Looks like a great start.

I look forward to good quantitative analyses, and a report that the campus community should be interested in.

-BJ

Parking Meters at Carnegie Mellon University

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Section 1: Introduction

Research Question and Motivation

Coin parking meters are becoming a rarity in today's technologically advanced era, so why at Carnegie Mellon has there not been a technological improvement in terms of parking on its campus since CMU is known for being such a big tech hub? *Parking Meters at Carnegie Mellon University* is a survey regarding on campus parking meters to determine if there is a high frequency in unpaid meters. Additionally, it would be interesting to see if there are any correlations between other factors, such as the estimated value of the vehicle, time of day, day of week, color of vehicle, etc.

This project is relevant for the portion of Carnegie Mellon community members who uses the parking meters on campus, and especially those who have been ticketed for parking violations. This survey is also significant, because it looks at the bigger picture. Through effective investigation and research, the results illustrate exactly how efficient the parking system at Carnegie Mellon University Pittsburgh campus actually is.

Overview

The main focus of this survey was to see if there is an abundance of people parking illegally. The time of day was also considered to see if there are certain times of day or certain days of the week that was correlated to a higher frequency of illegal parking. The state the vehicle is registered in was also recorded in order to see if there was a difference of out of state individuals versus Pennsylvania residents. Other variables such as make/model and color were noted in order to see if there is any connection with these factors and illegal parking.

This survey looked at different aspects of metered parking at Carnegie Mellon University and included the questions below amongst many others.

a. How frequent do people not pay meters
b. Are certain days/times more likely to have unpaid meters
c. Are different types (color/brand/model) of vehicles more likely to be at an unpaid meter
d. Are vehicles registered with Pennsylvania stickers or outside states (by checking license plate) more likely to be at an unpaid meter

Parking Meters at Carnegie Mellon University surveyed all campus parking meters at various hours in the day and on multiple days while recording how frequently the meters are unpaid and which types of vehicles are parked at those unpaid meters. Due to our findings,

Carnegie Mellon University should strive to seek alternative methods to coin operated parking meters for its campus community members.

Section 2: Methods

since you are doing a census and not a sample survey I'm going to suggest some simpler re-wording below.

Target Population

target popoulation

The ~~sampling frame~~ was parking meters on Frew, Tech, Margaret Morrison Street, and This is the University Center, and behind Morewood Gardens. ~~The target population was~~ all of the on campus parking meters, since the target population is not overwhelmingly large in size, all units and in the target population were observed.

~~*Sample Size*~~

Population description

There are total of 224 parking meters on campus:

Margaret Morrison St	5
Tech St	29
Frew St	168
University Center	6
Behind Morewood	16

The sampling scheme is a census of all 224 parking meters. The results from a census are more reliable than the ones we would obtain from doing a random sample since there is theoretically no error in a census. Since a census of all campus parking meters was conducted, the sample size was 224 and the margin of error was zero.

Survey

~~*Sample Design and*~~ *Methods*

The survey was conducted by checking each parking meter at varying times and on different days, whilst recording the observations. An EXCEL spreadsheet was used (using a small lap-top or pad-like lap-top) to record the findings. A copy of this EXCEL spreadsheet can be found in Appendix 2. Below is a general grouping of the aspects that were surveyed:

Questions related to the parking meter

1. Is there a vehicle parked at the parking meter?
2. Is the vehicle parked at an expired meter?

3. Is the meter broken?

Questions related to the vehicle

1. What color is the vehicle?
2. Type of vehicle (compact, minivan, truck, etc.)
3. Make of vehicle (Chevy, Ford, BMW, Mazda, Honda, Pontiac, etc.)
4. Model of vehicle (Accord, Focus, Protégé, Sunfire)
5. What state is their license plate from?
6. Does the vehicle have a ticket?
    a. How much is the ticket?
    b. What were they ticketed for?
7. Is the vehicle clean or dirty?
8. Do they have registration? (tag located on license place)
    a. Is the registration expired?
9. Do they have their vehicle inspected? (tag located on windshield)
    a. Is their inspection expired?
10. Does the vehicle have any after-market additions? (fancy exhaust system, suspension lift, spoiler, fancy rims)
11. Is the vehicle parked at a handicapped parking spot?
    a. Do they have a handicapped tag/license plate
12. Does the vehicle have any major dents, scrapes, or shattered windows?
13. Is the vehicle driving on a spare tire?
14. Does the vehicle have a parking pass to park on another on-campus location?

Questions not related to either the meter or the vehicle

1. What day of the week is it?
2. What is the time?
3. What street is the vehicle parked on?
4. What is the weather like? (sunny, rainy, cold, hot, etc.)
5. Total percentage of vehicles parked on each street/region

A reference sheet of most vehicle makes was created in a column format in order to be most efficient during the survey process. Specific to the questionnaire, most of the questions were "yes" or "no" questions, so coding "1" for "yes" and "0" and "no" was used. For the "type of vehicle" question, the following coding was used: 1 for a car/sudan, 2 for a truck, 3 for SUV, 4 for VAN, 5 for motorcycle/scooter, 6 for other. Coding was used for all but four questions in our survey in order to conduct the survey in the most efficient manner.

Since parking meter fees apply between 8:00am and 10:00pm for the Skibo/Baker parking meters, 8:00am until 5:00pm for the meters behind Morewood, and 24 hours at the University Center meters, two surveying groups were comprised in order to administer the census. The first group surveyed morning commuters, from 8:00am to 12:00pm, and the second group surveyed afternoon commuters, from 12:00pm to 5:00pm.

These subgroups cover some key demographics of student, faculty, and visitors for presence on campus which led to some interesting differences between morning commuters versus afternoon commuters' behavior towards paying parking meters on campus. In each of the subgroups, a full sample of all parking meters on campus (Frew Street, Tech Street, Margaret Morrison Street, University Center, behind Morewood Gardens) was recorded. The schedule of data collection times is below:

M W F census collection		
Jungmoon/Nancy (helped after 10:20pm on M W) & Victor (helped F)	Morning	9:00-12:00pm
Victor/Nancy	Afternoon	3:30-6:30pm
T Th census collection		
Jeff	Morning	9:30-12:00pm
Kaylee/Nancy	Afternoon	12:00-3:00pm

Given the survey census design, there were two cluster variables- Time and Location. First, there were two time variables, Day of the Weekday (M,T,W,TH,F) and Time of Day (Morning, Afternoon). Since commuters to Carnegie Mellon are probably very specific on what time they are on campus, each subgroup was aimed to yield similar responses. Second, location variable of parking meter spaces (Tech St., Frew St., Margret Morrison St., Morewood Parking Lot, Frew St.). Since parking meters are very location specific, we found that people who park at meters were different between and similar within each location. We surveyed for one week, and the calculations in Appendix 1 showcase why we believe one week was enough time to collect the data we need.

Post Survey Processing

After we compiled a data set from our 10 different runs of parking meters on campus, we examined that some variables became of little use whereas others were obviously correlated ~~in~~ with (?) ~~predicted~~ non paid parking meters on campus.

Coding categorical for expected change in not paid meters and which reference category type will be set to 0:
Color: Use black. (e.g. a car that is red may have more or less expected unpaid meters compared to black cars)
Car type: Use 1, Sudan type (e.g. a SUV may have more or less expected unpaid meters compared to sedans)

Registration state: Use PA, Pennsylvania (e.g. a car registered in Ohio may have more or less expected unpaid meters compared to cars registered in Pennsylvania)

Categorical variables with yes or no responses we will set no as the reference.
Clean: use dirty (e.g. a clean car will have more or less expected unpaid meters compared to dirty car)
Handicapped: Use not handicapped (e.g. a handicapped reserved space will have more or less expected unpaid meters compared to a non-reserved space)

I don't see any need for weighting in your work.

Design weights or Post Stratification weights: Weighting overly representative location, Frew Street, and under representative location, University Center if need be to reduce variances. However due to difficulty in interpreting location effects and meter ticketing effects by Pittsburgh authority or CMU of parking meters, weights do not seem like a plausible solution.
Imputation: There is not much need for imputation in our survey since we have little or no missing values for our data.

We will fit a general linear regression or logistic regression, then check for interactions, add any fitted regression line smoother. We will in the process check for the amount of variances that are reduced when we add or remove certain variables. In our census we must be aware of over fitting since some of our predictor variables may be correlated.
Then so we will find for example that for certain car colors, car types, or clot type there are more or less expected number of unpaid meters.
Also calculating expected values and variances, we hope to then further process the risk involved in paying and not paying for those who utilize parking meters.

Section 3: Results

General Results

Upon analyzing the results of the survey, we found relevant correlations that will illustrate how many members of the Carnegie Mellon University community park at a parking meter, and which of those individuals parking at a parking meter actually pay for parking.

We will add in more general results and conclusions after our data analysis.

Conclusions about our research question *...to be continued*

in your analyses and results, make use of the multiple censuses to estimate quantities that you cannot get estimates or SE's for, from a single census.

Section 4: Discussion

Our Research Questions

The survey *Parking Meters at Carnegie Mellon University* analyzed campus parking meters in order to find meaningful correlations between the frequency of unpaid meters along with any correlations between other factors, such as the estimated value of the vehicle, time of day, day of week, color of vehicle, etc. Many results from the survey begs the question, why is Carnegie Mellon University not actively searching for new ways of implementing technological improvements in terms of parking on its campus in order to monitor parking in the most efficient and cutting-edge manner?

Surprising Results

interesting...

Upon conducting our census survey, the lack of vehicles parked at the parking meters was overwhelming and quite surprising. Furthermore, an even greater surprise came from the proportion of those vehicles that were parked at a campus parking meter and did not pay. We found that only 40% of the parking meters on campus were being used, and of that forty percent, over 30% did not put money in the meter they were parked at.

Meaningful Results

Possible explanations for our findings can be drawn from the increase in price per hour for parking and the time limitations now in place that does not allow one to park park in a given parking zone for more than four hours a day are quite evident. Both of these aspects, along with various other stipulations now being enforced on those who chose to park on campus, are ultimately affecting the effectiveness of parking on campus. The next logical step to take is to find what other options Carnegie Mellon University can offer its campus community.

Weaknesses

Although we conducted a census, there are still some errors coming from ineligible units. First of all, we considered cars parked in between spaces as ineligible units. Usually, parking meters define parking spaces. However, there are sometimes spaces that are large enough so that a car can park but no parking meter is present, and the driver gets a free pass for the day. We noticed that this was usual case for cars parked in Frew Street. Also, there were issues with double parking; a car parked in two parking spaces, which we considered as ineligible unit as well. Sometimes, there were cars parked, but drivers were sitting in their cars, and we marked them as “not present” in our data. Another example of ineligible unit is CMU Transportation cars parked in parking spaces behind Morewood, which is administered by CMU and they were exempted from paying the parking meters. Also, cars parking at meters that we already had passed by and marked as “not present” remained to be “not present”.

Another error that arose was measurement error, in the sense that there was no way of knowing if a parking meter is really broken or not. If the meter was broken, the driver was obviously not able to pay and in some cases it was impossible to identify if the driver has not paid because the meter itself was broken or for some other reasons, all reflecting some aspect of measurement error.

Another source of error comes from missing values. Some cars did not have registration or inspection plates or sometimes both and there was no way for us to figure out whether the registration or inspection had expired or not. Therefore, we recorded such data as N/A. Also, there are some possible errors with making best judgment on colors of cars. Interestingly, as we were out there collecting data, people seemed to notice that we were making notes on cars and parking meters, and some drivers seemed to drive away from us, which could have resulted higher rate of no cars being parked at parking meters. Also, on Monday and Wednesday afternoon, cars behind Porter were unpaid for a particular reason (refer to Data Collection Stories below).

Data Collection Stories

1. ***"The Badge"***

On the first afternoon of Sampling, we (Victor and Nancy) were in the middle of recording data on a black Chevy Avalanche, when we were approached by a man inquiring what our business was. He acted tough and said we should be careful who we are spying on, then proceeded to show us his badge. From there we explained how we were only recording observational data about vehicles parked at meters and that it was for a class. Once he realized that we were doing nothing wrong he left us alone and went back into the building to resume the criminal justice class he was teaching.

2. ***"Cooper for Sale"***

On the third (Wednesday) afternoon of data collection, while on tech street collecting data on a Mini Cooper, the tech guy from Tepper tried to sell us the car. He was on break and noticed us closely observing his vehicle, not realizing we were just surveying he thought we were very interested in his car. He told us about all the great features, the low mileage, and the near pristine condition, he also said he planned on buying a new Mini Cooper after he sold that one. Once we explained we were just surveying for a class he began to tell us some personal accounts of parking. He was parked at a broken meter. He said that he knows where all the broken meters are so that he can avoid paying for parking. If his main broken meter spot is taken he tends to move his car around to different spots throughout the day, whereas if he gets the one on Tech Street he will not move all day. He also told us that CMU had at one time was in charge

presumably you have more current info on broken meters now (will you share? *smile*)

of on street parking on all three on campus roads with meters. He also said that before the price raise the streets were always filled and there were days he would have to park in Schenley Park for work.

yes this is certainly true!

3. *"Granny"*

On Wednesday morning, as I was on Tech St collecting data, an old lady parked in the parking space that I haven't yet passed by. However, since she was getting her stuff out of her car, and taking some time, I decided that I will come back to it and as I passed by, she was putting some coins in the meter. But, when I actually came back to take some notes on her car and checked the meter, the meter was unpaid. She was merely pretending that she was paying the meter because I think she realized that I was looking at people's cars and making notes.

Take Home Message

interesting and worth sharing with the campus community at some point.

There is a serious issue dealing with on campus parking meters. There is a very low rate of cars parked at meters on campus. Of the cars that do park on campus there is a significant amount that do not pay for parking. Although we are not sure of the underlying causes, one main concern is that hourly parking has recently had a hike in the rates. The parking system is very inefficient and changes should be made.

We may add more here too after our analysis.

References

We will add these in later.

be sure to use APA style discussed in class

Appendices

Appendix 1: Census Sample Size Calculation

N=224
P=.35
X=?
SD= Sqrt(224xPx(1-P)
SD=7.13
n=10 (number of Census)
*ME= (2*SD)/(sqr(n))*
*=(2*7.13)/(sqrt10)*
ME= 4.5

Appendix 2: Survey Questionnaire (next page)

	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T
1	Location	Parking Meter	Vehicle Present?	Color?	Type?	Make?	Model?	State of license plate?	Expired meter?	Broken meter?	Ticket?	What for?	How much?	Clean (1) or Dirty (0)?	Registration (license plate)?	Registration expired?	Inspected (windsheild)?	Inspection expired?	Handicapp spot?
2	Margaret Morrison St	1	1	black	3	toyota	rav4 4wd	pa	1	0	0	0	0	1	1	1		0	
3		2	0																
4		3	0																
5	Total % of cars	4	0																
6		5	0																
7	Tech St	1	1	white	2	honda	ridgeline 4wd	pa	0	0	0	0	0	1	1	0	1	0	
8		2	1	gray	1	toyota	camry le	il	1	0	1	notpaid	30	0	1	0	1	0	
9		3	0																
10		4	1	dark gray	1	toyota	corolla	pa	0	0	0	0	0	0	1	0	1	1	
11		5	1	white	1	volkswager	golf tdi	pa	0	0	0	0	0	0	1	0	1	0	
12		6	0																
13		7	1	blue	3	chrysler	pacifica	pa	0	0	0	0	0	1	1	0	1	0	
14		8	0																
15		9	0																
16		10	0																
17		11	0																
18		12	0																
19		13	1	black	3	toyota	4 runner	west virginia	0	1	0	0	0	1	1	0	1	0	
20		14	0																
21		15	0																
22		16	0																
23		17	0																
24		18	1	silver	1	benz	s430 4matic	pa	0	0	0	0	0	1	1	0	1	0	
25		19	0																

1) Vehicle Present?
2) Color?
3) Type?
   - Car/Sudan/Cross-over
   - Truck
   - SUV
   - Van
   - Motorcycle/Scooter
   - Other
4) Make?
5) Model?
6) State of license plate?
7) Expired meter?
8) Broken meter?
9) Ticket?
10) What for?
11) How much?
12) Clean/Dirty?
13) Registration present?
14) Registration expired?
15) Inspection present?

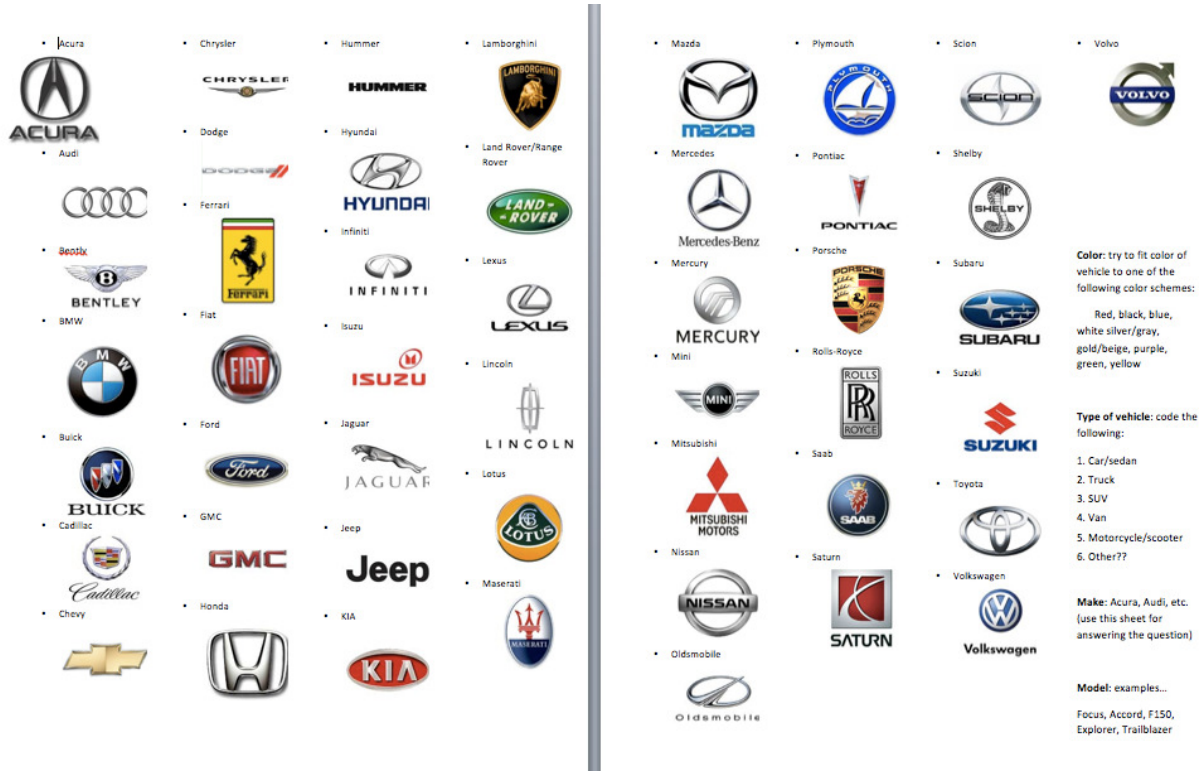
16) Inspection expired?
17) Handicapped spot?
18) Handicapped plate/tag?
19) Fancy market additions?
    - Tinted windows
    - Rims
    - Wing
    - Etc.
20) Major dents or scratches on vehicle?
21) Any cracked or shattered windows?
22) Vehicle driving on spare tire?
23) Vehicle has parking pass for another on-campus location?

GENERAL QUESTIONS in addition to vehicle/parking meter questions:

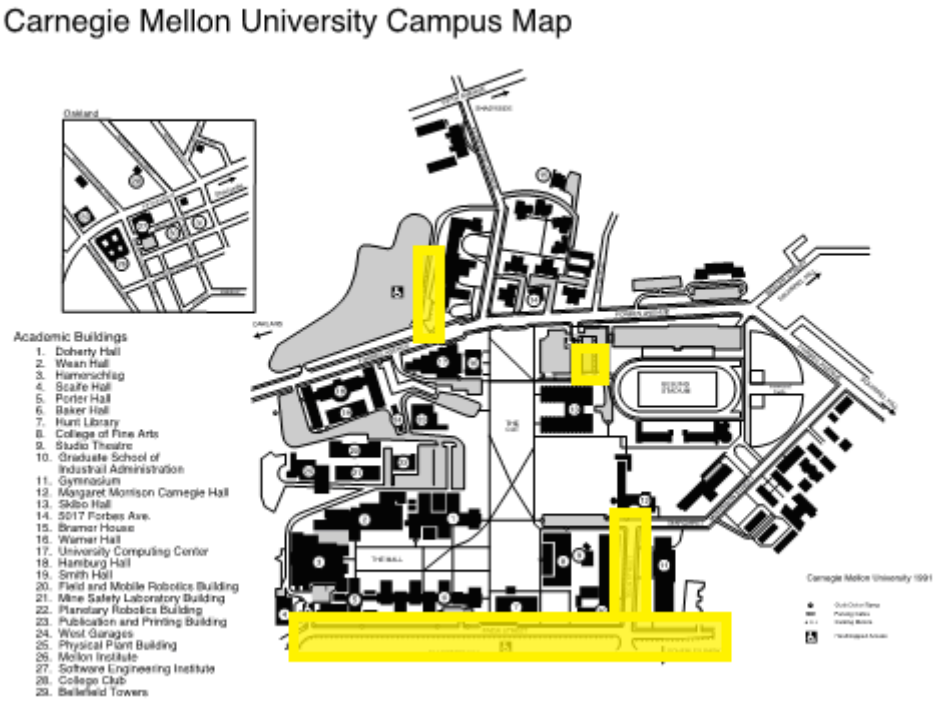
1. Date
2. Day of week
3. Surveyors
4. Outside temperature
5. Start time
6. End time

Appendix 3: next page

Appendix 3: Reference Sheet



Appendix 4: Carnegie Mellon University Campus Map



Appendix 5: Data Analysis (to be continued after data collection)