



<u>GROUP PROJECT – DIGBY</u>

PARKING BY CELL PHONE:

ECONOMIC EVALUATION OF A NEW PARKING SYSTEM FOR PORTLAND

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1 ABSTRACT

Currently the city of Portland Oregon utilizes pay stations to manage their street parking infrastructure. The pay stations allow car owners to pay for a designated public parking spot for a certain amount of time through the use of a variety of payment methods. While functionally these pay stations suffice the requirements, we believe there is another economical way to maintain this parking infrastructure. Their current design requires a lot of hardware and maintenance which greatly increases the operational cost. Because of the requirements on having hardware on every street, this requires a lot of overhead and maintenance. We will illustrate another functional model and show the economical analysis between the two models to allow decision makers to better evaluate alternatives of these two parking models. This alternative functional model has been deployed in other cities that remove the need for physical hardware on the streets and thus reducing the operational cost. We believe, once compared in our economic analysis, will give the city of Portland a footprint in which to review their parking infrastructure design.

2 PORTLAND'S CURRENT PARKING INFRASTRUCTURE

The city of Portland, incorporated in 1851, is located in the Northwestern United States, near the confluence of the Willamette and Columbia rivers in the state of Oregon. It has population of 557,706, the 29th most populous in the United States In July 2008 [1]. Portland is the most populous city in Oregon State, and the third most populous city in the Pacific Northwest, after Vancouver, British Columbia, and Seattle, Washington. It has been called the most environmentally friendly or green city in the United States [2]. Besides, it has been known as "The City of Roses" due to climate is ideal for growing roses and there are many rose gardens in the city [3]. Some detailed facts about Portland are shown in Table 2.1 [4].

| | | Facts a | Dout Portianu - ra |
|-----------|--------------------------|----------------------------------------|-------------------------|
| Flag | State | Counties | Founded |
| | Oregon | Multnomah, Washington, Clackamas | 1845 |
| | City | Land | Water |
| Area | 145.4 sq mi | 134.3 sq mi | 11.1 sq mi |
| | (376.5 km ²) | (347.9 km ²) | (28.6 km ²) |
| | City | Density | Metro |
| opulation | 557 705 | 4,288.38/sq mi | 0.450 700 |
| 2008 | 557,706 | (1,655.31/km ²) | 2,159,720 |

Source: Wikipedia

2.1 Transportation in Portland

Portland is well known throughout the nation for its excellent multi-modal transportation system. There are almost 4,000 miles of streets, over 300 miles of bikeways and 155 bridges in Portland. Some transportation numbers of Portland are shown in Table 2.2. The major bus and rail system is operated by TriMet, a distinctive regional-government. Figure 2.1 shows Portland's rate of public transit use (about 13% of commutes in 2008) is comparable to much larger cities like Los Angeles. 65% Portland residents drive alone to travel as shown in figure 2.2. [4]

Frate allowed Dentile and Table 2.4

| 3,949 lane miles of streets | 187 stairways | 1 aerial tram |
|-----------------------------|-------------------------------|-----------------------------------|
| 2,485 miles of sidewalks | 1,011 traffic signals | 10 streetcars |
| 305 miles of bikeways | 1,640 traffic calming devices | 7 miles of streetcar tracks |
| 11 bike boxes | 54,588 street lights | 537 retaining walls |
| 155 bridges | 143,654 street signs | 1 China Gate |
| 26 miles of guardrails | 1,733 parking meters | 17,742 pavement symbols and words |

Transportation Numbers of Portland - Table 2.2

Source: City of Portland Annual Report, 2008-09



Commuting Analysis - Figure 2.1





Source: City of Portland Annual Report, 2008-09

2.2 Parking in Downtown Portland

There are 7,388 on-street parking spaces located in the central city [5]. Most parking is paid at a parking SmartMeter (pay station). These machines, totaling 1,121 pay stations, accept nickels, dimes, guarters, the small dollar coin, prepaid cards, and credit/debit cards as payment. Parking is generally restricted by

time (Figure 2.3). The cost, changed on July 13, 2009, is as following: \$1.60/hour in the Downtown District, \$1.00/hour in the Lloyd District, and \$1.35/hour in the OHSU District.

In 2002, the Portland Office of Transportation began replacing its

aging coin parking meters with two kinds of multi-space, solar-

powered SmartMeters (Cale SmartMeter and Parkeon SmartMeter) as shown in figure 2.4. Each pay station costs about \$7,150 and

replaces up to 9 meters per block face (coin meters cost \$650 per

space). Each pay station also needs \$30 for operating (wireless two

way communication) per month. These pay stations have several benefits, such as solar powered, reducing waste from battery

disposal, simplifying and reducing maintenance, and reducing coin

collections. Besides Portland, other U.S. cities using similar

Parking Map - Figure 2.3

Source: City of Portland

technology include Chicago, IL; Denver, CO; Seattle, WA; and Washington, DC. The pay station works in the following three steps: 1) the driver goes to the pay station; 2) payment can be made via coin, credit,

debit or prepaid cards; 3) takes sticker receipt and place on the window inside of the car at street side. Due to this economic new parking system, the City of Portland won international parking award in 2005 [6].



Source: City of Portland

2.3 Parking System Operations

The City of Portland has 1,121 parking meters in the downtown area, maintained by the Portland Office of Transportation (PDOT), to control the use of more than 7,388 parking spaces. Portland's transportation system is funded through local, state, federal and private sources. Portland Bureau of Transportation has five groups: Office of the Director, Engineering & Technical Services, Development & Capital Program, Maintenance Operations, and System Management. System Management group manages the parking environment and on-street parking spaces. [5]

- Office of the Director: Provides leadership as well as overall planning, policy, financial, communications, and administrative services for transportation.
- Engineering & Technical Services: Provides technical support for transportation projects, preserve and rehabilitate facilities, and support land use through improvements to the city street and structures system.
- **Development & Capital Program:** Facilitates public and private development opportunities which lead to job creation, housing construction, and neighborhood livability.
- **Maintenance Operations:** Helps the City to adopt new technologies and innovative work methods that result in a cost-efficient and well-functioning transportation system.
- **System Management:** Pioneers solutions in safety, intersection improvements, and promoting transportation choices to enable the community to maximize the effective use of its transportation investments.

The FY 09-10 Adopted Budget includes \$11,000,000 estimated revenue for parking garages downtown, \$17,226,000 estimated revenue for parking pay stations downtown, \$174,000 estimated revenue for parking meters downtown, and \$1,040,000 estimated revenue for parking pay station and meter revenue from other areas such as Lloyd District and Marquam Hill (Appendix A-1). [5]

There are two employees hired by the City of Portland to collect coins from parking pay stations and parking meters. The FY 09-10 Adopted Budget for these positions is \$140,300, which includes salary, benefits, and payroll taxes, of which 70% is for collection coin from downtown pay stations. [5]

2.4 Parking System Maintenance

The FY 09-10 Adopted Budget includes \$1,156,000 for repairs and preventive maintenance for pay stations downtown and \$250,000 for maintenance projects such as programming and system modifications for pay stations downtown. It includes indirect costs, which is 65.88% of payroll costs. [5]

The indirect rate includes the following:

- Facilities (rent, electricity, water, sewer, building maintenance)
- Information Technology (computers, software, networks, servers)
- Communications (landlines, cell phones, radios, networks, dispatch)
- Printing and Distribution (printing, photocopiers, paper, mail delivery)
- Fleet (vehicles, maintenance, repairs, fuel)
- Insurance and Claims (liability and workers compensation)
- Accounting and Finance (payroll processing, accounts payable, accounts receivable, budget, finance, debt management)
- Purchases and Stores (bids, contracts, equipment purchase, inventory management)
- Human Resources, City Attorney, Auditor's Office
- Management (supervision, project management, administration)
- Support services (customer service, reception, office supplies)

3 ALTERNATIVE PARKING INFRASTRUCTURE MODEL

Parking and paying a parking meter is a procedure which everybody knows pretty well. Everybody knows how annoying it is to carry adequate coins or to change money before, how awkward it is to know exactly how long you will need to park your car or to go back and pay again and how inconvenient it is to put a sticker at your car's window. To make all those things easier, a new paying system has been invented and has already been implemented in some cities in Germany.

3.1 System Description

This paragraph intends to present this new system. In figure 3.1, all connections and integrated institutions are depicted. [7]





The first step before one can use this system is to fill in an online registration form which includes one's mobile number and license plate data. After this application has been successfully processed, the customer receives a parking pass to state that he/she is authorized. The parking pass shows the system operator (as there are several and a control person needs to know whom he/she should contact to figure out if this user has paid or not) and the specific customer number. The user needs to put the parking pass at the front window.

Having done these preparations once, the user could start paying the parking fees by cell phone. In order to that, there are four formal variations of different systems but basically there are two major differences. One is to contact the operator at the beginning and at the end of the parking period, so that the user only pays exactly of the time he/she needed. The other option is to tell the operator the time which the user thinks he/she needs. In this respect, the user could always contact the operator again to extend the parking time. Both systems could either be operated with a call or with a text message. The advantages and maybe disadvantages of each model will be discussed in another paragraph.

Besides the parking time, the operator also needs to know the parking zone number which could be found on the parking meter (on a sticker). When the parking time is activated by a call, the user is asked to type in the parking zone. With reference to the text message option, the user includes the parking zone number in the text message. There are several other possibilities in connection with this text message option, for further information please reference simity.com [8]. Those parking zones numbers are 6-digit numbers which are issued nationwide. The first three digits correspond to the city the others represent the area. With respect to the definition of the parking zones, manageability and clearness for the user should play the most important roles as the user needs to refer to the parking zones when activating a parking process.

The control for proper parking certifications is operated by the local police, via a data radio communication system. With this method, it could be clarified if the user has lawfully operated the parking process. The posted data set is compared to application on the operator server and will be confirmed correspondingly. Thereby, the system operator only states the license plate data. In general, as stated above, only the exact parking time is settled. The operator companies offer a monthly listing of all parking operations. [7, 9, 10, 11]

3.2 Operating Companies

Generally, the parking process will be activated through a call or a text message which are exempt from charges. Billing and service fees vary according to the operator company and the chosen rate model (11ct to 25 ct). The city settles directly with the particular operator. In this process, the operators shell out 100% of the charged parking fee to the city. The referenced table in appendix B-1 shows the

different characteristic and user options of several operator companies. According to those options, a user could choose the operator which suits him best.

The operating companies need to be certificated. The intention of this process is to secure that a user could trust the operators. Getting a certification includes several examinations. It is determined if the operator transacts business reliably and if they command orderly methods of paying. Furthermore, it is investigated if the operator's technique is operative and dependably. This is a very important point, as otherwise there would be the risk that parking activations would not reach the server and controlling persons would disperse fees spuriously. Lastly, it is also examined if the operator possesses a documentation processes which is compatible with valid data protection acts. Satisfying all the point named above forms the basis for an operator company to get a certificate.

In the German model, there is a platform which summarizes different operators, so that a customer does not need to register in several operator systems (as often different city have contract with different operators). To make the collaboration between operator companies and city as easy as possible, there is a standard framework contract which could be adjusted by every city and which is closed with every operator company in this city.

3.3 Advantages & Benefits

For Cities:

With respect to the city there are several advantages. In the context of cost savings, the costs for collecting the money which are about 2% of the parking fee are omitted. Similarly, there will be less work with handling the coins. Furthermore, cost intensive appointments are omitted.

Besides, the city does not have extra work with this new system as the operation is carried out by a third party. Apart from that, there will be a reduction of misdemeanors as the operating companies offer the service of reminding when the parking time expires. Additionally, the operators provide a list, where the controlling persons could see where cars are parked and therefore they could skip those zones. As they only need to control if the parking spaces where no cars have been registered are available or paid by the old system. As a result, less controlling people are needed and costs in this coherence could be saved as well. Moreover the city denotes a gain of image as this progressive model represents the modern spirit of the city. This could also serve a marking advantage. [7, 10]

For Users:

Referring to the prospective users, there will be several advantages as well. All model options (no matter if a call or a text message serves to activate the parking process) obtain cashless payment which means that a user does not have to have adequate coins or to search for a parking meter. Additionally, as most people are used to deal with their cell phone the handling is very easy.

Concerning the model of contacting the operator's system at the beginning and the end of the parking time, parking fees are accounted to the minute. In the current model, users often have to pay more as for example one hour is exceeded by ten minutes; the user has to pay for tow hours. In this new mobile parking model, the user only needs to pay exactly the time he/she needed. Moreover, the parking time is not defined in advance which provides more flexibility. Another major benefit in this context is that the user will never get penalty fees as they could never exceed their parking time again.

With respect to the to the model where the user tells the operator the parking time he/she will need, the user only needs to exactly for that time, too. In addition, the user could extend the parking time easily by a new message or call without going back to the car, which makes the whole process more convenient. Furthermore, the operators offer the service of reminding the user before the parking time expires, so that it is not possible to forget the time and thereby, users could avoid penalty fees. Moreover, the paying method of withdrawals through direct debit scheme is easy and convenient. Apart from all that, there will not be any fees for registration or phone log in which could also be regarded as benefits. [7, 10]

3.4 Costs

In connection with the implementation of the mobile parking system, several costs occur. First of all, the marker (sticker for parking meters), which shows the mobile paying option for parking on the street, are needed.

Then, an allocation of the online platform is required. However, those platforms exist in Germany and therefore no costs for the cities occur in this connection. Furthermore an allocation of a framework contract is needed. Equally to the prior point, there will be no additional costs for cities in Germany as

those contracts already exist. Moreover, an allocation of the gateway is needed. All operator systems are connected and provide an easy basis for the controlling persons.

Additionally, there will be costs for the configuration of the control process. There are different options, one is to query with GPRS compatible cell phone, and another one is to fit the control persons with special end devices. However, the second option needs upgraded hardware, as well as a modified software for the end devices and is therefore more expensive. In all cases a machine to machine data radio communication contract is necessary and this will increase the monthly operating costs.

Apart from all costs considered above, an external project management for the implementation has proved to be reasonable. All in all, these investment costs aggregate to 5 000 to 10 000 €. If new end devices are implemented by the police, costs will be much higher. Accessorily, there will be the following annual cost for data transmission. [12]

end devices* 5 €/month * 12 month

3.5 Problems

As everything has ambivalent sides, there are some problems with respect to this new system as well. This system is only useable for people how own a cell phone and not everyone has a cell phone. But, as the paying system is not changed completely at the current time this problem could be disregarded as a dual system during the time of changeover will exist.

Another problem is that some people have a cell phone, but are not able to write messages with it. For those people the call option is suitable. Furthermore, accounting to the minute could be cheaper or more expensive than the service flat rate depending on the parking time. So this could be a disadvantage of the system. But as the user is responsible for the parking time he/she could consider which option would be cheaper in his/her context.

Moreover, concerning the model where you need to send a message when the parking time starts and when it ends, there is the question about what happens if one forgets the second message? Probably those people need to pay the maximum time amount. Of course, this could be more expensive than a

normal ticket. In this context, the model of telling the operator the time he/she will need would get better assessments. However, users could decide on their one which model suits him/her best.

3.6 Application, Recognition, and Acceptance

This system especially appeals to frequent divers who will be in transit a lot and who will need collective billing. Furthermore, it is interesting for business customers who park frequently and who will also need collective billing. Apart from that, private users who value the convenience of mobile paying will be attracted by this system.

Statistics say that almost every citizen owns a cell phone in Germany, which is an important basis for the paying by text message or a call system. However, these statistics do not implicate that some business people have a business and a private cell phone. So, not every citizen owns a cell phone but the number of cell phone and car owners is considered to be high enough to implement this system. Surveys have shown that 71.2% would approve of this new system and would be willing to pay $2.50 - 50 \in (\$ 1.80 - 35)$ through debit memos via their cell phone. Direct debiting which is the common procedure in this platform connected mobile parking system is approved by 63.1%. In comparison to that, only 31.7% like the model of solitary text message parking.

This system does not only exist in the German cities. Many other cities have implemented such a system (e.g. Netherlands- Amsterdam, Austria (12 cities), Scandinavia). So far, Copenhagen (Denmark) has the highest penetration with 30% of all parking operations (there, the system has been implemented in the year 2001). Investigations in Berlin (Germany) have shown that the key users are between 35 and 55 years old. Cities preferred the voice recording system because of the communal control requirements. [7]

4 ECONOMIC ANALYSIS OF PARKING MODELS

The following section provides an economical analysis of the existing parking system in Portland and two alternative scenarios. The analysis includes economical values like the present worth and the internal rate of return of the different alternatives. In order to come to up with a conclusion, which system is the best a replacement analysis is included. Since the parking system is run by the City of Portland an evaluation based on benefit-cost ratios for public investments is added.

The analysis uses numbers from the annual report of the City of Portland's Bureau of Transportation (PBOT) and the financial forecast 2009-2014. Data for the new system is collected from a German parking system operator. The study period is determinate to be five financial years, since for this interval reliable data exists. All calculations are made with real dollars. The inflation rates are a weighted average for PBOT of the inflation factors distributed by the City Economist. As the Parking system is run by a public organization tax influences are not taken into account.

4.1 Evaluation of Existing Systems

From the annual report, the following numbers for expected expenditures are collected. As there is no detailed forecast for the expenditures, constant numbers are assumed. The influence of inflation is not important for this analysis, as this is an analysis with real dollars. Only the 4.4% inflation for the financial year 09/10 has to be taken into account.

| Expenditures | FY-09/10 | FY-10/11 | FY-11/12 | FY-12/13 | FY-13/14 |
|---------------------------------------------------------|--------------|--------------|--------------|--------------|--------------|
| Parking Enforcement | 2,690,000.00 | 2,690,000.00 | 2,690,000.00 | 2,690,000.00 | 2,690,000.00 |
| Parking Enforcement Radio | 630,819.00 | 630,819.00 | 630,819.00 | 630,819.00 | 630,819.00 |
| Parking Operations / Meter Districts Parking Control | 1,630,827.00 | 1,630,827.00 | 1,630,827.00 | 1,630,827.00 | 1,630,827.00 |
| Parking Finance | 979,893.00 | 979,893.00 | 979,893.00 | 979,893.00 | 979,893.00 |
| Replacement Parking Meters/ preventive | 1,156,000.00 | 1,156,000.00 | 1,156,000.00 | 1,156,000.00 | 1,156,000.00 |
| Sum | 7,087,539.00 | 7,087,539.00 | 7,087,539.00 | 7,087,539.00 | 7,087,539.00 |
| Uninflated Cash Out | 6,788,830.46 | 6,788,830.46 | 6,788,830.46 | 6,788,830.46 | 6,788,830.46 |

The revenue Forecast exists for 5 years and includes inflation. For our calculations the inflation rate, as used from the PBOT, are included. They are determined by:

| financial year | inflation rate |
|----------------|----------------|
| 09/10 | 4.4%, |
| 10/11 | 3.1% |
| 11/12 | 3.1% |
| 12/13 | 2.7% |
| 13/14 | 2.9% |

| Revenues | FY-09/10 | FY-10/11 | FY-11/12 | FY-12/13 | FY-13/14 |
|--------------------|---------------|---------------|---------------|---------------|---------------|
| Parking Meters | 14,000,000.00 | 14,300,000.00 | 14,500,000.00 | 14,800,000.00 | 15,100,000.00 |
| Parking Citations | 3,700,000.00 | 3,800,000.00 | 3,900,000.00 | 4,000,000.00 | 4,200,000.00 |
| Sum | 17,700,000.00 | 18,100,000.00 | 18,400,000.00 | 18,800,000.00 | 19,300,000.00 |
| Uninflated cash in | 16,954,022.99 | 16,799,578.25 | 16,548,473.15 | 16,463,702.60 | 16,425,235.21 |

The PBOT does not publish any information about the MARR they use for the internal project evaluation. Therefore, we assume a MARR of 7%, which is lower than the rates that are used by most companies, but takes into account that the PBOT is a public organization. [13] As the keeping of the existing system does not require an initial payment, there is no cash flow in year zero.

| | FY-09/10 | FY-10/11 | FY-11/12 | FY-12/13 | FY-13/14 |
|----------------|---------------|---------------|--------------|--------------|--------------|
| Net cash flows | 10,165,192.53 | 10,010,747.79 | 9,759,642.69 | 9,674,872.14 | 9,636,404.75 |
| Discounted CF | 9,500,179.93 | 8,743,774.82 | 7,966,775.61 | 7,380,913.63 | 6,870,623.41 |

The present worth of this alternative equals the sum of the discounted cash flows.

$$P = A_0 + \sum_{t} \frac{CF_t}{(1+i)^t} = 40,462,267.40$$

Where:

A₀ = Initial cash flow (usually negative, because it is an investment)

 CF_t = Cash flow in period t

i = MARR

As in this series of cash flows, all values are positive given the theoretical rate of return equals infinity.

4.2 Evaluation of the Alternative Model

Introducing a new parking system leads to changes in various positions of the expenditures and the revenues. Two scenarios will be discussed. First of all the introduction of text message parallel to the existing system will be evaluated. As a second option, a one step shift to text message parking only will be discussed. A shift to text message parking includes the possibility to shift to a new price model. In stead of the hour based fees, it will be possible that fees are only charged for the time someone actually parks. The influence of this new way of pricing will be calculated, too.

4.2.1 The Influence of a New Pricing Model

Introducing of the new parking system goes a long with the possibility to change the pricing model. The new technology allows that parking fees are only collected for the time the parking lot is actually used. This change will clearly affect the City of Portland's revenues. The difference between the different pricing models can be seen from the figure 4.1 below.



Influence on Revenue of a New Pricing Model - Figure 4.1

The dashed red line shows the savings from the customer's perspective. In the following paragraph, the expected value of these savings is calculated. It is obvious that the savings must equal the lost that the City of Portland suffers from the change in a pricing model.

The dimension of the expected savings is highly influenced by the parking habits. In this report, two assumptions are tested. The first approach is to assume that the parking time is distributed equally over the interval from 0 to the maximum of 3 h (see red line in figure 4.2). The second and probably more realistic approach is that nobody will park for less than 5 minutes or if someone parks for less than 5 minutes he or she does not buy a parking ticket. As most people do not want to waste money while they run their errands in a way that they cover the full period they paid for. Therefore in the second approach the assumption is made that the likelihood for a parking activity from minute 5 to 60 increases. The pattern repeats in the next two parking periods.



The expected value for the savings is calculated by adding up all savings multiplied with their related likelihood. With the assumption of equally distributed parking times the expected savings are:

$$E_{s1} = \sum_{t=1}^{180} s(t) \cdot f_1(t) = 0.615$$

This means reducing the average revenue to: $\frac{2.5 - 0.615}{2.5} = 0.754$ of the initial revenues. The revenue cuts by a quarter seem to be unacceptable. Using the more realistic second distribution of the parking times the expected savings are:

$$E_{s2} = \sum_{t=1}^{180} s(t) \cdot f_2(t) = 0.375$$

This leads to a revenue reduction by $\frac{0.375}{2.5} = 15\%$. But this estimation does not include the extra money that can be generated by an increasing number of parking activities that last shorter than five minutes. More people will pay a now much smaller amount of money, for this short stops rather than getting in trouble with parking enforcement officers. Also an increasing utilization of the parking lots can be expected, because the citizens will find the new pricing model fairer and use the parking lots more often. In addition to that the linear increasing probability, like assumed in this model, might not be the best approximation for the parking habits. More likely the majority of the people wait to the last minute before they leave.

Because of these additional thoughts, in the following part a reduction of the parking revenues by 10% is assumed.

4.2.2 Introducing the New Parking System Parallel to the Existing One

In this scenario, the introduction of a text message based parking system parallel to the existing ways of parking is discussed. This scenario is split up in two sub scenarios to incorporate the influence of the pricing model.

4.2.2.1 Introduction with the Old Pricing Model

For this report, we assume that in the first year 15% of the payments will be made with the new technology and in the following for years 20%, 30%, 40% and finally in the financial year 2013-2014 50%. In the following sections the influence of the new parking system on the expenditures will be analyzed.

According to the PBOT's annual report 2008-2009, 38 enforcement officers were employed. As from the new system, information can be collected which parking lots are in use. The parking officers now just have to check paring lots which are marked as free in the database. Using this efficiency improvement, we assume that the number of parking enforcement officers can be reduced by 8 to 30. This equals average savings of 8*3,355*12= \$322,128 per year. The new annual enforcement budget therefore is now (\$2,690,000.00/1.044) - \$322,128.00= \$2,254,500.35.

| Expenditures | FY-09/10 | FY-10/11 | FY-11/12 | FY-12/13 | FY-13/14 |
|-----------------------|--------------|--------------|--------------|--------------|--------------|
| Old Enforcement Costs | 2,576,628,35 | 2,576,628,35 | 2,576,628,35 | 2,576,628,35 | 2,576,628,35 |
| Enforcement Savings | 322,128.00 | 322,128.00 | 322,128.00 | 322,128.00 | 322,128.00 |
| New Enforcement Costs | 2,254,500.35 | 2,254,500.35 | 2,254,500.35 | 2,254,500.35 | 2,254,500.35 |

The Parking Enforcement Radio budget will be increased. For the economic evaluation we take the pessimistic view of $10,000 \in$ of hardware investments in mobile devices (section 3.4). In addition to these initial costs, we assume annual maintenance cost of 5% of the initial costs and $5 \in$ per month per device for the data transfer. This leads to initial costs in year zero of:

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10,000€*0.69$/€= 6900$ in year zero
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And additional annual costs for the following years in uninflated dollars:

(10,000€*0.05+5€*30*12)*0.69\$/€= (500€+ 1800€)*0.69\$/€ = 1587\$

The new cash outflows in uninflated \$ are the following:

| Expenditures | 0 | FY-09/10 | FY-10/11 | FY-11/12 | FY-12/13 | FY-13/14 |
|----------------------------|----------|------------|------------|------------|------------|------------|
| Old Radio Costs | 0 | 604,232.75 | 604,232.75 | 604,232.75 | 604,232.75 | 604,232.75 |
| Additional Radio Costs | 6,900.00 | 1,587.00 | 1,587.00 | 1,587.00 | 1,587.00 | 1,587.00 |
| New Uninflated Radio Costs | 6,900.00 | 602,645.75 | 602,645.75 | 602,645.75 | 602,645.75 | 602,645.75 |

Parking operations include the management of the parking meters and the pay stations. According to an e-mail of the PBOT, at the moment there are two employees that collect the money from the pay stations. The amount for this is \$140,300 including salary, benefits, and payroll taxes. As the percentage of payments made with coins will decrease, because of the text message parking we assume that this position can be reduced by 25% in the second year and cut it to the half at the fourth year. The cash flows in uninflated dollars change in the flowing way:

| Expenditures | FY-09/10 | FY-10/11 | FY-11/12 | FY-12/13 | FY-13/14 |
|----------------------------|--------------|--------------|--------------|--------------|--------------|
| old Parking Operations | 1,562,094.83 | 1,562,094.83 | 1,562,094.83 | 1,562,094.83 | 1,562,094.83 |
| Parking Operations savings | 0.00 | 35,075.00 | 35,075.00 | 70,150.00 | 70,150.00 |
| new Parking Operations | 1,562,094.83 | 1,527,019.83 | 1,527,019.83 | 1,491,944.83 | 1,491,944.83 |

Parking finance expenditures are costs created by credit card payments. These costs are expected to rise because in stead of coins the people will use their cell phone, which also includes a credit card payment. According to an e-mail of the PBOT, currently 75% of the payments are made with a credit card and only 25% of the payments are made with cash. For the first year no increase in these cost are expected, since cell phone parking would be used from advanced users, that in the old system pay with credit cards at the pay stations. For the following year we assume 80%, 85%, 90% and 95% payments made either by credit card or by cell phone. The costs for parking finance are expected to rise proportionally.

| Expenditures | FY-09/10 | FY-10/11 | FY-11/12 | FY-12/13 | FY-13/14 |
|-------------------------|------------|--------------|--------------|--------------|--------------|
| Old Parking Finance | 938,594.83 | 938,594.83 | 938,594.83 | 938,594.83 | 938,594.83 |
| Extra Costs for Finance | 0 | 110,572.99 | 176,145.97 | 241,718.96 | 307,291.95 |
| New Parking Finance | 938,594.83 | 1,049,167.82 | 1,114,740.80 | 1,180,313.79 | 1,245,886.78 |

As the pay stations are still needed the cash flow for replacement is still the same. Adjusted to the 4.4% inflation in the first year the following cash flows occur:

| Expenditures | FY-09/10 | FY-10/11 | FY-11/12 | FY-12/13 | FY-13/14 |
|-------------------------------------------|--------------|--------------|--------------|--------------|--------------|
| Replacement Parking Meters/ Preventive | 1,107,279.69 | 1,107,279.69 | 1,107,279.69 | 1,107,279.69 | 1,107,279.69 |

The following table sums up changes in expenditures:

| Expenditures | 0 | FY-09/10 | FY-10/11 | FY-11/12 | FY-12/13 | FY-13/14 |
|---------------------------------------------------------|----------|--------------|--------------|--------------|--------------|--------------|
| Parking Enforcement | | 2,254,500.35 | 2,254,500.35 | 2,254,500.35 | 2,254,500.35 | 2,254,500.35 |
| Parking Enforcement Radio | 6,900.00 | 602,645.75 | 602,645.75 | 602,645.75 | 602,645.75 | 602,645.75 |
| Parking Operations / Meter Districts Parking Control | | 1,562,094.83 | 1,527,019.83 | 1,527,019.83 | 1,491,944.83 | 1,491,944.83 |
| Parking Finance | | 938,594.83 | 1,049,167.82 | 1,114,740.80 | 1,180,313.79 | 1,245,886.78 |
| Replacement Parking Meters/ preventive | | 1,107,279.69 | 1,107,279.69 | 1,107,279.69 | 1,107,279.69 | 1,107,279.69 |
| Sum | 6,900.00 | 6,465,115.45 | 6,540,613.44 | 6,606,186.42 | 6,636,684.41 | 6,702,257.40 |

If no changes are made in the pricing model, the revenues are expected to be the same.

| Cash flows | 0 | FY-09/10 | FY-10/11 | FY-11/12 | FY-12/13 | FY-13/14 |
|----------------------|-----------|---------------|---------------|---------------|---------------|---------------|
| Expenditures | 6,900.00 | 6,465,115.45 | 6,540,613.44 | 6,606,186.42 | 6,636,684.41 | 6,702,257.40 |
| Revenues | | 16,954,022.99 | 16,799,578.25 | 16,548,473.15 | 16,463,702.60 | 16,425,235.21 |
| Net cash flow | -6,900.00 | 10,488,907.54 | 10,258,964.81 | 9,942,286.73 | 9,827,018.19 | 9,722,977.81 |
| Discounted Cash Flow | -6,900.00 | 9,802,717.33 | 8,960,577.17 | 8,115,867.55 | 7,496,985.13 | 6,932,348.80 |

The present worth of this scenario is:

$$\mathsf{P} = \mathsf{A}_{0} + \sum_{t} \frac{\mathsf{CF}_{t}}{(1+i)^{t}} = 41,301,595.98\$$$

This is a greater present worth than the present worth of the existing system without any changes.

To calculate the internal rate of return the following approach is used: Find the i* that makes the present worth of the investment zero.

$$P = A_0 + \sum_t \frac{CF_t}{(1+i^*)^t} = 0$$

Because of the comparatively small initial payment the internal rate of return is very high. The solution of Excel is: 152,011%

4.2.2.2 Introduction with New Pricing Model

If a new pricing model would be used, the revenues from parking fees are expected to fall by 10%, according to section 4.2.1 but this effect only applies for the payments that are made by cell phone. The new revenues R_N from parking fees are therefore:

$$R_N = R_O * (p*0.9+(1-p))$$

with:

- R_N new revenues from parking fees
- R_o old amount from parking fees
- p percentage of payments made by cell phone

| Revenues | FY-09/10 | FY-10/11 | FY-11/12 | FY-12/13 | FY-13/14 |
|----------------------|---------------|---------------|---------------|---------------|---------------|
| R _o | 14,000,000.00 | 14,300,000.00 | 14,500,000.00 | 14,800,000.00 | 15,100,000.00 |
| р | 0.15 | 0.2 | 0.3 | 0.4 | 0.5 |
| R _N | 13,790,000.00 | 14,014,000.00 | 14,065,000.00 | 14,208,000.00 | 14,345,000.00 |
| Parking Citations | 3,700,000.00 | 3,800,000.00 | 3,900,000.00 | 4,000,000.00 | 4,200,000.00 |
| Sum | 17,490,000.00 | 17,814,000.00 | 17,965,000.00 | 18,208,000.00 | 18,545,000.00 |
| Uninflated Cash Flow | 16,752,873.56 | 16,534,126.35 | 16,157,245.66 | 15,945,271.11 | 15,782,693.63 |

The expenditures are not affected by a change in the pricing model. This leads to the following net cash flows:

| Cash flows | 0 | FY-09/10 | FY-10/11 | FY-11/12 | FY-12/13 | FY-13/14 |
|-------------------------|----------|---------------|---------------|---------------|---------------|---------------|
| Expenditures | 6900.00 | 6,465,115.45 | 6,540,613.44 | 6,606,186.42 | 6,636,684.41 | 6,702,257.40 |
| Revenues | | 16,752,873.56 | 16,534,126.35 | 16,157,245.66 | 15,945,271.11 | 15,782,693.63 |
| Net cash flow | -6900.00 | 10287758.11 | 9993512.91 | 9551059.24 | 9308586.70 | 9080436.23 |
| Discounted Cash Flow | -6900.00 | 9614727.21 | 8728721.21 | 7796509.38 | 7101476.23 | 6474225.53 |

The present worth of this scenario is:

$$P = A_0 + \sum_{t} \frac{CF_t}{(1+i)^t} = 39,708,759.56$$

This present worth is smaller than the one of the existing system, due to the revenue losses caused by the new pricing model. Nevertheless the internal rate of return IRR=149,095% is still very high.

4.2.3 Using the New Parking System Only

In this scenario we assume that all parking meters and pay stations are abandoned right away. Paying for the parking fees is only possible by cell phone

4.2.3.1 Introduction with the Old Pricing Model

Parking enforcement becomes more efficient by this new system. The savings are the same as in the previous scenario.

| Expenditures | FY-09/10 | FY-10/11 | FY-11/12 | FY-12/13 | FY-13/14 |
|-----------------------|--------------|--------------|--------------|--------------|--------------|
| Old Enforcement Costs | 2,576,628,35 | 2,576,628,35 | 2,576,628,35 | 2,576,628,35 | 2,576,628,35 |
| Enforcement Savings | 322,128.00 | 322,128.00 | 322,128.00 | 322,128.00 | 322,128.00 |
| New Enforcement Costs | 2,254,500.35 | 2,254,500.35 | 2,254,500.35 | 2,254,500.35 | 2,254,500.35 |

Also the expenditures for the new devices and there costs of operation are the same as in the previous scenario.

| Expenditures | 0 | FY-09/10 | FY-10/11 | FY-11/12 | FY-12/13 | FY-13/14 |
|----------------------------|----------|------------|------------|------------|------------|------------|
| Old Radio Costs | 0 | 604,232.75 | 604,232.75 | 604,232.75 | 604,232.75 | 604,232.75 |
| Additional Radio Costs | 6,900.00 | 1,587.00 | 1,587.00 | 1,587.00 | 1,587.00 | 1,587.00 |
| New Uninflated Radio Costs | 6,900.00 | 602,645.75 | 602,645.75 | 602,645.75 | 602,645.75 | 602,645.75 |

As there is nobody needed to collect the money from the parking meters and pay stations, this result in annual savings of \$140,300.

| Expenditures | FY-09/10 | FY-10/11 | FY-11/12 | FY-12/13 | FY-13/14 |
|----------------------------|--------------|--------------|--------------|--------------|--------------|
| old Parking Operations | 1,562,094.83 | 1,562,094.83 | 1,562,094.83 | 1,562,094.83 | 1,562,094.83 |
| Parking Operations savings | 140,300.00 | 140,300.00 | 140,300.00 | 140,300.00 | 140,300.00 |
| new Parking Operations | 1,421,794.83 | 1,421,794.83 | 1,421,794.83 | 1,421,794.83 | 1,421,794.83 |

Currently 75% of the payments are made with credit cards. As there is only the option to pay with credit cards after the introduction of a new system, we assume that costs for parking finance will rise by to 1,311,459.77.

| Expenditures | FY-09/10 | FY-10/11 | FY-11/12 | FY-12/13 | FY-13/14 |
|-------------------------|--------------|--------------|--------------|--------------|--------------|
| Old Parking Finance | 938,594.83 | 938,594.83 | 938,594.83 | 938,594.83 | 938,594.83 |
| Extra Costs for Finance | 327,864,94 | 327,864,94 | 327,864,94 | 327,864,94 | 327,864,94 |
| New Parking Finance | 1,311,459.77 | 1,311,459.77 | 1,311,459.77 | 1,311,459.77 | 1,311,459.77 |

As there are no pay stations and parking meters needed anymore, there are also no costs for replacements. We assume that the salvage value from the parking meters and pay station is used to pay for tearing down the old meters and setting up signs that inform about the new parking system. This leads to the following cash flow serious.

| Expenditures | FY-09/10 | FY-10/11 | FY-11/12 | FY-12/13 | FY-13/14 |
|-------------------------------------------|----------|----------|----------|----------|----------|
| Replacement Parking Meters/ Preventive | 0 | 0 | 0 | 0 | 0 |

The following table sum up the expenditures in this scenario.

| Expenditures | 0 | FY-09/10 | FY-10/11 | FY-11/12 | FY-12/13 | FY-13/14 |
|---------------------------------------------------------|----------|--------------|--------------|--------------|--------------|--------------|
| Parking Enforcement | | 2,254,500.35 | 2,254,500.35 | 2,254,500.35 | 2,254,500.35 | 2,254,500.35 |
| Parking Enforcement Radio | 6,900.00 | 602,645.75 | 602,645.75 | 602,645.75 | 602,645.75 | 602,645.75 |
| Parking Operations / Meter Districts Parking Control | | 1,421,794.83 | 1,421,794.83 | 1,421,794.83 | 1,421,794.83 | 1,421,794.83 |
| Parking Finance | | 1,311,459.77 | 1,311,459.77 | 1,311,459.77 | 1,311,459.77 | 1,311,459.77 |
| Replacement Parking Meters/ preventive | | 0 | 0 | 0 | 0 | 0 |
| Sum | 6,900.00 | 5,590,400.70 | 5,590,400.70 | 5,590,400.70 | 5,590,400.70 | 5,590,400.70 |

The revenues are not affected as long as there are no changes in the pricing model.

| Cash flows | | FY-09/10 | FY-10/11 | FY-11/12 | FY-12/13 | FY-13/14 |
|----------------------|-----------|---------------|---------------|---------------|---------------|---------------|
| Expenditures | 6,900.00 | 5,590,400.70 | 5,590,400.70 | 5,590,400.70 | 5,590,400.70 | 5,590,400.70 |
| Revenues | 0.00 | 16,954,022.99 | 16,799,578.25 | 16,548,473.15 | 16,463,702.60 | 16,425,235.21 |
| Net cash flow | -6,900.00 | 11,363,622.29 | 11,209,177.55 | 10,958,072.45 | 10,873,301.90 | 10,834,834.51 |
| Discounted Cash Flow | -6,900.00 | 10,620,207.75 | 9,790,529.78 | 8,945,051.28 | 8,295,189.96 | 7,725,087.26 |

$$P = A_0 + \sum_{t} \frac{CF_t}{(1+i)^t} = 45,369,166.03$$

IRR = 164,689%

The present worth and the internal rate of return are the highest so far in this analysis.

4.2.3.2 Introduction with the New Pricing Model

The new pricing model will reduce the revenues in the same way as it is presented in the previous scenario.

| Revenues | FY-09/10 | FY-10/11 | FY-11/12 | FY-12/13 | FY-13/14 |
|----------------------|---------------|---------------|---------------|---------------|---------------|
| R _o | 14,000,000.00 | 14,300,000.00 | 14,500,000.00 | 14,800,000.00 | 15,100,000.00 |
| р | 1 | 1 | 1 | 1 | 1 |
| R _N | 12,600,000.00 | 12,870,000.00 | 13,050,000.00 | 13,320,000.00 | 13,590,000.00 |
| Parking Citations | 3,700,000.00 | 3,800,000.00 | 3,900,000.00 | 4,000,000.00 | 4,200,000.00 |
| Sum | 16,300,000.00 | 16,670,000.00 | 16,950,000.00 | 17,320,000.00 | 17,790,000.00 |
| Uninflated Cash Flow | 15,613,026.82 | 15,472,318.75 | 15,244,381.52 | 15,167,623.89 | 15,140,152.04 |

The expenditures do not change compared with the previous section, which leads to the following table:

| Cash flows | 0 | FY-09/10 | FY-10/11 | FY-11/12 | FY-12/13 | FY-13/14 |
|-------------------------|-----------|---------------|---------------|---------------|---------------|---------------|
| Expenditures | 6,900.00 | 5,590,400.70 | 5,590,400.70 | 5,590,400.70 | 5,590,400.70 | 5,590,400.70 |
| Revenues | | 15,613,026.82 | 15,472,318.75 | 15,244,381.52 | 15,167,623.89 | 15,140,152.04 |
| Net cash flow | -6,900.00 | 10,022,626.12 | 9,881,918.05 | 9,653,980.82 | 9,577,223.19 | 9,549,751.34 |
| Discounted Cash Flow | -6,900.00 | 9,366,940.30 | 8,631,249.93 | 7,880,524.05 | 7,306,417.71 | 6,808,840.72 |

$$P = A_0 + \sum_{t} \frac{CF_t}{(1+i)^t} = 39,987,072.72\$$$

IRR = 145,254%

The savings can not compensate the losses from the revenues, due to the new pricing model.

4.3 Recommendations from a Financial Point of View

The financial evaluation is made by using the present worth of the different scenarios. This method is acceptable, as all scenarios have a study period of 5 years. The following table includes the numbers for the different options.

| | Parallel Introduction | One Step Introduction | No Introduction at All |
|-------------------|-----------------------|-----------------------|------------------------|
| Old Pricing Model | 41,301,595.98\$ | 45,369,166.03\$ | 40,462,267.40\$ |
| New Pricing Model | 39,708,759.56\$ | 39,987,072.72\$ | - |

From the table above, it can be concluded that from a financial point of view the cell phone parking system should be introduced right away with using the old pricing model. Due to the feasibility aspects, probably the parallel introduction is the most realistic option, though. It should be kept in mind that the long term goal should be switching to cell phone parking only in order to get rid of the expensive annual maintenance and labor costs for parking meters and pay stations. Switching to a new pricing model has a serious impact and makes the system less profitable. However, all scenarios have a positive present worth and are therefore attractive.

4.4 Evaluation with the Benefit - Cost Ratio Method

The previous calculations aimed for the maximum profit for Portland's Bureau of Transportation. Since the PBOT is a public organization and changing the parking system is a public project, a financial evaluation of the project alone is not enough. Therefore an evaluation based on costs, benefits and disbenefits is provided in this section.

Before starting the analysis, the first step is to define what exactly the benefits or disbenefits are in this context. Aspects that are hard to quantify as time savings because of a better parking system or disbenefits caused by redundancies are not considered in this analysis. Since there is no way to come up with reliable numbers they only cause misleading results.

The most obvious part is the costs aspect. All expenditures that have been identified in the previous part of this analysis are clearly costs. But what are the revenues? Are they costs to the public because the citizens of Portland will have to pay for them or are they disbenefits of the system. Even though, the revenues from the parking system have to be paid by the people of Portland, in this analysis they are considered as benefits. The revenue can be used to fund other activities of the PBOT, which are free for the citizens, therefore the fees are beneficial.

Disbenefits to the public are the 0.25 €, which were collected for every parking action by the operating company. These fees haven't played any role in the financial evaluation, as they are directly collected by the operating company and do not affect costs or revenues of the PBOT.

For this report the conventional B-C ratio with present worth is used, which is defined as:

$$B - C = \frac{PW(benefits) - PW(disbenefits)}{PW(costs)}$$

The MARR is still 7%

4.4.1 Keeping the Existing System

| | FY-09/10 | FY-10/11 | FY-11/12 | FY-12/13 | FY-13/14 |
|-----------------------|---------------|---------------|---------------|---------------|---------------|
| Revenues | 16,954,022.99 | 16,799,578.25 | 16,548,473.15 | 16,463,702.60 | 16,425,235.21 |
| Discounted cash flows | 15,844,881.30 | 14,673,402.26 | 13,508,483.50 | 12,560,079.89 | 11,710,965.70 |

The benefits result from the revenue generated by parking fees and citations.

PW(benefits) = \$15,844,881.30+ \$14,673,402.26+ \$13,508,483.50+ \$12,560,079.89+ \$11,710,965.70 = \$68,297,812.65

The costs equal the present worth of the expenditures.

| | FY-09/10 | FY-10/11 | FY-11/12 | FY-12/13 | FY-13/14 |
|-----------------------|--------------|--------------|--------------|--------------|--------------|
| Expenditure | 6,788,830.46 | 6,788,830.46 | 6,788,830.46 | 6,788,830.46 | 6,788,830.46 |
| Discounted cash flows | 6,344,701.36 | 5,929,627.44 | 5,541,707.89 | 5,179,166.25 | 4,840,342.29 |

PW(costs)= \$6,344,701.36+ \$5,929,627.44+ \$5,541,707.89+ \$5,179,166.25+ \$4,840,342.29 =\$27,835,545.25

As there are no disbenefits, because no cell phone parking is used in this scenario, the benefit-cost ratio is the following:

$$BC = \frac{\$68,297,812.65}{\$27,835,545.25} = 2.45$$

4.4.2 Introducing the new parking system parallel to the existing

We assume consistently to the analysis in 4.2.2.1 introduction with the old pricing model, that in the first year 15% of the payments will be made with the new technology and in the following for years 20%, 30%, 40% and finally in the financial year 2013-2014 50%.

4.4.2.1 Introduction with the old pricing model

| | FY-09/10 | FY-10/11 | FY-11/12 | FY-12/13 | FY-13/14 |
|-----------------------|---------------|---------------|---------------|---------------|---------------|
| Revenues | 16,954,022.99 | 16,799,578.25 | 16,548,473.15 | 16,463,702.60 | 16,425,235.21 |
| Discounted cash flows | 15,844,881.30 | 14,673,402.26 | 13,508,483.50 | 12,560,079.89 | 11,710,965.70 |

The benefits result from the revenue generated by parking fees and citations.

PW(Benefits)= \$15,844,881.30+ \$14,673,402.26+ \$13,508,483.50+ \$12,560,079.89+

\$11,710,965.70 = \$68,297,812.65

The costs are determined by the present worth of the expenditures.

| | 0 | FY-09/10 | FY-10/11 | FY-11/12 | FY-12/13 | FY-13/14 |
|-----------------------|----------|--------------|--------------|--------------|--------------|--------------|
| Expenditure | 6,900.00 | 6,465,115.45 | 6,540,613.44 | 6,606,186.42 | 6,636,684.41 | 6,702,257.40 |
| Discounted cash flows | 6,900.00 | 6,042,163.97 | 5,712,825.09 | 5,392,615.95 | 5,063,094.76 | 4,778,616.90 |

PW(Costs)= \$ 6,900.00+ \$6,042,163.97+ \$5,712,825.09+ \$5,392,615.95+ \$5,063,094.76+

\$4,778,616.90 = \$26,996,216.66

To calculate the disbenefits we first have to estimate the number of parking processes that use the cell phone parking option.

We assume an average parking fee of \$2.5 and divide the uninflated parking fee revenues by this in order to get the number to parking processes. Parking processes multiplied by the percentage of cell phone payments leads o the number of cell phone payments. For every cell phone payment disbenefits of $0.25 \in 0.69$ occur. The disbenefits, which are used in the benefit-cost ratio, are the sum of the discounted cash flows.

| | FY-09/10 | FY-10/11 | FY-11/12 | FY-12/13 | FY-13/14 |
|--------------------------------------|---------------|---------------|---------------|---------------|---------------|
| Parking Fee Revenue Forecast | 14,000,000.00 | 14,300,000.00 | 14,500,000.00 | 14,800,000.00 | 15,100,000.00 |
| Uninflated Revenues | 13409961.69 | 13285468.48 | 13066226.22 | 12619962.6 | 13249170.06 |
| Parking Processes | 5363984.674 | 5314187.394 | 5226490.488 | 5047985.039 | 5299668.023 |
| Percentage of Cell Phone Payments | 0.15 | 0.20 | 0.30 | 0.40 | 0.50 |
| Cell Phone Parking Processes | 804,598 | 1,062,837 | 1,567,947 | 2,019,194 | 2,649,834 |
| Amount Due to Operating Company | 138,793.16 | 183,339.38 | 270,470.86 | 348,310.97 | 457,096.37 |
| Discounted Cash Flow | 129,713.23 | 160,135.72 | 220,784.79 | 265,724.77 | 325,903.39 |

PW(Disbenefits) = \$129,713.23 + \$160,135.72+ \$220,784.79+ \$265,724.77+ \$325,903.39

= \$ 1,102,261.89

$$BC = \frac{\$68,297,812.65 - \$1,102,261.89}{\$26,996,216.66} = 2.49$$

4.4.2.2 Introduction with the new pricing model

The new pricing model does not affect costs or disbenefits, only the benefits change due to the changes in the revenues.

| | FY-09/10 | FY-10/11 | FY-11/12 | FY-12/13 | FY-13/14 |
|-----------------------|---------------|---------------|---------------|---------------|---------------|
| Revenues | 16,752,873.56 | 16,534,126.35 | 16,157,245.66 | 15,945,271.11 | 15,782,693.63 |
| Discounted cash flows | 15,844,881.30 | 14,673,402.26 | 13,508,483.50 | 12,560,079.89 | 11,710,965.70 |

$$BC = \frac{\$66,704,976.22 - \$1,102,261.89}{\$26,996,216.66} = 2.43$$

4.4.3 Using the New Parking System Only

4.4.3.1 Introduction with the Old Pricing Model

As the old pricing model is used, there are no changes in the revenues and therefore the present worth oft the benefits is:

PW(Benefits)= \$68,297,812.65

The costs are determined by the present worth of the expenditures.

| | 0 | FY-09/10 | FY-10/11 | FY-11/12 | FY-12/13 | FY-13/14 |
|-----------------------|----------|--------------|--------------|--------------|--------------|--------------|
| Expenditure | 6,900.00 | 5,590,400.70 | 5,590,400.70 | 5,590,400.70 | 5,590,400.70 | 5,590,400.70 |
| Discounted cash flows | 6,900.00 | 5,224,673.55 | 4,882,872.48 | 4,563,432.22 | 426,488,9.93 | 3,9858,78.44 |

PW(Costs)= \$6,900.00+ \$5,224,673.55+ \$4,882,872.48+ \$4,563,432.22+ \$426,488,9.93+

3,9858,78.44 = 22,928,646.62

In this scenario all payments are made by cell phone. This leads to increased disbenefits, due to the service charge of the operating company.

| | FY-09/10 | FY-10/11 | FY-11/12 | FY-12/13 | FY-13/14 |
|--------------------------------------|---------------|---------------|---------------|---------------|---------------|
| Parking Fee Revenue Forecast | 14,000,000.00 | 14,300,000.00 | 14,500,000.00 | 14,800,000.00 | 15,100,000.00 |
| Uninflated Revenues | 13409961.69 | 13285468.48 | 13066226.22 | 12619962.6 | 13249170.06 |
| Parking Processes | 5363984.674 | 5314187.394 | 5226490.488 | 5047985.039 | 5299668.023 |
| Percentage of Cell Phone Payments | 1 | 1 | 1 | 1 | 1 |
| Cell Phone Parking Processes | 5,363,985 | 5,314,187 | 5,226,490 | 5,047,985 | 5,299,668 |
| Amount Due to Operating Company | 925,287.41 | 916,697.26 | 901,569.53 | 870,777.41 | 914,192.73 |
| Discounted Cash Flow | 864,754.59 | 800,678.89 | 735,949.29 | 664,311.92 | 651,806.78 |

PW(Disbenefits) = \$864,754.59+ **\$**800,678.89+ **\$**735,949.29+ **\$**664,311.92+ **\$**651,806.78

= \$3,717,501.47

$$BC = \frac{\$68,297,812.65 - \$3,717,501.47}{\$22,928,646.62} = 2.82$$

4.4.3.2 Introduction with the new pricing model

Compared with the situation in 4.5.3.1 introduction with the old pricing model, there are only changes of the expected revenues due to the new pricing model.

| | FY-09/10 | FY-10/11 | FY-11/12 | FY-12/13 | FY-13/14 |
|-----------------------|---------------|---------------|---------------|---------------|---------------|
| Revenues | 15,613,026.82 | 15,472,318.75 | 15,244,381.52 | 15,167,623.89 | 15,140,152.04 |
| Discounted Cash Flows | 14,591,613.85 | 13,514,122.41 | 12,443,956.27 | 11,571,307.64 | 10,794,719.16 |

PW(Benefits)= \$14,591,613.85+ \$13,514,122.41+ \$12,443,956.27+ \$11,571,307.64+

\$10,794,719.16 = 62,915,719.33

$BC = \frac{\$62,915,719.33 - \$3,717,501.47}{\$22,928,646.62} = 2.58$

| Keeping the existing system | | Introducing the ne parallel to the exis | w parking system ting | Using the new parking system only | | |
|--------------------------------|---------------|--------------------------------------------|--------------------------|-----------------------------------|---------------|--|
| | | old pricing | new pricing | old pricing | new pricing | |
| Benefits | 68,297,812.65 | 68,297,812.65 | 66,704,976.22 | 68,297,812.65 | 62,915,719.33 | |
| Disbenefits | 0 | 1,102,261.89 | 1,102,261.89 | 3,717,501.47 | 3,717,501.47 | |
| Costs | 27,835,545.25 | 26,996,212.66 | 26,996,212.66 | 22,928,646.62 | 22,928,646.62 | |
| B-C Ratio | 2.45 | 2.49 | 2.43 | 2.82 | 2.58 | |

From the table above it can be concluded that all options are attractive, even if disbenefits are considered. As the different options are mutually exclusive, a ranking based on the conventional rates of returns is not applicable.

4.5 Incremental comparison of mutually exclusive projects

In order to find out which option has the highest performance an incremental analysis of the benefit and cost ratio is needed. First of all, the alternatives are ranked in order of increasing present worth of costs.

| | Using the new pa | arking system only | Introducing the new system parallel to t | Keeping the existing | | |
|-------------|------------------|--------------------|------------------------------------------|-------------------------|---------------|--|
| | new pricing | old pricing | new pricing | old pricing | | |
| Benefits | 62,915,719.33 | 68,297,812.65 | 66,704,976.23 | 68,297,812.65 | 68,297,812.65 | |
| Disbenefits | 3,717,501.47 | 3,717,501.47 | 1,102,261.89 | 1,102,261.89 | 0 | |
| Costs | 22,928,646.62 | 22,928,646.62 | 26,996,212.66 | 26,996,212.66 | 27,835,545.25 | |
| B-C Ratio | 2.58 | 2.82 | 2.43 | 2.49 | 2.45 | |

Calculating the incremental B-C ratio between the new parking system with or without the new pricing model is not possible, since the costs are equal and the result for the denominator would be 0. Therefore only the benefits matter and the new baseline is the new parking system only with the old pricing model. Incremental comparison of this option with the remaining three option shows that none of them is better, since the incremental B-C ratios are all smaller than 1.

$$\Delta BC = \frac{(\$66,704,976.23 - 68,297,812.65) - (1,102,261.89 - 3,717,501.47)}{26,996,212.66 - 22,928,646.62} = 0.25$$

$$\Delta BC = \frac{(\$68,297,812.65 - 68,297,812.65) - (1,102,261.89 - 3,717,501.47)}{26,996,212.66 - 22,928,646.62} = 0.64$$

$$\Delta BC = \frac{(\$68,297,812.65 - 68,297,812.65) - (0 - 3,717,501.47)}{27,835,545.25 - 22,928,646.62} = 0.76$$

From this analysis, based on benefit cost ratio, the new parking system should be introduced right a way but the old pricing should be kept.

5 CONCLUSION

In any decision making process, there are a variety a variables (tangible or intangible) to be incorporated in which to calculate and/or consider for the final decision. What we have done up until this point is to show the financial feasibility assessment given the current infrastructure design in comparison with available alternative models. With this economic analysis, we have applied a variety of known financial models in order to compare and contrast the stated parking models. Even with an alternative model, there is also a decision on the paying structure to be employed for further assessment.

Given the analysis, it has shown from a financial perspective the feasibility of employing a new parking model with the known data. As stated, in any decision making process, we have only calculated the financial feasibility. A functional feasibility assessment will be needed for the specific geographical region in which one would want to deploy this new parking model. Not all infrastructures are the same, and with the success in one region, might be a complex and/or non-practical implementation in another.

Lastly, we have conducted our economic analysis with the available data we were able to acquire. There could be extended financial variables that will need to be analyzed by the city of Portland. For example, there could be union issues with employees, existing contract with service providers, and the available resources and/or impact in the current climate in which to undertake this project.

6 FURTHER STUDY

With the economic analysis of an alternative parking model, it is purely focused on street parking. Given extended economic and functional feasibility assessments, the alternative model could also be applied in similar infrastructures such as Mass Transit (e.g. Max, Busses). In stead of paying at a pay stations and/or paying the driver, a user could purchase the fair via their telephone. This again can remove a lot of the physical hardware to sustain their current infrastructure and make this operation more profitable.

Besides just applying this alternative model to similar public infrastructure, further study could also be looked into integrating this parking model with mapping services (i.e. Google Maps). Where based on logic, a system could defer the available parking spots based on the ones taken in a certain section. This in turn could be transmitted to a mapping service where by a user could view their current location and see the available parking spots in the surrounding area.

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APPENDIX

| Revenue Source | FY03-04 | FY04-05 | F¥05-06 | FY06-07 | FY07-08 | Extinuated FY08-09 |
|-------------------------------------|---------------|----------------------|----------------------|--------------|----------------------|-----------------------|
| State Highway Inist Fund Allocation | \$ 24,455 | \$ 26,574 | \$ 26 <i>7</i> 89 | \$ 26,009 | \$ 24,556 | \$ 23,400 |
| Gas TaxIGA with Mulmonah County | \$ 21,902 | \$ 20,827 | \$ 21,173 | \$ 20,496 | \$ 20,540 | \$ 20,200 |
| Total-Gas Tax | \$ 46,357 | \$ 47,401 | \$ 47,962 | \$ 46,505 | \$ 4 <i>5</i> ,0% | \$ 43 <i>5</i> 00 |
| Parking Meters | \$ 8960 | \$ 9 <i>\$</i> 15 | \$ 13,231 | \$ 14,277 | \$ 14 <i>6</i> 84 | \$ 13 <i>,</i> 600 |
| Parking Citations | \$ 2,668 | \$ 2 <i>7</i> 82 | \$ 3,327 | \$ 3,773 | \$ 3 <i>8</i> 13 | \$ 3 <i>7</i> 00 |
| Parking Permits | \$ 1,326 | \$ 1,289 | \$ 1,265 | \$ 2,000 | \$ 2,412 | \$ 1,900 |
| Total - On-Street Parking | \$ 12,9.54 | \$ 13,886 | \$ 17,823 | \$ 20,050 | \$ 20,909 | \$ 19,200 |
| Parking Garages Transfer | \$ 700 | \$ 700 | \$ 700 | \$ 700 | \$ 700 | \$ 1,500 |
| Revenue Total | \$ 60,011 | \$ 61,987 | \$ 66,485 | \$ 67,255 | \$ 66,705 | \$ 64,300 |

Appendix A-1: Portland Historical Revenue

History of Transportation Discretionary Revenue (\$1,000)

Source: City of Portland Financial Forecast 2009-14

Appendix A-2: Portland Forecasted Revenue

| | | _ | | | | | | | | |
|---------------------------------------|----------------------|----|-------------------|----|----------------|----|---------|-----------------------|----|----------------|
| | E stimated | | Forecast - \$1000 | | | | | | | |
| Revenue Source | FY08-09 | | FY09-10 | | FY10-11 | | FY11-12 | FY12-13 | | FY13-14 |
| State Highway Thu st Fund Allo cation | \$ 23,400 | \$ | 23,400 | \$ | 24,800 | \$ | 25,600 | \$ 25,800 | \$ | 26.DOO |
| Gas TaxIGA with Mulmomah County | \$ 20,200 | \$ | 20,200 | \$ | 20,400 | \$ | 20,500 | \$ 20 <i>\$</i> 00 | \$ | 20 <i>≴</i> 00 |
| Total- Gas Tax | \$ 43 <i>6</i> 00 | \$ | 43 <i>\$</i> 00 | \$ | 45,200 | \$ | 46,100 | \$ 46,400 | \$ | 46 <i>6</i> 00 |
| Parking Meters | \$ 13,600 | \$ | 14 J 00 | \$ | 14,300 | \$ | 14,300 | \$ 14,800 | \$ | 15,100 |
| Parking Citation s | \$ 3,700 | \$ | 3 <i>,</i> 700 | \$ | 3,800 | \$ | 3,900 | \$ 4 £00 | \$ | 4,200 |
| Parking Permits | \$ 1,900 | \$ | 1,900 | \$ | 2, 0 00 | \$ | 2,000 | \$ 2,100 | \$ | 2,100 |
| Total- On-Street Parking | \$ 19,200 | \$ | 19 <i>\$</i> 00 | \$ | 20,100 | \$ | 20,400 | \$ 20,900 | \$ | 21,400 |
| Parking Garage s Transfer | \$ 1,500 | \$ | 1,300 | \$ | 1,500 | \$ | 1,700 | \$ 1,900 | \$ | 2,100 |
| ULF in Excess of Gen Find Forecast | \$ | \$ | 2,300 | \$ | 3,200 | \$ | 4,100 | \$ 4,300 | \$ | 4,400 |
| Revenue Total | \$ 64,300 | \$ | 67,000 | \$ | 70,000 | \$ | 72,300 | \$ 73 ,500 | \$ | 74,500 |

Forecast Transportation Discretionary Revenue (\$1,000)

Source: City of Portland Financial Forecast 2009-14

Appendix B-1: Difference between Operators

| Criteria | | | Options | | |
|-------------------|------------------|-------------------|------------|-----------------|-----------------|
| Execution of | call 0800 number | call fix network | write text | | |
| transaction | | number | message | | |
| Dial number | number of | Number of | | | |
| | operator | operator and | | | |
| | | zone number | | | |
| Monthly service | none | family rate | Firm rate | | |
| Costs per parking | none | depending on | | | |
| transaction | | rate (see above), | | | |
| | | 9 to 18 cent | | | |
| | | | | | |
| Costs for bills | none with | normal mail rate | | | |
| | online bills | for paper bills | | | |
| Means of payment | credit card | debit memo | pay pal | prepaid card of | payment in |
| | | | | cell phone | advance, direct |
| | | | | | debit |
| Text message | yes, for free | yes, with fee | no | | |
| reminder before | | | | | |
| parking time | | | | | |
| Corporate client | yes, data for | xls or MS access | | | |
| service | accounting | | | | |