How to improve our current on-campus parking system?

36302 Sampling survey society

Team C: Silvia Manolache, Nicholas Thieme, Shu Wang, Yijia Zhou

Section 1: Introduction

1.1 Overview

On January 1st, 2011 the rates for the metered parking spots behind CMU were increased by the Pittsburgh Parking Authority to $2 per hour from $1 per hour, and the hours of enforcement for these meters were increased from 6 p.m. to 10 p.m. for all days except Sunday[1]. The reason for this increase, and others before it in recent years, was in part to pay for a bailout of the city's pension system. Other results of this increase as noted by the Pittsburgh Parking Authority were an increase in the number of employees hired to check the meters and write tickets, as well as an increase in broken meters from overfilling (the number of quarters needed to park doubled, and in some areas of Pittsburgh tripled, resulting in meters filling twice as quickly with quarters)[2].

Given all of this information, the Pittsburgh Parking Authority has considered updating the meters to be able to accept credit cards, but this change has not yet occurred for meters surrounding the CMU campus. There have been many outspoken critics of the rate hike and other changes, including even CMU professors who were cited in articles explaining why the rate hike was not necessarily a good economic idea (citation needed – my article with marketing prof). However, there have also been numerous sources of praise for the new income stream generated by the higher rates.

Being members of the Carnegie Mellon community, we noticed the rift in opinions regarding the metered parking situation at CMU, with some people claiming that it has unclogged the previously impenetrable parking area on Frew Street, and others claiming that rates were too high to be reasonable. We were curious whether the Carnegie Mellon Community is overall pleased with the metered parking system on Frew Street, Tech Street, and Schenley Park, or whether there were improvements, such as the updated meters the Pittsburgh Parking Authority has considered, which could improve both use and satisfaction levels of the metered spots.

Couple of paragraphs about results in a very broad overview.

We asked students and faculty members questions both regarding how satisfied they are with the current metered parking at CMU as well as questions regarding how satisfied they would be if meters would accept credit cards or coins other than quarters. We wanted to test separately the level of satisfaction with parking availability, costs of parking, number of tickets received, and times when the meters were checked, and also asked for input on what would be considered most fair in those categories by our respondents. For instance, we asked what time is most fair to stop collecting payment at the meters. *We then compiled the data into a few*

---

[1] City of Pittsburgh. http://www.city.pittsburgh.pa.us

[2] Vidonic, Bill. "Pittsburgh Parking Meter Rates to Increase as of Jan. 1" http://www.pittsburghlive.com/x/pittsburghtrib/news/pittsburgh/s_772245.html

measures of satisfaction and perceived fairness. <- this part is clearly not done yet since we don't have all the data ☺

We hope that the survey could be used by the Pittsburgh Parking Authority to determine whether their strategy for increasing rates and collection times is producing the effects that they want. While we don't have figures to indicate whether the new system is bringing in more money than before (or how much more money), we can offer statistics on prices which may create an optimal level of supply and demand for the meters, and on enforcement times which may better allow the Pittsburgh Parking Authority to match their marginal cost of patrolling the meters with their marginal benefit of money collected from tickets.

It is important not only to the campus community, but to the Pittsburgh Parking Authority as well, that the people using their services feel the services are satisfactory, and this survey aims to give a glimpse into one segment of their consumer population and how effectively this sector feels it is being served.

[include couple of sentences here about whether or not we have seen that people are satisfied and what this might mean to the Pittsburgh Parking Authority].

1.2 Relevant Prior Studies

In beginning our research into the opinions surrounding the on-campus parking at CMU and potential methods of improvement, we tasked ourselves with building upon already completed relevant research while ensuring substantially different methods and end results in order to expand the field of research conducted in the area of parking satisfaction. We understand that without baseline meter price and availability data, it becomes more difficult to understand information we may gather. As such we located *Financial Analysis of Parking Assets of the Public Parking Authority of Pittsburgh*[3], an analysis conducted by Desman Associates regarding the state of the current Pittsburgh Parking Authority. The data in this article is used throughout our analysis as a baseline for meter prices and availability data. Additionally, in order to gain a better understanding of the parking situation in Pittsburgh, and specifically , why the rates at CMU have been increasing we consulted an analysis conducted by the Finance Scholars Group entitled *Analysis of Pittsburgh's Parking Assets*.[4] This analysis suggested a number of potential ways to increase revenues from parking, one of which was an increase in parking meter costs. However, as we are interested in what factors motivate people to park at meters, as well as what factors determine a person's satisfaction with their parking system, we consulted more diverse literature than merely financial analyses. Using *On Street Meter Parking Behavior*[5], and *The Urban Project and Policy Planning University Survey*[6] we were able to identify we would create positive and

[3] Desman Associates. *Financial Analysis of Parking Assets of the Public Parking Authority of Pittsburgh*. Rep. Chicago, 2010. Print.

[4] Spatt, Chester. *Analysis of Pittsburgh's Parking Assets*. Rep. Finance Scholars Group, 2010. Print.

[5] Adiv, Aaron. *On Street Meter Parking Behavior*. Rep. no. UMTA-MI-0009-02. Ann Arbor, MI, 1987. Print.

[6] Evans-Cowely, Jennifer. *Urban Project and Policy Planning University Survey*. Rep. 2005. Print.

negative aspects of prior survey's in order to measure attitudes and preferences of on campus parking in a more effective manner.

Section 2: Methods

2.1 Target population and Frame

In our survey, the target population for sampling is the population of all students and faculties at Carnegie Mellon University. In order to get a random sample from this population, we have decided to use the C-Book as our sampling frame. C-book is a student and faculty directory produced by Alpha Phi Omega that contains students and faculties' Andrew IDs, associated colleges/departments, and other information. Because we are uncertain how information are collected in the C-Book (i.e. how it treats new hired professors, study abroad students, etc.), our sampling frame might contain coverage errors as it can be potentially smaller than our target population.

To ensure a random sampling process where every member has the equal chance of being selected, we used a computer-based random number generator to generate a set of three numbers each time. According to our designed stratified sample sizes, we have generated 1500 sets of numbers, expecting a response rate of approximately 20%. For each set of three numbers, it is shown in the form of 21-1-38 (Exhibit 1). The first number represents the page number, the second represents the column number and the third represents item number. So the 38th person in column 1 of page 21 is randomly chosen to be in our sample.

2.2 Sample Size and Sampling Scheme

In electing our Margin of Error (hereafter known as MOE) we aimed to balance the strength of our survey with the possibility of attaining the necessary sample size. As MOE decreases as sample size increases, the lower MOE we would like, the larger sample size we would need. Our MOE was determined based on two primary questions, "Do you own a car which you use (either regularly or occasionally) to commute to and from CMU?" and " Do you use a friend's or family member's car to commute to and from CMU (either regularly or occasionally)?", however, as both questions can be assumed to have the same Standard Error, one MOE calculation with suffice for both questions. The logic behind choosing these questions is simple. As our aim is to determine satisfaction with on campus parking, it is vital for us to be able to accurately estimate the number of people who drive to campus and are thus involved with our topic of interest.

Our sampling method is a Stratified Random Sample, stratifying between faculty and students at Carnegie Mellon, as we believe these groups will differ significantly on their views about the on-campus parking system, and additionally, the proportion of car owners. Through online sources, we determined the faculty population at CMU was 1,368 and the student population was 11,955 coming to a total of

13,323. Additionally, two assumptions were made regarding Standard Deviations to make calculations possible. We assumed the proportion of car owners and car users for faculty to be .8 as most faculties live off campus (and excluding the .2 who take the bus or carpool) will drive. The proportion of students was assumed to be .5 as we did not know the true proportion.

Using $1.96\times\sqrt{\sum_{h=1}^{H} W_h^2(1-f_h)\frac{s_h^2}{n_h}}$ formula to determine the MOE for a n=300, we find:

$$1.96\times\sqrt{\left[\left(\frac{11,955}{13,323}\right)\left(1-\frac{168}{11,955}\right)\frac{.5^2}{168}\right]+\left[\left(\frac{1,368}{13,323}\right)\left(1-\frac{132}{1,368}\right)\frac{.4^2}{132}\right]}=.076$$

To determine n_h two calculations were needed, the first was s_h where s_1 corresponded with faculty sd, and where s_2 corresponded with student sd. The second was $n_h=\frac{s_h}{\sum_h s_h}$ where the same s_1 and s_2 apply. The calculations were as follows.

$$s_1=\sqrt{.8(.2)}=.4 \qquad n_1=\frac{.4}{.9}$$
$$s_2=\sqrt{.5(.5)}=.5 \qquad n_2=\frac{.5}{.9}$$

The values of .4444, and .5556 correspond to the fractions of the total sample of 300 for faculty and students. These fractions correspond to strata sizes of 133 and 166 for faculty and students respectively.

2.3 Data Collection

After we entered students' contact information into a list, we at the initial phase sent out 800 emails to students and 320 emails to faculties. We chose the CSAQ (Computerized Self-Administered Questionnaires) through a web-based survey on www.surveymonkey.com. In the email, we attached the survey link, explained our motivation to conduct the survey and emphasized why the completion of our survey is. To ensure the participants' confidentiality is protected, we also stressed the fact that no confidential or identifiable information will be included in our final report and we will not allow others to access their information.

We used the online survey over other methods of data collection because it helps us to reach to a variety of target population conveniently. This CSAQ through survey monkey's website will help protect respondents' credential information, collecting their responses in a more effective and accurate way. We have considered the problem associated with low response rate, and to increase the response rate,

we will a reminder email a week after the initial email to the same group of people in case they accidently missed the first email or forgot to answer the survey for some reason. We have yet entered the phrase to follow up, and we will try to understand whether the follow-up email has actually increased the response rate.

Both emails can be found in the appendix section of this paper (Appendix 3).

2.4 Questionnaire

Our outcome variables are satisfaction scores, which contain students and faculties' current satisfaction towards on-campus parking system and their "future" satisfaction if the assumed scenarios happen. Our independent variables are demographic information such as class year, gender, college, their parking habits such as how many times in a week they park on Tech Street, Frew Street or Schenley Park and how often they get tickets, as well as their opinions such as what time of day they consider to be the most fair to start requiring payment and what they think the most reasonable amount should be.

Some sample questions from our survey included, but were not limited to:

Type A: Demographic based questions

In what college do you belong to? (Only apply to undergraduate students)

Please select your gender

Type B: stratum-designating question

a) Class year and status

Please select which of the following best describe you:

Undergraduate-first year; Undergraduate-second year; Undergraduate-third year; Undergraduate-fourth year; Undergraduate-fifth year; Graduate-Master program; Graduate-PhD program; Faculty

b) Car ownership

Do you own a car that you use (either regularly or occasionally) to commute to and from CMU?

Do you use a friend's or family member's car to commute to and from CMU (either regularly or occasionally)?

c) Questions regarding parking habits

How many times in an average week in the past semester have you parked at a metered spot on Tech Street, Frew Street, or surrounding Schenley Park? If you leave campus and return on the same day please count each distinct number of times you have parked.

d) Overall satisfaction/fairness toward pricing

Please state your overall satisfaction with the metered parking spots on Tech Street, Frew Street, or surrounding Schenley Park. Think about the time periods in which the meters are checked, costs of parking, space availability, etc.

e) Possible improvements

How much more or less satisfied would you be if the following scenario happened?

(Check one box in each column)

	Much Less Satisfied	*Less Satisfied*	*Equally Satisfied*	*More Satisfied*	*Much More Satisfied*	*I don't know*
You are allowed to pay with multiple kinds of coins (quarters, dimes, nickels) at the metered spots.						
You are allowed to pay with credit and debit cards at the metered spots.						

2.5 Post-Survey Processing

[By the time we wrote this rough draft, we have just finished phase I and haven't given people enough time to respond to the survey, so results, response rate and nonresponse/refusal information will be filled in here later]

Section 3: Results

3.1 Post-stratification

We might likely see this and will re-weight the sample to make them agree.

3.2 Adjustments

As a faculty member of statistics department noticed, there had been some display problems in survey monkey's website where some of the questions did not show up properly while one question got repeated over times. We have updated the questions when 67 respondents have answered the question, and this might somewhat affect our result.

3.3 Discussion

Current results have identified that over 75% of the respondent are slightly unsatisfied or very unsatisfied with the current cost of parking at the metered spot on Tech Street, Frew Street, or surrounding Schenley Park. ____% of the respondents have expressed their concerns over the cost of the parking metered as ___% of respondent considered the cost equal or less than $0.50 per hour to be a fair

price for the metered spots on Tech, Frew Street or surrounding Schenley park. This percentage increase to ___ for the cost equal to $1 or less.

Noticeably, the question regarding the crowdedness of the metered parking spots on Tech, Frew Street or surrounding Schenley park has been skipped frequently as ___of the respondent did not provide an answer. A potential explanation of this problem is participants usually do not park in these space, so they do not have the knowledge of the crowdedness.

Appendix 1: Random Number Generator (Selected)

Student Emails

Silvia				Nick				Shu				Yijia			
Identifier	P	C	L	Identifier	P	C	L	Identifier	P	C	L	Identifier	P	C	L
11-1-23	11	1	23	11-2-16	11	2	16	11-2-1	11	2	1	123-2-8	123	2	8
11-1-35	11	1	35	11-2-24	11	2	24	11-2-9	11	2	9	122-1-20	122	1	20
12-1-12	12	1	12	11-2-28	11	2	28	12-1-11	12	1	11	121-1-3	121	1	3
12-2-25	12	2	25	12-1-20	12	1	20	12-1-14	12	1	14	121-1-19	121	1	19
13-1-36	13	1	36	12-1-32	12	1	32	12-2-13	12	2	13	120-1-33	120	1	33
13-2-1	13	2	1	12-2-31	12	2	31	12-2-27	12	2	27	120-2-12	120	2	12
13-2-16	13	2	16	13-2-12	13	2	12	14-1-21	14	1	21	118-2-18	118	2	18
14-1-22	14	1	22	14-2-9	14	2	9	14-2-12	14	2	12	118-2-36	118	2	36
14-1-31	14	1	31	14-2-10	14	2	10	15-1-10	15	1	10	118-2-38	118	2	38
14-2-37	14	2	37	14-2-14	14	2	14	16-2-28	16	2	28	117-1-11	117	1	11
15-2-3	15	2	3	15-2-25	15	2	25	17-1-4	17	1	4	116-1-14	116	1	14
15-2-4	15	2	4	16-1-9	16	1	9	17-2-12	17	2	12	116-1-19	116	1	19
16-1-37	16	1	37	16-1-26	16	1	26	18-2-13	18	2	13	116-2-26	116	2	26
16-2-19	16	2	19	16-2-1	16	2	1	18-2-36	18	2	36	116-2-35	116	2	35
17-1-10	17	1	10	16-2-18	16	2	18	19-1-32	19	1	32	115-1-20	115	1	20
17-1-29	17	1	29	17-1-2	17	1	2	20-1-36	20	1	36	114-1-1	114	1	1
18-1-3	18	1	3	17-1-12	17	1	12	20-2-8	20	2	8	114-1-15	114	1	15

Faculty Emails

Silvia				Nick				Shu				Yijia			
Identifier	P	C	L	Identifier	P	C	L	Identifier	P	C	L	Identifier	P	C	L
128-1-11	128	1	11	126-2-8	126	2	8	126-2-27	126	2	27	128-1-19	128	1	19
134-1-25	134	1	25	134-1-2	134	1	2	134-2-14	134	2	14	140-1-1	140	1	1
133-2-35	133	2	35	138-2-17	138	2	17	133-2-40	133	2	40	136-1-32	136	1	32
132-1-19	132	1	19	139-1-39	139	1	39	139-2-19	139	2	19	135-2-24	135	2	24
132-1-4	132	1	4	134-1-34	134	1	34	127-2-8	127	2	8	124-1-11	124	1	11
137-1-27	137	1	27	125-1-40	125	1	40	131-1-13	131	1	13	129-1-16	129	1	16
125-1-27	125	1	27	134-2-26	134	2	26	132-2-39	132	2	39	127-1-33	127	1	33
137-1-28	137	1	28	133-1-40	133	1	40	140-1-12	140	1	12	133-2-33	133	2	33
125-2-40	125	2	40	129-1-4	129	1	4	141-2-19	141	2	19	130-2-30	130	2	30

140-1-31	140	1	31		141-1-33	141	1	33		131-2-35	131	2	35		129-2-7	129	2	7
133-2-21	133	2	21		128-1-16	128	1	16		124-1-27	124	1	27		130-1-30	130	1	30
135-2-35	135	2	35		137-2-7	137	2	7		141-2-20	141	2	20		139-1-2	139	1	2

Appendix 2 (Complete Survey Questions):

1. Please select which of the following best describes you:
    a) Undergraduate – first year
    b) Undergraduate – second year
    c) Undergraduate – third year
    d) Undergraduate – fourth year
    e) Undergraduate – fifth year
    f) Graduate – Masters program
    g) Graduate –PhD program
    h) Faculty
    i) Others _____

2. Please select your gender:
    a) Male
    b) Female

3. Please select the college you are enrolled in (college of your primary major). If you are a faculty member, please select the college you are employed in.
    a) HSS
    b) MCS
    c) CIT
    d) CFA
    e) Tepper
    f) SCS
    g) Heinz
    h) CMU (BSA, BXA, and other intercollege programs)
    i) Others _____

4. Do you own a car that you use (either regularly or occasionally) to commute to and from CMU? If you live on campus this can include trips to the grocery store and back, etc.
    a) Yes
    b) No

5. Do you use a friend's or family member's car to commute to and from CMU (either regularly or occasionally)?
    a) Yes
    b) No

For the following questions, please think about how often in THIS SEMESTER (starting January 16, 2012), you have parked at the METERED parking spots on Tech Streets, Frew Street, or surrounding Schenley Park.

6. How many times in an average week in the past semester have you parked at a metered spot on Tech Street, Frew Street, or surrounding Schenley Park? If you leave campus and return on the same day please count each distinct number of times you have parked. Please enter your answer in the blank below.

7. How fair do you think the rates for the metered spots on Tech Street, Frew Street, or surrounding Schenley Park are? The rate is $1 for 30 minutes ($2 per hour).

a) Very fair
b) Moderately fair
c) Neither fair nor unfair
d) Slightly unfair
e) Very unfair
f) No opinion

8. How many times have you gotten a ticket in this semester (since January 16, 2012) because you have parked at a metered spot on Tech Street, Frew Street, or surrounding Schenley Park and the meter has run out or you have failed to pay? Please enter your answer in the blank below.

9. How many times in this semester (since January 16, 2012) have you parked at a metered spot on Tech Street, Frew Street, or surrounding Schenley Park and wanted to pay, but have not been able to pay in full or at all because you did not have enough quarters? Please enter your answer in the blank below.

10. What time of day (on every day but Sunday) would you consider to be the most fair to START requiring payment at the meters on Tech Street, Frew Street, or surrounding Schenley Park? Be sure to mention AM or PM, and note 12 pm is noon. Please enter your answer in the blank below.

11. What time of day (on every day but Sunday) would you consider to be the most fair to STOP requiring payment at the meters on Tech Street, Frew Street, or surrounding Schenley Park? Be sure to mention AM or PM, and note 12 pm is noon. Please enter your answer in the blank below.

12. Which of the following rates would you consider to be the most fair for parking at the meters on Tech Street, Frew Street, or surrounding Schenley Park?

a) less than $.5 per hour

b) $.5 per hour
c) $1 per hour
d) $1.5 per hour
e) $2 per hour
f) $2.5 per hour
g) $3 per hour
h) $3.5 per hour
i) More than $3.5 per hour
j) I don't know

13. For how long do you normally park at the metered spots on Tech Street, Frew Street, or surrounding Schenley Park at any given time?

a) Less than 1 hour
b) About 1 hour
c) Between 1 and 2 hours
d) About 2 hours
e) Between 2 and 3 hours
f) About 3 hours
g) Between 3 and 4 hours
h) About 4 hours
i) More than 4 hours
j) I don't park there

14. How many times in a given week do you park at the metered spots on Tech Street, Frew Street, or surrounding Schenley Park in the following time slots?

a) Before 12PM (noon)
b) 12PM – 7PM
c) After 7PM

15. How much more or less satisfied would you be if the following scenario happened with regard to the metered spots on Tech Street, Frew Street, or surrounding Schenley Park?

	Much Less Satisfied	Less Satisfied	Equally Satisfied	More Satisfied	Much More Satisfied	I don't know
You are allowed to pay with multiple kinds of coins (quarters, dimes, nickels) at the metered spots.						
You are allowed to pay with credit and debit cards at the metered spots.						

16. How much more or less often would you park at the metered spots on Tech Street, Frew Street, or surrounding Schenley Park if the following scenario happened?

	Much Less Often	Slightly Less Often	The Same Amount	Slightly More Often	Much More Often	I don't know
You are allowed to pay with multiple kinds of coins (quarters, dimes, nickels) at the metered spots.						
You are allowed to pay with credit and debit cards at the metered spots.						

7. How crowded do you perceive the metered parking spots on Tech Street, Frew Street, or surrounding Schenley Park to be during the following hours on a regular day?

	Almost no cars (close to 0%)	About 0% - 25% spaces taken	About 25% - 50% spaces taken	About 75% - 100% spaces taken	Pretty much 100% spaces taken	I don't know
Before 12 PM (noon)						
12 PM – 7 PM						
After 7 PM						

18. How satisfied are you with the current cost of parking at the metered spots on Tech Street, Frew Street, or surrounding Schenley Park?

a) Very Unsatisfied
b) Slightly Unsatisfied
c) Neither Satisfied nor Unsatisfied
d) Slightly Satisfied
e) Very Satisfied
f) No opinion

19. Please state your overall satisfaction with the metered parking spots on Tech Street, Frew Street, or surrounding Schenley Park. Think about the time periods in which the meters are checked, costs of parking, space availability, etc.

a) Very Unsatisfied
b) Slightly Unsatisfied
c) Neither Satisfied nor Unsatisfied
d) Slightly Satisfied
e) Very Satisfied
f) No opinion

20. Please let us know any comments or suggestions which you may have.

Appendix 3 (Email Invitation):

Dear CMU students/faculty members,

I hope this email finds you well. I am writing to you on behalf of the CMU 36-303 Survey Sampling and Society Group C in order to improve the on campus parking for CMU students. We all understand that parking at CMU is not perfect, and could be greatly improved. However, in order to do so we are collecting student and faculty opinions on a variety of topics regarding the on campus parking. The end goal is to compile a report which demonstrates student and faculty opinions on the matter, and aim to make changes in the parking system.

Your input is extremely valuable and should take fewer than 10 minutes using the link below.

Please click here to participate in the survey:

https://www.surveymonkey.com/s/QNV6P2B

No confidential or identifiable information will be included in the final report, and the list will not be used for any other purposes. We are being sponsored by our professor, Dr. Brian Junker of the Statistics department. I am available at any hour, and on the weekends for contact if you have any questions regarding the project as a whole. If you would be interested in receiving a copy of the final report, we would be more than happy to provide you one when it is completed. This is a topic of importance to all of us on campus, please take a couple of minutes out of your schedule to improve the lives of your fellow students.

We highly appreciate your time and input.