the airport parking operation to meet the basic cost/revenue benefits of affiliated parking lots. The application Lingo software simulates different parking fees to analyzing different pricing cost/profits of parking spaces, through sensitivity cost-benefit analysis of each charge program, and to further evaluate the possible options to recommend possible management strategies for different diversity charge under staying length days and weekday and weekend.

Key words: Airport Parking Pricing, Passenger Parking Behavior, Parking Management Strategies, Mathematics Model

1. INTROUCTION

Recent world all airports increase in non-aeronautical revenue to be useful sources of finance main airport such as 26% airport non-aeronautical revenue of US airport parking revenue Makung airport source is aeronautical revenue not non-aeronautical revenue for airline revenue is not much 102 annual income of yuan employee parking is 404,100 yuan. The parking outsourcing business premium income 2,368,000 yuan (accounting for 7.13% of all the airport's premium income sources), both total revenue are 2,772,100 yuan only 2.30% of the 120,639,833 yuan. As the Government increasingly heavy financial burden, the airport operator has become a mainstream trend of self-financing, in addition to traditional aviation airport revenue gains Makung airport real need to increase non-aeronautical revenues or open up new sources of income in order to activate the airport operating performance. Table 1 shows the site to collect the domestic airport site parking standards derived data compilation,

we found that the domestic airport parking charges and the level of service is closely related to the extent to which the amount of passengers the airport and near the airport urbanization, each airport has free preferential parking for 30 minutes, 1 hour mostly basic service rates, more than one hour after the number of passengers Taoyuan international Airport and Kaohsiung international Airport to the airport every half hour for the standard are subject to 15 to 20 yuan, Chiayi Airport Tainan Airport is more than one hour after each additional 10 hours to 30 yuan, Matsuyama airport close to the city is taken sharp, off-peak pricing principle peak (at 08-21) received 40 yuan, off-peak (day 21 - when the next day 08) 10 yuan, to encourage community residents use nearby parking facilities. Compare suburban Taichung Airport also is 30 yuan per hour, as Hualien, Taitung and Kinmen is 20 per hour. Only Makung airport parking also maintains the number of calculations by the standard, a lot cheaper compared to other airport charges, unless the traveler is a short stay over 30 minutes less than two hours, fairly priced hourly fee. Parking Makung airport pick up the car the same day \$ 30, pick up the car the next day and then increased by only 30 yuan, only 60 dollars. Such as automobile can run 12 kilometers a liter, 1 liter of oil costs about 33 dollars, when the car stay at the airport 1-11 days, by the city center to the airport (10 km) car oil money to return to the airport parking fees tend to aggregate Enter the money to take a taxi than 400 yuan cheaper. Thus, their baggage are not easily travel, and the fee of cheap parking for residents really value for money. The problem is when the residents are concentrated on weekends, when the day use parking lots Makung airport subsidiary, will result in Makung airport parking space excess demand problems. To solve this excess demand and increase profitability parking, Makung airport real need to discuss the current subsidiary parking spaces fees and pricing.

Thus, the US private car broaden the popularity and convenience of the airport and the highway connecting the airport, public transportation is not developed, only a number of major airports such as Atlanta Airport, New York JFK, O'Hare Airport, San Francisco Airport only subway, MRT and buses and other public transportation systems, according to the American transportation Research Institute aboard private passenger transport with preference to the airport (transportation Research Board 2009). Penghu also have well-developed highway system ground, so Makung airport at the time of elaboration airport charging system should fly the substitution ratios of residents or travelers with transport and transport between having to provide more passengers fly yuan choices and services provided, as to how the parking rate structure can be suppressed fly passengers directly to the airport by car, select a different operation to achieve the goal of a carpool or take public transit is indeed not easy. Many studies have pointed out that unless there is public transport improved considerably space or supporting measures (Mei-Ling Tam, William HKLam, Hing-Po Lo, 2012; Lucy Budd, Stephen Ison, Thomas Budd, 2013), or the passengers still prefer private transport the vehicle. The highest rate of using public transportations is in Hong Kong Chek Lap Kok

Airport, which provides ground transit passengers fast and convenient households (hotels or major cities stronghold) service. Therefore, the elaboration of this study with the parking system could explore how to respond to the proposed short-term shortage of airport parking space situation, how to develop different rates, and to manage the distribution of residents using the airport parking time and space to achieve maximum efficiency, services to most users. As long-term planning or supporting measures and to provide planning, transportation and other related tools of transparency have parking information. Even long-term planning must consider whether to build a second car park to cater to the needs of travelers and improve the airport non-aeronautical revenue sources, but also the future Makung airport major project must review the overall direction.

Table 1 Car parking fee of domestic airport (Taiwan dollars)

Airport	Charge standard (Free charge in half hour)	Day charge upper bound	Motorcycle charge	Month ticket of car parking	Service time
Taoyuan International	30/hour, over one hour increase 20/half hour	490	-	1200	24 hours
Kaohsiung International	30/hour, over one hour increase 15/half hour	240	-	3000 Employee:600	-
Songshan	40/peak hours,10/off hours	-	20/time	-	24 hours
Taichung	30/hour	150	20/day	-	-
Tainan	20/hour, over one hour increase 30/half hour	240	-	-	07:00~19:15
Makung	30/time,30/day	-	Free	-	-
Kinmen	20/hour	200	20/day	700	07:00~19:00
Chiayi	20/hour, over one hour increase 10/half hour	100	20/time	1200 Employee:600	06:30~19:30
Hualien	20/hour	-	Free	-	Auto machine
Taitung	20/hour	200	Free	-	-

Furthermore, when the airport to raise parking rates, guests may not want to pay for parking chaos, at the same time, attention must also begin near the airport management and its residents might start operating parking space rental or valet parking, resulting in passenger safety or produce derivative regional transportation issues. Such as the UK airport parking charges higher one day about 10.75 pounds (more than the number of days to stay low rates) to 39.75 pounds (valet parking) range, the British also prefer to take a private transport to the airport (Thomas Budd, stephen Ison, Tim Ryley, 2011), such as the UK Manchester airport passengers 60% of passengers using private transport tools, usually by relatives and friends, pick-up or car to the airport, private transportation with use of the airport and get off lane no more than 10 minutes of temporary parking is only paid £ 1 to 1.61 yuan, but often cause

airport congestion problems. Since 2008 the British began to virtual network services Parking Rental rise of the market (Lucy Budd, Stephen Ison, Thomas Budd, 2013), according to Brown University, UK Budd et al British survey fly passengers using virtual Parking Rental Internet trading platform Availability is very popular and popular for yourparkingspace.co.uk, park_uk.com, and parkatmyhouse.com three largest virtual trading platform to provide network parking rental Bed parking fly passengers, the United Kingdom found that the supply of 25 houses near the airport car park Gai Weite to London (Gatwick), Heathrow (Heathrow), Manchester, Birmingham, Southampton and other airports outside there are more than 82-137 parking Bed and Breakfast offers 199-445 parking spaces and services, which provides bit London Gai Weite Bed and Breakfast has 2,179 parking a passenger, there are 2,268 parking Sisters B & B travelers. Parking fee day is about 5.1 pounds, seven days about 26.65 pounds, equivalent to half the cost of airport parking and valet parking service and thoughtful. It is also necessary to catch up Makung airport parking convenience phone or online parking reservation system services.

911 major airports in the event of impact have strengthened intelligence security system (Leone and Liu 2005; Gkritza et al 2006;. Yoo and Choi 2006; Salter 2007), so that the quality of airport services, no longer limited to the standard of service of the airport facilities measure, recent scholars pay more attention to planning airport facility should meet the demand of tourists (Macario 2010), not only the Terminal facilities standard of service upgrade, even guest parking, parking time, how to improve the added value guest parking (such as valet parking), how to provide passengers need complementary services (such as car park there are other restaurants or shopping), guidance systems parking space, parking non-cash transaction services, security and facilities maintenance services and increase revenue strategies are based passenger service point of view to meet the information needs of passengers and airport services planning project growing (Transportation Research Board 2010; 2012). US Department of Transportation had elaboration learn how to increase non-aviation airport parking revenue service providers, large airports have short and long term sub-customer charges, credit card charges, private parking around the airport to provide airport valet parking, airport Real Time Flight Data app free download, usage and other instant messaging provides airport parking measures is particularly important, how to enhance passenger terminal parking service quality, but Makung airport authorities to be one of the topics DMC attention and management.

In view of the foregoing foreign airports emphasis on real-time information for the convenience of passengers and importance, recalling airport travelers with transport problems faced by domestic and international airports, passenger transport preferences with congestion problems generated by the high cost of airport parking rates are rental parking spaces lead to the emerging Internet industry and local residents did not pass the security check parking spaces. In this study, the current airport parking space attached to the use of demand

management, conduct research Makung airport parking bit attached charging system to control the growth of the number of parking. In addition to the content of the case study attached to forecast demand for parking outside the airport, and to review the existing parking facilities planning, elaboration of different users of the parking period of use, pricing strategies and the use of space fare and investigate different time travelers parking charges Information and advice acceptance, elaboration and evaluation of the relevance of the airport parking fee charging system to inhibit the growth of the number of parking and as a reference for future Makung airport to handle the parking.

Therefore, this study will consider parking pricing strategies must consider factors such as airport parking service value, service costs, resident affordability and acceptance, and parking demand management. Therefore, this study will measure passenger parking behavior to generate parking pricing strategies to meet the parking economic efficiency of cost recovery, the equity of the society, the convenience of management and coordination. In order to realize the passenger different staying days patterns and the number of vehicles parking distributions in a week, the parking arrival/departure data in year 2014 at Makung airport was applied to estimate behavior relationship function between passenger parking staying days and travel days during weekday and weekend to discuss the parking allocation efficiency. Therefore, the this study will applied mathematics model to study the optimal pricing for different staying length parking suggests that parking traveler efficient use of parking space and parking fee. A two-stage optimization model are applied to evaluate parking pricing strategies, the first stage model is to simulate the best service level and meet the goal of maximum passengers utilities at weekend and weekday, to consider each parking demand distributions of stay length types and airport parking capacity constraints. The second stage model is to maintain the service level of the first stage operation, to minimize costs of the pricing objectives, and to consider the airport parking operation to meet the basic cost/revenue benefits of affiliated parking lots. The different parking restrictions of airport ground / underground car parking number, the constraints of airport operating costs, and other limiting factors. The application Lingo software simulates different parking fees to analyzing different pricing cost/profits of parking spaces, through sensitivity cost-benefit analysis of each charge program, and to further evaluate the possible options to recommend possible management strategies for different diversity charge under staying length days and weekday and weekend.

2. THE CAR PARKING CHARGE OF DOMESTIC AND INTERNATIONAL AIRPORT

Recalling the airport parking system at home and abroad, including the pricing method (cost pricing, pricing method income, profit pricing method, etc.), different types of vehicles (including locomotives) short-term, long-term parking hours, on weekends, holidays and

general day parking rates, the use of time (days or weeks of sharp tip off peak off-peak) way ticket service, booking reservations and parking information application using airport parking information, and other related services.

Airports Council International in 2013 economic report noted that in 2012 the world's only non-aeronautical revenue sources related to retail concession revenues accounted for up to 29% of the first rent to income and revenue Airport Parking airport property and real estate each about 20% car rental licensing revenue accounted for 7%, only 5% of food and beverage revenue, 4% of advertising revenue trends, and statistics 168 airports in Asia Pacific total revenues of 31,600 million dollars yuan, accounting for 27% of the world's income, only inferior to Europe, and the total revenue of aeronautical and non-aeronautical millions of dollars are all 15,800 yuan. Total non-aeronautical revenue items in the Asia-Pacific airports, retail concession revenues up 44.5% accounted for the first, real estate rental income accounted for 23.1% ranked second, airport parking revenue occupies 10.6% ranked third, lesser income ratio as advertising revenues accounted for 4.9%, 4.9% food and beverage revenue stations, car rental licensing revenue accounted for 1.8%. These data show that non-aeronautical revenue sources booming Asia-Pacific airports facility and commercial opportunities. World airports operating non-aeronautical revenue trends also provide the future management strategies of Makung airport parking, in addition to resolving the two-day weekend insufficient parking capacity issues or continuous holiday, it can also appropriate to adjust the airport parking toll rate to increase airport operations income.

Since the supply and demand characteristics of the airport parking lot different from the general enterprise, and therefore belong in the public utilities rates on considerations must develop characteristics of transportation and social justice and so on. Therefore, this section will review the pricing theory, the factors taken into account pricing, domestic and international parking rate structure to facilitate the construction of this study parking rate regime. Common pricing such as the maximum profit pricing, Ba Moer pricing, average cost pricing, marginal cost pricing, Leimu Xi (second best) pricing theory, differential pricing method, the cost plus method, ROI and business law gross profit method. Pricing advantages and disadvantages of the various methods are described in Table 2, the so-called differential pricing refers to a homogeneous product or service according to different markets and consumer and take a different price. This method uses the three basic conditions for the market, namely manufacturers have exclusive power, manufacturers have the ability to market segmentation and each product can not be resold small market demand and various small markets different elasticity. Therefore, domestic government airports attached carpark planning and various segments of the short-term and long-term parking and employee parking services, parking fees are generally a differentiated pricing method, pricing provide different service levels to improve parking use efficiency, reduce service costs are assessed for each parking space. In order to avoid the implementation of differential pricing caused by popular

opposition, the price development also reflect the basic operating income and service the needs of users as the main parking pricing objectives. Therefore, the present study also will depend on a variety of pricing and conception through the resident questionnaire investigation and optimization mathematical model to assess the adequacy of the parking fee program.

Table 2 The benefits and shortages of each pricing approach

Pricing	Benefits	Shortage
The maximum profit pricing	corporate profit-oriented	Price is too high to use the small amount of the minimum social welfare
Ba Moer pricing	the characteristics of public service	How much profit is at least reasonably possible only controversial
Average cost pricing	Balance of payments in line with price stability	The lack of efficiency of resource allocation, huge capital and operating cost recovery is not easy
Marginal cost pricing	Make the most effective use of resources and the largest social welfare	Industry losses and may require government subsidies, the practice difficult to implement
Lei Muxi pricing	Both users and industry revenue income, and the largest social welfare	For difficult to estimate the elasticity of demand and the marginal cost of cross-elasticity of the same characteristics contrary to public utilities
Differential pricing method	lift and increase facility energy usage, reduce per unit volume of the share of fixed costs	Easy to cause public opposition is more difficult to implement, more difficult to set prices and can lead to controversy
Cost plus method	Obviate the fixed asset valuation, the price calculation is simple, it can be controlled between industry expenditures, revenues and earnings Relations	Fixed investment costs can not be reduced to reflect the industry's willingness to invest, can not accurately estimate the return on investment, the industry is based on the interests of high fares are often overstated the cost of motivation
ROI method	clear tariff adjustment to reflect the capital increase in the willingness to invest in the industry	Fixed assets is not easy to assess
Operating margin method	Simplify the tariff review process, eliminating cost sharing common problems and improve the credibility of information on the cost and improve the industry's larger operating flexibility, timeliness strengthen reflect operating costs, facilitate the implementation of differential pricing, subsidies to facilitate consideration of the job	Reasonable calculation of the Function may be controversial

Public parking rate pricing purposes generally must consider the economic efficiency of pricing, cost recovery, the equity of the society, to facilitate the management and coordination of. Factor in the pricing of the process that must be considered include airport parking service value, farm machine service costs, residents parking of affordability, competition for parking, the demand Makung airport reasonable remuneration and service policies and residents of flexibility and acceptance of local residents. Taiwan airports generally charges There are three main ways, namely metering, timing or count days (times) three ways, and the ratio of the rate system, packet rate system and uniform mixing rate pricing system. Meanwhile, the transit of Makung airport as the bus service is not close to the people, the only city of Makung airport bus trips a day back and forth a total of 23 classes, every 1-2 hours departure from the Makung, few flights per day Airport Last bus near Makung back at 18:00, the bus will take no luggage or large resident who lives in the bus stay. To residents of other towns by bus must transfer to Makung City, very convenient, almost on their own car or call a taxi or shuttle relatives. Thus, over the years Makung airport charges are taken into account is the total time day and very inexpensive fee arrangement to serve residents parking use, but also take up the service of private transport with parking job.

3 .THE RELATIONSHIP BETWEEN PARKING DAYS AND OCCUPYING DAYS AT WEEKDAYS/WEEKENDS

In this study, for the benefit of the discussion of per management strategies, and a different number of parking days for travelers may cause insufficient parking capacity and parking problems. Therefore, this study is the relationship will analyze the number of parking distribution on each day and parking pattern of day length, further clarify stay days and difference relation between weekday and weekend. Table 3 May 31 Days Daily Days patterns for a variety of travel-size correlation coefficient daily parking demand nuance, stay clear understanding of the amount of days will affect the number of parking daily amount, which stay four days and three days to stay the daily total parking demand the greatest impact, the correlation coefficients were 0.875 and 0.831, the subsequent impact on the total demand for daily parking lesser order, is suspended for five days, stayping for two days, stayping seven days , stay for six days, stayping for two days, closed for one day and stayed within 30 minutes. However, the daily from Monday to Friday only Sunday's parking all on demand, the correlation coefficient was 0.469. At the same time, the parking number on Monday and Tuesday, their parking number of travel patterns is not significantly affect the number of days. Wednesday, its' parking number only for a day to have an impact on the number of patterns, and the correlation coefficient was 0.394. Thursday, the number of parking on the residence for five days, six days have an impact on the number of patterns, and the correlation

coefficients were 0.597 and 0.587. The number of parking on Friday to stay three, four have an impact on the number of patterns, and the correlation coefficients were 0.696 and 0.562. The number of parking on Saturday for a day or two days have an impact on the number of patterns, and the correlation coefficients were -0.530 and 0.493, show a smaller number of parking Saturday closed for one day more stay for two days. The number of parking on Sunday for a day to have an impact on patterns, and the correlation coefficients were -0.494, showing the number of parking less closed for one day on Sunday.

Table 3 the correlated coefficient of the relation between parking demand and parking patterns of every day on May

Coefficient	Parking 0 day	Parking 1day	Parking 2 days	Parking 3 days	Parking 4 days	Parking 5 days	Parking 6 days	Parking 7 days	Over 7days
Number of every day parking	.356(*)	.370(*)	.488(**)	.831(**)	.875(**)	.600(**)	.396(*)	.459(**)	.259
Monday	.244	.144	-.079	-.180	-.188	-.088	-.154	.092	.178
Tuesday	-.130	.248	-.055	-.222	-.214	-.171	-.180	.159	.082
Wednesday	-.058	.394(*)	-.071	-.149	-.241	.050	-.233	.092	.082
Thursday	.114	.147	-.040	-.144	.287	.597(**)	.587(**)	-.092	.057
Friday	-.030	.115	-.111	.696(**)	.562(**)	.082	.011	.029	-.266
Saturday	-.279	-.530(**)	.493(**)	.136	-.049	-.232	-.277	-.031	-.002
Sunday	.158	-.494(**)	-.171	-.203	-.235	-.281	.215	-.241	-.111
Parking 0day	1	-.001	.054	.166	.187	.198	.564(**)	.500(**)	.289
Parking 1day	-.001	1	-.006	.043	.174	.311	-.050	.125	.170
Parking 2day	.054	-.006	1	.364(*)	.215	.071	-.048	.343	.207
Parking 3day	.166	.043	.364(*)	1	.784(**)	.241	.110	.268	-.023
Parking 4day	.187	.174	.215	.784(**)	1	.647(**)	.521(**)	.182	.106
Parking 5day	.198	.311	.071	.241	.647(**)	1	.608(**)	.379(*)	.289
Parking 6day	.564(**)	-.050	-.048	.110	.521(**)	.608(**)	1	.221	.164
Parking 7day	.500(**)	.125	.343	.268	.182	.379(*)	.221	1	.409(*)
Over 7day	.289	.170	.207	-.023	.106	.289	.164	.409(*)	1

* Represents under the level of significance is $\alpha = 0.05$ (two tails), we accept Pearson correlation coefficient

** Represents under the level of significance is $\alpha = 0.01$ (two tails), we accept Pearson correlation coefficient

Table 3 the correlated coefficient of the relation between parking demand and parking patterns of every day on May (continue)

Coefficient	Number of every day parking	Monday parking	Tuesday parking	Wednesday parking	Thursday parking	Friday parking	Saturday parking	Sunday parking
Number of every day parking	1	-.094	-.151	-.058	.169	.469(**)	-.056	-.337
Monday parking	-.094	1	-.148	-.148	-.169	-.169	-.169	-.148
Tuesday parking	-.151	-.148	1	-.148	-.169	-.169	-.169	-.148
Wednesday parking	-.058	-.148	-.148	1	-.169	-.169	-.169	-.148
Thursday parking	.169	-.169	-.169	-.169	1	-.192	-.192	-.169
Friday parking	.469(**)	-.169	-.169	-.169	-.192	1	-.192	-.169
Saturday parking	-.056	-.169	-.169	-.169	-.192	-.192	1	-.169
Sunday parking	-.337	-.148	-.148	-.148	-.169	-.169	-.169	1
Parking 0day	.356(*)	.244	-.130	-.058	.114	-.030	-.279	.158
Parking 1day	.370(*)	.144	.248	.394(*)	.147	.115	-.530(**)	-.494(**)
Parking 2day	.488(**)	-.079	-.055	-.071	-.040	-.111	.493(**)	-.171
Parking 3day	.831(**)	-.180	-.222	-.149	-.144	.696(**)	.136	-.203
Parking 4day	.875(**)	-.188	-.214	-.241	.287	.562(**)	-.049	-.235
Parking 5day	.600(**)	-.088	-.171	.050	.597(**)	.082	-.232	-.281
Parking 6day	.396(*)	-.154	-.180	-.233	.587(**)	.011	-.277	.215
Parking 7day	.459(**)	.092	.159	.092	-.092	.029	-.031	-.241
Over 7day	.259	.178	.082	.082	.057	-.266	-.002	-.111

* Represents under the level of significance is $\alpha = 0.05$ (two tails), we accept Pearson correlation coefficient

** Represents under the level of significance is $\alpha = 0.01$ (two tails), we accept Pearson correlation coefficient

This paper collect the data of 31 days on May , the number of stay days various patterns of correlation coefficient of the size of the daily demand for parking, stay clear understanding of the amount of days will affect the amount of the number of daily parking, this study is the use of regression analysis Construction May every day of reckoning various needs several days parking patterns, such as the function (1) and (2), where the regression fitness is better, but the constant term is not significant. Roughly seven days to stay, stay, stay for four days, five days to stay the number of within 30 minutes and stay two days parking patterns will affect the daily parking capacity are more than double the influence, as closed for one day and three-day stay parking type the number of states will affect the daily parking are less than the amount of influence doubled.

$$\hat{SCAR} = 67.909 + 3.042S_4 + 1.362S_2 \quad (1)$$

$$(t = 6.250)(11.183) (4.355) \quad R^2 = 0.861 \quad F=86.449 \quad N=31$$

$$\hat{SCAR} = 1.185 + 1.324S_0 + 0.960S_1 + 1.039S_2 + 0.837S_3 + 1.314S_4 + 1.074S_5 + 1.643S_7 \quad (2)$$

$$(t = 0.389)(12.946) (22.211) \quad (20.060) \quad (15.850) \quad (11.403) \quad (1.074) (2.736)$$

$$R^2 = 0.997 \quad F=1296.920 \quad N=31$$

\hat{SCAR} : Number of every day parking for different dwelling days

S_i : Number of dwelling days for demand of i type

4. THE CONSTRUCTION PARKING PRICING MODEL

Public parking rate pricing purposes generally must consider the economic efficiency of pricing, cost recovery, the equity of the society, to facilitate the management and coordination of. Therefore, parking pricing process must consider factors such as airport parking service value, farm machine service costs, acceptance residents parking of affordability, demand competition carpark, Makung airport reasonable remuneration and service policies and residents of flexibility and local residents . Secondly, this study will also apply mathematical models Construction optimal parking pricing model, in addition to construction of the appropriate airport parking target type, but will also consider the pricing level of different types of vehicles and different parking spaces, the limit airport ground / underground number of parking place airport operating costs and maintenance costs of the lowest profit and other limiting factors.

4.1 Conception and assumptions of model

Since the supply and demand characteristics of the airport parking lot different from the general enterprise, and therefore belong in the public utilities rates on considerations must develop characteristics of transportation and social justice and so on. Objective public car park is established in order to improve passenger convenience and not for profit, the more necessary to meet the target type human needs as the goal, to reach the airport passengers fly purposes, but also to consider the number of days each guest parking fees differences, in order to allocate space for parking used to achieve an equitable and efficient use, since the issue

involves changes in the number of days the amount of daily travel needs. Second, the limited capacity of the airport stands does not encourage long-term parking, or long-term parking spaces will be segments to facilitate airport operations management and increase non-aeronautical revenue. Guests can use other tools to run the airport, therefore, the present study suggests that long-term guest parking occupancy airport for too long, could easily lead to the airport in addition to the space turnover inconvenient to use, but also when there is insufficient airport capacity more easily to short-term parking traveler efficient use of space, therefore, the present study was to collect more fees for long-term parking.

4.2 Mode variables and parameter description

$SCAR_{i,j}$: Variable for number of Weekday/weekend i dwelling j days type

$Fare_{i,j}$: Charge standard variable of Weekday/weekend i dwelling j days type

$Park_i^0$: Number of weekday/weekend i dwelling j days type for constraints

$DCAR_{i,j}^{lowdemand}$: Demand parameters of weekday/weekend i dwelling j days type

$DCAR_{i,j}^{highdemand}$: Demand parameters of weekday/weekend i dwelling j days for the peak hours

Revenue⁰ : Parameters of week revenue for airport parking lot

$Fare_{i,j}^{lowbound}$: Standard parameter for i weekday/weekend parking

$Fare_{i,j}^{upperbound}$: Standard parameter for i weekday/weekend parking car

4.3 Construction of the two-stage optimization model

Collocation service is different from the optimum number of days a week with different travel needs of passengers and the number of vehicles parking fee pricing, the present study is the construction of a two-stage optimization mode, the first stage is to obtain the best service and meet the goal of most people to the same time, consider each entity day limit parking demand different types of distribution and airport parking capacity. The second stage is to maintain the standard of service the first phase of the operation, the pursuit of a different date passenger car to stay a few days the burden of cost minimization for this stage of the pricing objectives, and consider limiting the airport to meet the basic earnings of affiliated parking lot at present. Have the mode described as follows;

4.3.1 The first phase of the best mode

This phase mode system service and meet the overwhelming majority of human goals, so the Function (3) is the sum of different days daily parking demand, the total number of service showing greater efficiency in the use of the car parking, at the same time, taking into consideration daily physical limit parking demand different types of distribution and airport parking capacity. Function (4) compared with the various types of the total number of parking needs daily to stay the day to not be exceeding the total number of daily airport parking. Compared with Function (5) Priority needs of daily use of various types of use of the parking times, number of days that the stay of the less of a priority to meet the people, the more the more the number of days of non-stay no chance to stay, and to strengthen the airport's turnover and quality of service. Function (6) is the number of daily different parking types can't exceed the parking number of physical constraints for the daily parking spaces. Function (7) and (8) is the daily needs of a variety of different types of vehicles parking number is a positive integer variable settings.

$$\text{MAX} \sum_{i=1}^n \sum_{j=1}^m \text{SCAR}_{i,j} \quad (3)$$

s.t.

$$\sum_{j=1}^{m-1} \text{SCAR}_{i-1,j} + \sum_{j=1}^m \text{SCAR}_{i,j} \leq \text{Park}_i^0 \quad (4)$$

$$\text{SCAR}_{i,j} \geq \text{SCAR}_{i,j+1} \quad (5)$$

$$\text{SCAR}_{i,j} \leq \text{DCAR}_{i,j}^{\text{highdemand}} \quad (6)$$

$$\text{SCAR}_{i,j} \in \text{integer} \quad (7)$$

$$\text{SCAR}_{i,j} \geq 0 \quad (8)$$

4.3.2 The second phase of the best mode

This phase mode system service and meet the required burden of the cost of parking by the smaller the better goals, but also meet the operating costs of the parking lot, so the Function (9) is added to the total number of days of the week day different people parking fees, parking fees paid by parking the smaller the better, better able to meet the residents parking opinion, the best pursuit of different pricing date target cost burden on passengers to stay a few days to minimize the car, the current airport to meet and consider the subsidiary parking basic earnings limited parking in order to facilitate the operation of Function (10). Function (11) for the difference in the level of daily needs of a variety of different types of parking rates, the

number of days that the stay of the less the person parking fee, the lower, the more the more the number of days to stay the parking fee is higher. There is a height difference of Function (12) one week the daily parking fee, that is usually associated with a particular day has different holiday parking rates to encourage more parking weekdays, holiday periods and more use of other transport equipment. Function (13) is the different days of the week the daily parking fee at least stay people parking fee at the current manner. Function (14) is the different days of the week the daily parking fee can not stay people parking fee higher than the current way. Daily parking fee needs to strengthen the turnover rate and the quality of service the airport. Function (15) for the different days of the week daily parking stay people parking fee is a positive real number variables.

$$\text{MIN } \sum_{i=1}^n \sum_{j=1}^m \text{Fare}_{i,j} \times \text{SCAR}_{i,j} \quad (9)$$

s.t.

$$\sum_{i=1}^n \sum_{j=1}^m \text{Fare}_{i,j} \times \text{SCAR}_{i,j} \geq \text{Revenue}^0 \quad (10)$$

$$\text{Fare}_{i,j} \leq \text{Fare}_{i,j+1} \quad (11)$$

$$\text{Fare}_{i,j} \leq \text{Fare}_{i+1,j} \quad (12)$$

$$\text{Fare}_{i,j} \geq \text{Fare}_{i,j}^{\text{lowerbound}} \quad (13)$$

$$\text{Fare}_{i,j} \leq \text{Fare}_{i,j}^{\text{upperbound}} \quad (14)$$

$$\text{Fare}_{ij} \geq 0 \quad (15)$$

4.4 Examples of two-stage optimization pricing model analysis

Residents via the upper and lower limits of acceptable change fee, parking pricing adjustment foregoing mathematical model different lower limit, the application Lingo software to simulate different charge levels of profit or revenue targets and other vehicles on the degree of achievement of different levels and pricing of parking spaces, through sensitivity cost-benefit analysis of each program, and to further evaluate the possible options in order to recommend possible solutions.

4.4.1 The first stage of the number of vehicles parking

Since the survey showed that the majority of residents still pay per view mode is the most efficient way, this study is based on the first phase of the preceding model by solving the capacity problems and the more points of this year's May car park data capture May 5 to May 11 a week to stay a few days the number of parking as shown in table 4, and calculates the number of vehicles on the evening of May 4 has 25 stays two days on, 3 days of 10, stay there are five four days, stay for 5 days of three, there are 17 stays six days, seven days have 6 stay, stay more than 7 days have a total of 69 135, the number of vehicles serviced first stage of the largest Solution.

Table 4 Parking days of demand from 5 May to 11 May

Parking days	0 day	1day	2 days	3 days	4 days	5 days	6 days	7 days	Over 7days
Monday	17	50	33	20	8	10	1	3	7
Tuesday	14	72	37	16	5	6	4	5	6
Wednesday	15	69	24	21	10	7	2	2	8
Thursday	12	70	31	25	41	29	8	2	6
Friday	16	64	28	98	54	11	6	1	4
Saturday	7	31	52	41	24	7	2	2	4
Sunday	14	48	28	10	10	2	5	0	6

In this study, for the benefit of the discussion of pay-per-management strategies, and a different number of days stay travelers may cause insufficient parking capacity or have parking problems generated waste. Therefore, this study is designed 16 kinds of parking management strategy that gradually loosening restrictions Function (4) restrictions, such as limiting the number of days the priority short-term parking more than a day, more than two days parking restrictions, parking restrictions more than three days, more than four days parking restrictions restrict parking more than five days, six days or more parking restrictions, parking restrictions and does not limit the number of parking days more than seven days, eight kinds solved by LINGO software management strategy than one week parking optimal solution as shown in table 5, then table 6 proposes management strategies of optimal solution in table 5 of the subtraction can be obtained a number of demand management strategies might not serve, and then 16 strategies as shown in table 6.

Solving via LINGO software 16 kinds of management strategies target value in Table 5

of the total management strategy, the display does not limit the number of days to get the parking service vehicles up to a week, up to 1188. Moreover, 16 kinds of management strategies via LINGO software to solve the optimal solution as shown in Table 4, can count 16 kinds of demand management strategy in a week of daily use efficiency remaining parking grid, as shown in Table 5 more than three days to limit parking, parking restrictions more than four days, parking restrictions more than five days, six days or more parking restrictions, parking restrictions more than seven days and do not limit the number of days six kinds of parking management parking management strategy, on Friday, Saturday and will produce daily full stay the phenomenon, and no wasted parking grid. Another priority parking more than two days, more than a day priority parking management strategy will be on Saturday, will have to stay full day phenomenon, and no wasted parking grid, the above eight kinds of tactics so as not to limit the number of days parking services the maximum number of resident visitors also provides parking reference to the operating management strategy. The number of vehicles 16 Number of parking management strategies of a-week daily number of days for each type of parking optimal solution for its optimal configuration plus total generated Table 5 vehicle can be obtained daily parking optimal number of aggregate Table 7 are shown. At the same table can also be generated by 416 a-week parking management strategy of the park each day the number of days the number of types of vehicles that the total excess demand can be obtained over the number of daily parking demand, aggregate as shown in Table 8 . Then subtracting 481 Table 7 produced 16 kinds of one week parking management strategy of optimal daily amount of parking can be obtained in Table 9 one week minimum daily vacancy distribution. The resulting number of days parked vehicle in Table 5 . The 16 types of one week parking management strategy of the optimal solution for each day plus total deductions and the number of vehicles parked at day 0, Table 10 aggregate are shown.

The second phase of the 16 kinds of various management strategies of the optimal solution value generated by the aforementioned into the model of (9) to (15) to solve the application Lingo, Zoe Makung airport parking 102 passenger outsourcing business premium income 2,368,000 yuan, divided by 52 weeks for 45,538 yuan, or 45,538 yuan of weekly profit. The results of various revenue management strategies of priority Table 11 shows only the number of days of short-term parking management strategies and costs 30 yuan less than 45,538 yuan, and other 15 kinds of strategies are profitable than the current value, as shown in Table 12 to improve metering 40 yuan / times tables 13 and comprehensively improve the pay per 50 yuan / time, total time table 14 ground for 30 yuan / times to raise the total time underground is 40 yuan / time, table 15 meter ground-keeping 30 yuan / times to raise the total time underground is 50 yuan / times. Therefore, the proposed short-term parking (parking within five days) accounts for at least 84%, in order to solve Friday, Saturday, will have the situation when parking in Japan, but also receive higher benefits than the current non-aeronautical revenues, it is recommended to limit the use of four days more stay for

several days, the number of visitors to stay longer days to give up should be given a very high price, in order to let him choose other transport equipment replacement. And passengers abandoned because some revenue generated by several days long stay guests or visitors of all burden of the fee, plus the original cost to set out charging methods.

Table 7 16 management strategies of optimization parking number for each day

Management strategies	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday
First come, first served	256	296	302	383	481	481	302
Parking 7 day or more	249	289	287	368	479	481	300
Parking 30 minutes is better than parking one days	223	238	248	331	452	481	290
Parking 1 day is better than 2 days parking	255	295	301	382	481	481	320
Parking 2 day is better than 3 days parking	259	314	324	413	459	473	354
Parking 3 day is better than 4 days parking	249	300	304	369	388	370	281
Parking 4 day is better than 5 days parking	254	293	299	380	481	481	305
Parking 5 day is better than 6 days parking	254	293	299	380	481	481	305
Parking 6 day is better than 7 days parking	249	289	295	376	481	481	306
Constraint over 7days	249	289	287	368	479	481	300
Constraint over 6days	249	300	304	387	481	481	299
Constraint over 5days	250	302	304	387	481	481	295
Constraint over 4days	249	300	302	385	481	481	296
Constraint over 3days	248	299	301	362	475	481	309
Constraint over 2days	249	300	304	369	388	401	291
Constraint over 1days	249	300	304	369	388	370	281
Constraint over 30 minutes	197	214	233	247	265	231	167

Table 8 16 strategies of not parking distributions for overbooking in one week

Management strategies	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday	Number of overbooking
First come, first served	-3	-15	-4	-8	-18	-14	0	-62
Parking 7 days or more	-10	-15	-12	-8	-5	-12	-6	-68
Parking 30 minutes is better than parking one days	-36	-73	-58	-60	-53	-33	-34	-347
Parking 1 day is better than 2 days parking	-4	-15	-4	-8	-17	-21	0	-69
Parking 2 day is better than 3 days parking	0	0	0	0	-70	0	0	-70
Parking 3 day is better than 4 days parking	-10	-4	-6	-24	-99	-33	-9	-185
Parking 4 day is better than 5 days parking	-5	-16	-4	-8	-17	-15	0	-65
Parking 5 day is better than 6 days parking	-5	-16	-4	-8	-17	-15	0	-65
Parking 6 day is better than 7 days parking	-10	-15	-4	-8	-11	-14	0	-62
Constraint over 7days	-10	-15	-12	-8	-5	-12	-6	-68
Constraint over 6days	-10	-5	-6	-6	-22	-14	-6	-68
Constraint over 5days	-9	-3	-8	-6	-22	-14	-9	-71
Constraint over 4days	-10	-4	-8	-6	-22	-15	-9	-74
Constraint over 3days	-12	-4	-8	-28	-5	-9	-9	-74
Constraint over 2days	-10	-4	-6	-24	-99	-2	-9	-154
Constraint over 1days	-10	-4	-6	-24	-99	-33	-9	-185
Constraint over 30 minutes	-62	-88	-75	-136	-183	-122	-57	-726

Table 9 16 Strategies of empty parking distributions each day in one week

Management strategies	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday
First come, first served	225	185	179	98	0	0	179
Parking 7 days or more	232	192	194	113	2	0	181
Parking 30 minutes is better than parking one days	258	243	233	150	29	0	191
Parking 1 day is better than 2 days parking	226	186	180	99	0	0	161
Parking 2 day is better than 3 days parking	222	167	157	68	22	8	127
Parking 3 day is better than 4 days parking	232	181	177	112	93	111	200
Parking 4 day is better than 5 days parking	227	188	182	101	0	0	176
Parking 5 day is better than 6 days parking	227	188	182	101	0	0	176
Parking 6 day is better than 7 days parking	232	192	186	105	0	0	175
Constraint over 7days	232	192	194	113	2	0	181
Constraint over 6days	232	181	177	94	0	0	182
Constraint over 5days	231	179	177	94	0	0	186
Constraint over 4days	232	181	179	96	0	0	185
Constraint over 3days	233	182	180	119	6	0	173
Constraint over 2days	232	181	177	112	93	80	190
Constraint over 1days	232	181	177	112	93	111	200
Constraint over 30 minutes	284	267	248	234	216	250	314

Table 10 16 strategies of maximum parking distributions each day in one week

Management strategies	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday
First come, first served	239	282	287	371	465	477	288
Parking 7 days or more	232	275	272	356	463	481	286
Parking 30 minutes is better than parking one days	206	224	233	319	436	474	276
Parking 1 day is better than 2 days parking	238	281	286	370	465	474	306
Parking 2 day is better than 3 days parking	242	300	309	401	443	466	340
Parking 3 day is better than 4 days parking	232	286	289	357	372	363	267
Parking 4 day is better than 5 days parking	237	279	284	368	465	480	291
Parking 5 day is better than 6 days parking	237	279	284	368	465	480	291
Parking 6 day is better than 7 days parking	232	275	280	364	465	481	292
Constraint over 7days	232	275	272	356	463	481	286
Constraint over 6days	232	286	289	375	465	474	285
Constraint over 5days	233	288	289	375	465	481	281
Constraint over 4days	232	286	287	373	465	481	282
Constraint over 3days	231	285	286	350	459	481	295
Constraint over 2days	232	286	289	357	372	394	277
Constraint over 1days	232	286	289	357	372	363	267
Constraint over 30 minutes	180	200	218	235	249	224	153

4.4.2 Optimal pricing outcome of the second phase model

16 kinds of various management strategies of the optimal solution value generated by the aforementioned into the Function of (9) to (15) to solve the application Lingo, Zuo Makung airport parking 102 passenger outsourcing business premium income 2,368,000 yuan, divided by 52 weeks for 45,538 yuan, or 45,538 yuan of weekly profit. The results of various revenue management strategies of priority Table 11 shows only the number of days of short-term parking management strategies and costs 30 yuan less than 45,538 yuan, and other 15 kinds of strategies are profitable than the current value, as shown in Table 12 to improve metering 40 yuan / times tables 13 and comprehensively improve the pay per 50 yuan / time, total time table 14 ground for 30 yuan / times to raise the total time underground is 40 yuan / time, table 15 meter ground-keeping 30 yuan / times to raise the total time underground is 50 yuan / times. Therefore, the proposed short-term parking (parking within five days) accounts for at least 84%, in order to solve Friday, Saturday, will have the situation when parking in Japan, but also receive higher benefits than the current non-aeronautical revenues, it is recommended to limit the use of four days more stay for several days, the number of visitors to stay longer days to give up should be given a very high price, in order to let him choose other transport equipment replacement. And passengers abandoned because some revenue generated by several days long stay guests or visitors of all burden of the fee, plus the original cost to set out charging methods.

Table 11 Minimum parking revenue of 16 management strategies each day in one week
(30 dollars/one time)

Management strategies	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday	Total
First come, first served	7170	8460	8610	11130	13950	14310	8640	72270
Parking 7 days or more	6960	8250	8160	10680	13890	14430	8580	70950
Parking 30 minutes is better than parking one days	6180	6720	6990	9570	13080	14220	8280	65040
Parking 1 day is better than 2 days parking	7140	8430	8580	11100	13950	14220	9180	72600
Parking 2 day is better than 3 days parking	7260	9000	9270	12030	13290	13980	10200	75030
Parking 3 day is better than 4 days parking	6960	8580	8670	10710	11160	10890	8010	64980
Parking 4 day is better than 5 days parking	7110	8370	8520	11040	13950	14400	8730	72120
Parking 5 day is better than 6 days parking	7110	8370	8520	11040	13950	14400	8730	72120
Parking 6 day is better than 7 days parking	6960	8250	8400	10920	13950	14430	8760	71670
Constraint over 7days	6960	8250	8160	10680	13890	14430	8580	70950
Constraint over 6days	6960	8580	8670	11250	13950	14220	8550	72180
Constraint over 5days	6990	8640	8670	11250	13950	14430	8430	72360
Constraint over 4days	6960	8580	8610	11190	13950	14430	8460	72180
Constraint over 3days	6930	8550	8580	10500	13770	14430	8835	71595
Constraint over 2days	6960	8580	8670	10710	11160	11820	8310	66210
Constraint over 1days	6960	8580	8670	10710	11160	10890	8010	64980
Constraint over 30 minutes	5400	6000	6540	7050	7470	6720	4590	43770

Table 12 Minimum parking revenue of 16 management strategies each day in one week
(40 dollars/ one time)

Management strategies	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday	Total
First come, first served	9560	11280	11480	14840	18600	19080	11520	96360
Parking 7 days or more	9280	11000	10880	14240	18520	19240	11440	94600
Parking 30 minutes is better than parking one days	8240	8960	9320	12760	17440	18960	11040	86720
Parking 1 day is better than 2 days parking	9520	11240	11440	14800	18600	18960	12240	96800
Parking 2 day is better than 3 days parking	9680	12000	12360	16040	17720	18640	13600	100040
Parking 3 day is better than 4 days parking	9280	11440	11560	14280	14880	14520	10680	86640
Parking 4 day is better than 5 days parking	9480	11160	11360	14720	18600	19200	11640	96160
Parking 5 day is better than 6 days parking	9480	11160	11360	14720	18600	19200	11640	96160
Parking 6 day is better than 7 days parking	9280	11000	11200	14560	18600	19240	11680	95560
Constraint over 7days	9280	11000	10880	14240	18520	19240	11440	94600
Constraint over 6days	9280	11440	11560	15000	18600	18960	11400	96240
Constraint over 5days	9320	11520	11560	15000	18600	19240	11240	96480
Constraint over 4days	9280	11440	11480	14920	18600	19240	11280	96240
Constraint over 3days	9240	11400	11440	14000	18360	19240	11780	95460
Constraint over 2days	9280	11440	11560	14280	14880	15760	11080	88280
Constraint over 1days	9280	11440	11560	14280	14880	14520	10680	86640
Constraint over 30 minutes	7200	8000	8720	9400	9960	8960	6120	58360

Table 13 Minimum parking revenue of 16 management strategies each day in one week
(50 dollars/ one time)

Management strategies	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday	Total
First come, first served	11950	14100	14350	18550	23250	23850	14400	120450
Parking 7 days or more	11600	13750	13600	17800	23150	24050	14300	118250
Parking 30 minutes is better than parking one days	10300	11200	11650	15950	21800	23700	13800	108400
Parking 1 day is better than 2 days parking	11900	14050	14300	18500	23250	23700	15300	121000
Parking 2 day is better than 3 days parking	12100	15000	15450	20050	22150	23300	17000	125050
Parking 3 day is better than 4 days parking	11600	14300	14450	17850	18600	18150	13350	108300
Parking 4 day is better than 5 days parking	11850	13950	14200	18400	23250	24000	14550	120200
Parking 5 day is better than 6 days parking	11850	13950	14200	18400	23250	24000	14550	120200
Parking 6 day is better than 7 days parking	11600	13750	14000	18200	23250	24050	14600	119450
Constraint over 7days	11600	13750	13600	17800	23150	24050	14300	118250
Constraint over 6days	11600	14300	14450	18750	23250	23700	14250	120300
Constraint over 5days	11650	14400	14450	18750	23250	24050	14050	120600
Constraint over 4days	11600	14300	14350	18650	23250	24050	14100	120300
Constraint over 3days	11550	14250	14300	17500	22950	24050	14725	119325
Constraint over 2days	11600	14300	14450	17850	18600	19700	13850	110350
Constraint over 1days	11600	14300	14450	17850	18600	18150	13350	108300
Constraint over 30 minutes	9000	10000	10900	11750	12450	11200	7650	72950

Table 14 Parking revenue of 16 management strategies each day in one week (30 dollars/ one time of ground parking fee and 40 dollars/ one time of underground parking fee)

Management strategies	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday	Total
First come, first served	9190	10480	10630	13150	15970	16330	10660	86410
Parking 7 days or more	8980	10270	10180	12700	15910	16450	10600	85090
Parking 30 minutes is better than parking one days	8200	8740	9010	11590	15100	16240	10300	79180
Parking 1 day is better than 2 days parking	9160	10450	10600	13120	15970	16240	11200	86740
Parking 2 day is better than 3 days parking	9280	11020	11290	14050	15310	16000	12220	89170
Parking 3 day is better than 4 days parking	8980	10600	10690	12730	13180	12910	10030	79120
Parking 4 day is better than 5 days parking	9130	10390	10540	13060	15970	16420	10750	86260
Parking 5 day is better than 6 days parking	9130	10390	10540	13060	15970	16420	10750	86260
Parking 6 day is better than 7 days parking	8980	10270	10420	12940	15970	16450	10780	85810
Constraint over 7days	8980	10270	10180	12700	15910	16450	10600	85090
Constraint over 6days	8980	10600	10690	13270	15970	16240	10570	86320
Constraint over 5days	9010	10660	10690	13270	15970	16450	10450	86500
Constraint over 4days	8980	10600	10630	13210	15970	16450	10480	86320
Constraint over 3days	8950	10570	10600	12520	15790	16450	10855	85735
Constraint over 2days	8980	10600	10690	12730	13180	13840	10330	80350
Constraint over 1days	8980	10600	10690	12730	13180	12910	10030	79120
Constraint over 30 minutes	9190	10480	10630	13150	15970	16330	10660	86410

Table 15 Parking revenue of 16 management strategies each day in one week (30 dollars/ one time of ground parking fee and 50 dollars/ one time of underground parking fee)

Management strategies	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday	Total
First come, first served	11210	12500	12650	15170	17990	18350	12680	100550
Parking 7 days or more	11000	12290	12200	14720	17930	18470	12620	99230
Parking 30 minutes is better than parking one days	10220	10760	11030	13610	17120	18260	12320	93320
Parking 1 day is better than 2 days parking	11180	12470	12620	15140	17990	18260	13220	100880
Parking 2 day is better than 3 days parking	11300	13040	13310	16070	17330	18020	14240	103310
Parking 3 day is better than 4 days parking	11000	12620	12710	14750	15200	14930	12050	93260
Parking 4 day is better than 5 days parking	11150	12410	12560	15080	17990	18440	12770	100400
Parking 5 day is better than 6 days parking	11150	12410	12560	15080	17990	18440	12770	100400
Parking 6 day is better than 7 days parking	11000	12290	12440	14960	17990	18470	12800	99950
Constraint over 7days	11000	12290	12200	14720	17930	18470	12620	99230
Constraint over 6days	11000	12620	12710	15290	17990	18260	12590	100460
Constraint over 5days	11030	12680	12710	15290	17990	18470	12470	100640
Constraint over 4days	11000	12620	12650	15230	17990	18470	12500	100460
Constraint over 3days	10970	12590	12620	14540	17810	18470	12875	99875
Constraint over 2days	11000	12620	12710	14750	15200	15860	12350	94490
Constraint over 1days	11000	12620	12710	14750	15200	14930	12050	93260
Constraint over 30 minutes	9000	10000	10580	11090	11510	10760	7650	70590

5. THE BENEFIT EVALUATION AND SELECTION OF OPTIMAL PARKING CHARGE PROGRAMS

Finishing by the aforementioned two-stage optimization pricing models as shown in Table 16, can be found eight kinds of management policy enforcement. In order to solve the short-stay problem, five, six, will have the status of recommendations can be parked more than three days to limit the use of a parking strategy is the number of days to resolve Friday, Saturday, will have the situation when parking in Japanese. Resident passengers mainly to stay for a day or two the main difference between the amount of parking rate-setting should be increased by more than a few days is a daily need to count \$ 200, does not encourage long-term use of the car park as a private parking. If you want to increase the revenue adjustment costs may limit the number of parking days more than the usual four days of toll increases are relatively high profit status, but also difficult to produce the phenomenon of insufficient parking capacity, and reduce resident passengers rebound.

To encourage short stay several days, turnover increased airport parking initial recommendations to stay seven days of current total time (days) 30 yuan, 77,790 yuan count of weekly income is still higher than one week premium income of 45,538 yuan or improve each parking (days) 33-35 yuan is still up to one week with the current level of income of 83,790 yuan, or improve underground parking once (day) will exceed the current 50 yuan to 83,790 yuan in one week income level, more than seven days eighth day after day additional \$ 250, more than seven days of the 25 parking spaces, parking can be released within 7 days a shortage of parking demand excess, can also reduce the number of parking spaces on Friday and Saturday, not enough to stay the problem.

Secondly, in order to solve the general problem of Friday, not enough to stay may be further shortened to encourage short-term stays for several days, turnover increased airport parking generally recommend staying at the date five days of current total time (days) 30 yuan, the count of weekly income 75,270 yuan or parking will increase each time (days) 32-35 yuan is still up to one week with the current level of income of 83,790 yuan, or improve underground parking once (day) will exceed the current 50 yuan to 83,790 yuan income one week level, more than five days from the day additional 200 yuan sixth day, when resolves Friday, Saturday excess demand is not enough to stay the problems. Also can be Monday to Sunday 39 parking spaces more than the number of parked for six days, Friday and six parking spaces can be stay four days the number of days you can solve the problem of insufficient stay.

Even on the eve of the holiday travel days should be shortened, increasing the turnover rate of the airport, such as Sunday through Thursday recommend staying four days of current total time (days) 30 yuan, the count of weekly income or \$ 75,270 each will increase parking (days) up to 34-35 yuan is still one week with the current income level of \$ 83,790, or to

improve the underground parking time (days) will exceed the current 50 yuan to 83,790 yuan in one week income levels or four days more than the fifth day daily from additional 200 yuan, when resolves Friday, Saturday may have enough to stay the problem. Monday to Thursday but will lose 52 of parking spaces can be stay five days, Friday and 6 can be stay four days the number of parking spaces on Sundays can solve the problem of insufficient stay. There's 39 number of parking spaces can be stay more than six days can also create short-term demand for the release of the number of days. As the airport for short and long term parking are mixing operations and is not planning a long-term and short-term parking area separated bit more difficult to demonstrate management and short-term parking turnover rate, therefore, recommended that the future can be set up in the old terminal, or a small number of long-term parking underground parking setting a few long-term parking spaces, in order to increase non-aeronautical revenues increased airport.

Since coming weekend compensatory or at least four days in a row, may have exceeded the capacity of the additional parking demand, therefore, the present study suggests can be for Friday and Saturday in the three-day stay of current total time (days) 30 yuan, count of weekly received 72,870 yuan or improve each parking (days) up to 31-35 yuan is still one week with the current income level of \$ 83,790, or to improve the underground parking time (days) \$ 50 to more than 83,790 current income for one week yuan level, more than three days from the day the fourth day additional 200 yuan, you can stay more than four days on Friday to curb the number of days and when. But the four days that the stay loss of 58 parking spaces and stay for five days, from Monday to Thursday 28 to stay the loss of 52 can be stay five days the number of parking spaces.

Excess demand is currently for weekends or holidays in a row, the proposed short-term floating parking Sites continued to promote the management, on the ground in the parking lot channel does not interfere with any of the vehicles entering and leaving a parking space, security or turn straight, the parking configuration temporary floating grid , commissioned by the business administrator supervision parking lot parking place. If there is excess demand in the 62 May this year to 11 JCP week, the administrator will continue this week 62 cars were in a moderately supervise parking people be configured parking place, lined up on the ground at the parking lot side of the channel section, nor affect the safety of vehicles in and out of.

Table 16 The evaluation and assessment of different parking charge programming

Management strategies	Current service status	30dollars/one time	underground 40 dollars/one time e	underground 50 dollars/one time	40dollars/one time	50dollars/one time
First come, first served	-62	72270	86410	100550	96360	120450
7 days or more than the amount of parking	-68	70950	85090	99230	94600	118250
30 minutes a day is better than parking one days	-347	65040	79180	93320	86720	108400
1 day is better than 2 days parking	-69	72600	86740	100880	96800	121000
2 day is better than 3 days parking	-70	75030	89170	103310	100040	125050
3 day is better than 4 days parking	-185	64980	79120	93260	86640	108300
4 day is better than 5 days parking	-65	72120	86260	100400	96160	120200
5 day is better than 6 days parking	-65	72120	86260	100400	96160	120200
6 day is better than 7 days parking	-62	71670	85810	99950	95560	119450
Over 7days	-68	70950	85090	99230	94600	118250
Over 6days	-68	72180	86320	100460	96240	120300
Over 5days	-71	72360	86500	100640	96480	120600
Over 4days	-74	72180	86320	100460	96240	120300
Over 3days	-74	71595	85735	99875	95460	119325
Over 2days	-154	66210	80350	94490	88280	110350
Over 1days	-185	64980	79120	93260	86640	108300
Over 30 minutes	-726	43770	57180	70590	58360	72950

6. CONCLUSION AND SUGGESTION

Recalling this project to collect domestic and foreign airport parking fees and parking fees downtown Magong level data access to Makung airport parking parking statistics calendar month, and now use the Makung airport parking facility capacity and status conditions, push use of time and the amount of use of the parking lot of the estimated source, and that is reckoning income parking number of parking and to go beyond some of the basic amount of parking revenue, to discuss the feasibility of fee hike. In addition to the increase in passengers through the questionnaire limit the magnitude of fare acceptance givers, and construct optimal pricing mathematical model, simulation analysis on different days, at different times (days), ground and underground levels of profitability and charges to meet the maximum amount of passengers cost-benefit analysis and sensitivity analysis in the present research is more conducive to Makung airport parking fees set and parking ground, underground parking management strategy elaboration. Hereby present important research results as follows:

By the aforementioned study found that in August last year to July this year, 52 weeks, the number of passenger vehicle parked a few days for most types of vehicles parked one day accounted for 28.35 percent, followed by staying two days accounted for 19.14 percent, followed by stays in order, is 3 days accounted for 16.97 percent, staying four days have accounted for 11.52%, stay 0 days accounted for 7.48 percent, stay for 5 days accounted for 6.45%, or more stay seven days accounted for 4.10%, staying six days accounted for 3.67% and staying more than 7 days accounted for 2.32%. This year parked vehicle count for more than 7 days and 1 month has exceeded staying five days, staying six days and stay seven days type of parked vehicle number, and last year's 8 - more than 7 days of 6 months - the October and this year 1 the number of parked vehicles, has been suspended more than six days and seven days to stay the type of the number of vehicles parked, only last December 11 and parked the smallest ratios of more than 7 days.

Therefore, in this study the use of short-term priority parking for several days, priority parking more than seven days, six days or more priority parking, priority stay more than five days, more than four days priority parking, priority parking more than three days, more than two days priority parking, priority parking more than a day, parking restrictions more than a day, more than two days parking restrictions, parking restrictions more than three days, more than four days parking restrictions, parking restrictions more than five days, six days or more parking restrictions, parking restrictions more than seven days and not limit the number of days parking and other 16 kinds of parking management strategies , the display does not limit the number of days one week service vehicle parking gained the most, up to 1188. 16 kinds of management strategies use efficiency than one week remaining daily parking grid to limit

parking more than three days, more than four days parking restrictions, parking restrictions more than five days, six days or more parking restrictions, parking restrictions more than seven days and days without parking restrictions number six kinds of parking management policy management efficiency of the best, in Friday and Saturday, will have to stay full day phenomenon, and no wasted parking grid. Another priority parking more than two days, more than a day priority parking management strategies will be on Saturday, will produce full stay when the phenomenon of day, and no wasted parking grid, resident passengers above eight kinds of policies to stay a few days does not limit the maximum number of the service also available parking reference to the operating management strategy.

Residents generally are reluctant to increase passenger fares, charges related to adjustments to the number of short-term parking management priority policy days a week terms of premium income 45,538 yuan or 83,790 yuan at current operating income as income level assessment of 15 other strategies are compared one week return value is high, therefore. To encourage short stay several days, turnover increased airport parking initial recommendations in the park seven days of current total time (days) 30 yuan, or improve each parking (days) 33-35 yuan, or increase the underground parking time (days) 50 yuan, more than seven days from the eighth day closing day plus 250. A typical daily recommend staying five days of current total time (days) 30 yuan, or improve each parking (days) 32-35 yuan, or increase the underground parking time (days) 50 yuan, more than five days from the sixth day plus daily income of 200 yuan. Sunday to Thursday recommend staying four days of current total time (days) 30 yuan, or improve each parking (days) increase of 34-35 yuan or underground parking time (days) 50 yuan, more than four days fifth day plus a daily income of 200 yuan.

Next weekend or compensatory time off at least four days in a row, may generate additional demand exceeds the capacity of parking, therefore, the present study suggests can be for Friday and Saturday in the three-day stay of current total time (days) 30 yuan, or increase per parking times (days) is 31-35 yuan, or increase the underground parking time (days) 50 yuan, more than three days from the day the fourth day additional 200 yuan, you can stay more than four days on Friday to curb the number of days and when. As the airport for long and short-term planning does not stay all the mixing operations separated by long-term and short-term parking location, and the turnover rate is more difficult to demonstrate management's short-term parking, therefore, it recommended that the future can be set up in the old terminal, or a small number of long-term parking spaces underground the parking lot a few long-term parking spaces, in order to increase non-aeronautical revenues increased airport.

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parking regression Function, based on the current operating capacity and design capacity of reckoning must provide 486 parking spaces, more than the current number of 481 parking spaces, it is recommended Possible future review attached to the number of airport parking spaces. Especially now that the cause of underdeveloped outlying transit, airport if open space, parking facilities should be developed to facilitate the construction of park visitors, but also increase the income of non-aviation airport.

Excess demand is currently for weekends or holidays in a row, the proposed short-term floating parking Sites continued to promote the management, on the ground in the parking lot channel does not interfere with any of the vehicles entering and leaving a parking space, security or turn straight, the parking configuration temporary floating grid , commissioned by the business administrator supervision parking lot parking place.

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