PERCEPTIONS OF PARKING FACILITIES: FACTORS TO CONSIDER IN DESIGN AND MAINTENANCE

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There are a number of factors to consider when developing new parking lots and modifying existing structures. The present research reports the results of two studies designed to assess perceived problems of parking facilities. In the first study, 319 participants were asked to generate a set of parking facility-related problems from their life experience. These were categorized into different problem categories. The second had participants rate the 30 problem categories. Five main factors were identified: (a) Compliance and Visibility, (b) Layout and Design, (c) Safety and Crowding, (d) Difficulties at Access Points and Environment, and (e) Aesthetics. Aspects of each of these factors have implications for improving parking facilities.

INTRODUCTION

With the ever-increasing number of vehicles on the road, parking demands have also increased. However, most evidence of driver frustration with parking facilities has been anecdotal. No study using users/consumers has attempted to identify the major sources of concerns with parking facilities. The lone exception is a study by Shaffer and Anderson (1983) who looked at aesthetic concerns of parking lots.

Shaffer and Anderson (1983) were interested in the perceptions of security and attractiveness of urban parking lots. In their study, participants viewed different scenes of various parking facilities and were asked to rate the slides for attractiveness, security, or prominence of various variables in the scenes. Using a factor analytic technique, nine main factors (physical features) were identified as composing participants' perceptions of personal security and attractiveness.

The present study had a broader scope than Shaffer and Anderson's (1983) consideration of aesthetic properties. In the present study, participants generated and considered a broader set of problems with parking facilities.

Most of the other research on parking focuses on the technological advances available to transportation planners. One technological approach has been the development of parking guidance systems which can give a real time status on availability of parking and convenient access points (Sobbi, 1995). Hester, Fisher, and Collura (2002) noted the importance of identifying decision-making strategies of drivers prior to implementation of any advanced parking management system. These systems appear to be a viable approach for some parking demands, but do not address other aspects of parking facilities. In the present research, we assessed individuals' beliefs, specifically their negative perceptions of parking lots to determine what kinds of issues people deem as important. Potentially, research in this domain may lead to a reduction of some of negative aspects. Some of the cited problems may be addressable by Human Factors and Engineering (HF/E) professionals.

METHOD

Participants. A total of 598 individuals participated in this research. A total of 319 respondents participated in the first phase of this research in which 174 were male and 145 were female. The respondents ranged in age from 17 to 82 years ($M = 26.6$, $SD = 10.8$) with 31% between 17 and 21, 31% between 21 and 25 years and the remainder (38%) over 25 years. The second phase consisted of 279 respondents of whom 136 were male and 143 were female. The age of respondents ranged from 17 to 84 years ($M = 26.7$, $SD = 12.2$), with 57% of the participant's 17 to 21, 23% between 21 and 29 years and 20% over age 29.

Participants were recruited by means of an Ergonomics class research assignment in which students administered the questionnaires to participants from various places in the community (e.g., schools, malls, etc.).

Materials and Procedure. In the first phase, data were generated from responses to an item in a section of a larger ergonomics and safety issues questionnaire. Specifically, participants were presented the following: *"Parking lots and decks at shopping centers and malls provide areas for people to leave their vehicles while they visit business for products and services. Parking lots and decks are also sometimes provided in downtown, urban areas as well as for specific businesses and events, such as for restaurants and stadiums. In general, parking lots and decks have both positive and negative aspects. Please list all of the negative aspects, or concerns that you have had, about parking lots and decks that you have visited."*

Participants were asked to indicate up to four problems they perceived with various parking facilities. Four blanks were provided below the question for participants to write in their responses.

The second phase consisted of a 30-item list of parking concerns. The 30 items were derived from the first questionnaire with a few additional items generated by the experimenters. Participants were asked to rate the severity or extent of the problem using a 9-point Likert-type scale with the following numerical anchors and wording: (0) Not a problem; (2) Somewhat of a problem; (4) Moderate problem; (6) Very much a problem; and (8) Extremely a problem. A mean rating of parking severity was obtained for each item.

Table 1. Frequency of reported problem categories with parking facilities

Negative Aspects	Frequency	%
Crowded	125	39
Visibility	123	39
Personal Safety	94	29
Confusing	53	17
Accidents	50	16
Theft	50	16
Cost	29	9
Aesthetics	22	7
Lack of Cleanliness	10	3
Reckless Drivers	10	3
Small Spaces	7	2
Poorly Parked Vehicles	5	2
Numerous Handicap Spots	4	1
Other	32	10

RESULTS

Study 1

The free responses were categorized into 13 main issues. These categories and the assigned frequency of report are shown in Table 1. The percentages in the table do not add to 100% because participants could report more than one problem. Personal safety and visibility of parking facilities were the most often reported problems. The next highest reported problems of the respondents were crowded and confusing parking facilities. Analyses examining differences in response patterns as a function of several demographic variables such as student-status, age, or gender showed no significant effects ($ps > .05$).

Study 2

The problem issues identified by participants in the first questionnaire, and the identification of additional issues as determined from the responses in the "other" category, and the experimenters' judgments yielded a list of 30 potential problems with parking facilities. This list was given to participants in Study 2 in the form of a questionnaire with which respondents were to rate each issue on a 9-point Likert-type scale from 0 to 8 of "not a problem at all" to "extremely a problem" respectively. Mean ratings are shown ordered from highest to lowest in Table 2 together with standard deviations.

A 3 (age: 17 to 21 or 21 to 29 or 29 and older) X 2 (gender) X 2 (student status: full-time student vs. not full-time student) analysis of variance with a dependent measure of ratings across all items revealed three main effects with no significant interactions. Both younger age ranges, 17 to 21 ($M = 110.50$) and 21 to 29 ($M = 101.95$) had greater overall beliefs about problems with parking facilities than those respondents over age 29 ($M = 93.23$), $F(1, 277) = 8.59$, $p < .003$. In addition, females ($M = 110.88$) rated the parking issues more of a concern than males ($M = 98.97$), $F(1, 277) = 8.65$, $p < .004$. Full-time students ($M = 109.27$) also considered parking issues more severe than did non-full-time students ($M = 96.11$), $F(1, 277) = 9.21$, $p < .003$.

Table 2. Mean ratings and standard deviations on items used in Phase 2 (0-8-response scale)

	Negative Aspects of Parking Facilities	Mean	SD
(a)	Difficult to find open parking spaces	4.89	2.15
(b)	Crowded (too many vehicles, people, etc.)	4.62	1.99
(c)	Small parking spaces	4.59	2.34
(d)	Poor visibility (bad lighting, blind corners, etc.)	4.30	2.07
(e)	Drivers who are not operating vehicles carefully	4.27	2.12
(f)	Vehicles speeding	4.22	2.05
(g)	Vehicles that are poorly parked (out of marked space)	4.20	2.05
(h)	Vehicle damage from other persons or vehicles	4.16	2.16
(i)	Maneuverability limits of vehicle within parking lot	4.09	2.19
(j)	Parking fee costs for some lot	3.96	2.18
(k)	Pedestrians not watching for vehicles	3.77	2.16
(l)	Bad layout or design of parking lot	3.66	2.18
(m)	Personal safety	3.63	2.18
(n)	Poor design of lanes to drive across lot	3.58	2.06
(o)	Distance of parking lot from intended destination	3.57	2.15
(p)	Poorly designed parking structure	3.47	2.15
(q)	Difficulty exiting parking lot to street	3.38	1.97
(r)	Difficulty seeing pedestrians	3.32	2.05
(s)	Not enough walkways for pedestrians	3.32	2.12
(t)	Theft of personal property	3.24	2.26
(u)	Confusing to navigate	3.19	2.02
(v)	Vehicle accidents	2.91	2.04
(w)	Difficulty entering parking lot from street	2.79	1.92
(x)	Difficulty turning into lot from street	2.77	1.87
(y)	Distance of parking spaces from entrance	2.76	2.10
(z)	Poor aesthetics (unattractive)	2.74	2.23
(aa)	Lack of cleanliness	2.66	1.86
(bb)	Low clearance in parking decks	2.45	2.15
(cc)	Exhaust from vehicles	2.42	2.02
(dd)	Too Many Handicap Parking spots	2.16	2.29

Table 3. Factor Analysis and items with high factor loadings

Factor 1 (Visibility and Compliance)		
(f)	Vehicles speeding	.68
(d)	Poor visibility (bad lighting, blind corners, etc.)	.57
(s)	Not enough walkways for pedestrians	.54
(r)	Difficulty seeing pedestrians	.52
(e)	Drivers who are not operating vehicles carefully	.46
Factor 2 (Layout and Design)		
(i)	Maneuverability limits of vehicle within parking lot	.67
(n)	Poor design of lanes to drive across lot	.63
(p)	Poorly designed parking structure	.50
(bb)	Low clearance in parking decks	.48
(l)	Bad layout or design of parking lot	.45
Factor 3 (Safety and Crowding)		
(a)	Difficult to find open parking spaces	.63
(t)	Theft of personal property	.53
(h)	Vehicle damage from other persons or vehicles	.50
(j)	Parking fee costs for some lots	.49
(m)	Personal Safety	.48
(v)	Vehicle Accidents	.48
(o)	Distance of parking lot from intended destination	.46
(g)	Vehicles that are poorly parked (out of marked space)	.37
(b)	Crowded (too many vehicles, people, etc.)	.37
(c)	Small parking spaces	.68
Factor 4 (Difficulties at Access Points)		
(x)	Difficulty turning into lot from street	.72
(dd)	Too many handicap parking spots	.72
(q)	Difficulty exiting parking lot to street	.60
(k)	Pedestrians not watching for vehicles	.38
Factor 5 (Environment and Aesthetics)		
(z)	Poor aesthetics	.71
(aa)	Lack of cleanliness	.58
(cc)	Exhaust from vehicles	.57
(y)	Distance of parking spaces from entrance	.57

Using a Principle Components Analysis with a Varimax rotation, five main negative factors of parking facilities were identified and named based on the composition of the highest item loadings. A Varimax rotation was employed to produce as simple a structure while also retaining independence between eigenvectors (Bryant & Yarnold, 1995).

Five items loaded onto the first factor (Compliance and Visibility) while five items loaded

onto the second factor (Layout and Design). Ten items loaded onto the third factor (Safety and Crowding) and four items loaded onto (Difficulties at Access Points). Finally, four items loaded onto a fifth factor labeled (Environment and Aesthetics). The five main factors with their respective items and factor loadings are presented in Table 3.

DISCUSSION

The first study shows that there are a number of perceived negative aspects of parking facilities. Because free report may not have reflected the degree of severity of the problems, a second study was conducted to determine those perceptions. The results from the second study show a relatively restricted range of perceptions as a function of severity ranging from 2.16 to 4.89. Nevertheless, it provides a priority list of problem areas. Given that funding is not unlimited, Table 2 could serve as a guide to most important perceived problems to fix.

A factor analysis was conducted on the ratings to ascertain any consistent factor structure as suggested by the categories as identified by the first questionnaire. Most interesting is that each of these issues encompass areas of interest and expertise related to the Human Factors/Ergonomics profession. For example, safety aspects can readily be addressed by HF/E professionals such as determining adequate lighting throughout the facility. To alleviate confusing aspects of many facilities, HF/E professionals may consider implementing better markings and signs within the parking facilities. Strategically placing signs for greater visibility is another option that could also help while navigating within a facility.

This factor structure also has implications for other professionals such as architects, security companies and personnel, and maintenance professionals. For example, environment and aesthetics has aspects that could be considered by maintenance professionals to encourage cleaner facilities by offering more frequent inspection of each site. In design and renovation, architects could address the issues of access points, pedestrian walkways, and vehicular lanes of travel.

By increasing visibility of security personnel or equipment, consumers may perceive a greater sense of security and allow for greater comfort in using the facility. Issues of crowding could be addressed with the parking guidance systems as has been pointed out earlier in this article. To reduce speeding of vehicles, speed gauges can be placed within the facility, etc. These suggestions are not intended to be exhaustive but generative possibilities for a number of professionals.

A committee report from the American Concrete Institute (1987) states that in addition to construction characteristics, parking lot characteristics such as lighting, well-defined entrances and exits, and critical stall dimensions should be addressed. The authors mention providing "satisfactory service" to users as a necessity for well-designed parking lots. In another study, Chen and Schonfeld (1988) found that increasing the minimum standard stall angle from 90° to 70° can result in better maneuverability and safety in parking lots. Thus, previous research has addressed some of the problem areas and has offered potential solutions. However as our research indicates, there are still many problem areas that remain. HF/E professionals can use data on people's subjective perceptions to help champion better designs of parking facilities. The approach we took in this study may also be applicable to other kinds of public venues such as convention centers, coliseums, and auditoriums.

Future research would benefit from further investigation of people's perceptions of public facilities and how human factors/engineering professionals can play a role in improving environments to provide consumers with a more positive experience.

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