

data, which reported 98.4 percent men and 1.4 percent women observed riding.

Age

The average age was 35; the median was 33. Half of the respondents were between 21 and 35. The oldest respondent was 83 years old and 101 respondents were 70 or older.

Less than 2 percent of the respondents were younger than 17 years old, which supports the quality of the data. The age question was left blank by 88 respondents.

Compared with the Hurt-study riders, our respondents are a little older; the median rider age in the Hurt exposure data was 26.7 compared with our median of 33.

Education

High school degree alone was the education level most frequently indicated, by 21.3 percent. Next came college degree (17.1 percent), two or more years of college (16.3 percent), professional degree (13.3 percent), less than two years of college (13 percent), and technical school (12.6 percent). Respondents who have attended at least some college made up 60 percent of the survey.

Residence

The most responses (13.8 percent) were from California, as might be expected. New York (6.2 percent) and Illinois (5.7 percent) were the only other states with more than 5 percent response. Texas,

Pennsylvania, and Ohio were next with 4.7 percent each.

CONCLUSION

Perhaps the most interesting finding is that motorcyclists are so willing to participate in a study of this nature. More than 16 000 cyclists took the time to complete the form, address an envelope, and use their own stamp. This study showed that valuable information can be collected from a national (and even international) sample of motorcyclists with a minimal cost to the surveyor.

A number of our findings duplicate or approximate the findings in the Hurt study. Although the Hurt study was only done in a portion of one state, our national figures help to show that the findings apply to the rest of the country.

REFERENCES

1. H.H. Hurt, Jr., J.V. Ouellet, and D.R. Thom. Motorcycle Accident Cause Factors and Identification of Countermeasures--Volume 1: Technical Report. Traffic Safety Center, Univ. of Southern California, Los Angeles, Jan. 1981. NTIS: PB 81-206443.
2. E. Youngblood. Nationwide Survey of Rider Attitudes Concerning Safety Helmets. In Proc., International Safety Conference, Vol. 3, Motorcycle Safety Foundation, Chadds Ford, PA, 1980.

Publication of this paper sponsored by Committee on Motorcycles and Mopeds.

Moped and Bicycle Use by University of Hawaii Students

C. S. PAPACOSTAS

The findings of two user surveys that attempted to determine the characteristics of moped and bicycle users and their school trips are discussed. Among the items covered are the degree of use of these devices, modal shifts, impact on other modes, trip-length characteristics, and problem areas. Because school trips by college students represent a significant market share of bicycles and mopeds, the information derived can add to the accumulating knowledge regarding mopeds and bicycles and the competition between them.

Recent increases in bicycle and moped use for both utility and recreational travel have stimulated the allotment of considerable attention to these modes. In Hawaii as elsewhere in the nation, an accelerated rate of construction of special facilities has occurred. In addition, the 1978 State Legislature defined mopeds and bicycles as separate categories of devices distinguished from motor vehicles and revised the rules and regulations governing their use.

A paper by Papacostas and Yoshioka in this Record describes the legislative background of moped and bicycle use in Hawaii and presents the findings of a study that has analyzed the characteristics of mopeds renters in Honolulu, their trips, and their accident patterns.

This paper concentrates on another significant market segment, University of Hawaii students and their school trips. The scope of the study was ini-

tially envisioned to be confined to moped users. However, during the early stages of the study it became evident that a significant portion of current moped users had shifted from bicycles. Consequently, the scope of the study was expanded to include bicyclists in an attempt to also discern the reasons behind the decision not to shift from bicycles to mopeds.

STUDY APPROACH AND DATA SOURCES

The study consisted of conducting and analyzing two similar user surveys. Bicycle and moped users were interviewed at various locations on the university campus. The questionnaires employed were divided into three sections. The first section elicited information about the respondents such as age and sex. The second section concentrated on the attributes of school trips and included items relating to the respondent's previous mode of travel and the reasons for shifting to the current mode. The last section sought information about the highway system from the perspective of the respondents and asked for suggestions for improvement.

In addition to the interviews, a series of counts of parked devices were taken throughout the campus at various times of the day in order to ascertain

the relative numbers of bicycles and mopeds in use by students for their school trips. To arrive at an estimate of the absolute numbers of these devices, approximately 450 students were approached and asked to indicate the mode by which they traveled to school. This information was used in conjunction with enrollment data to arrive at an estimate of the number of bicycle and moped commuters.

STUDY FINDINGS

Degree of Use

The counts of stationary devices made on different days and times, which reveals a constant ratio of about nine bicycles for every moped, are listed below:

Day and Time	No. of Mopeds	No. of Bicycles
Thursday a.m.	40	326
Thursday p.m.	20	274
Friday a.m.	48	410
Friday noon	47	441
Friday p.m.	31	260

In order to estimate the absolute numbers of bicyclists and moped users, 454 students were approached randomly and asked to indicate their mode of travel. The resulting frequencies are given below. Multiplication of the total enrollment at the university by the sample frequencies gave an estimate of the total market share of each of the modes; these values are also included:

Mode	Sample Frequency	Relative Frequency (%)	Estimated Total
Walking	100	22.0	4400
Bicycle	37	8.2	1630
Moped	5	1.1	220
City bus	83	18.3	3660
Car (driver)	159	35.0	7000
Car (passenger)	68	15.0	3000
Motorcycle	2	0.4	90

Considering the sample size, the ratio of bicyclists to moped users shown is consistent with the earlier counts. According to the table above, approximately 220 students travel to school by moped and 1630 by bicycle. The most common mode of travel is the automobile, which, including both drivers and passengers, accounts for 40 percent of the total. Walking is next with a 22 percent share, followed by the city bus system, which attracts approximately 18 percent of the students. Taken together, bicycles and mopeds account for a little more than 9 percent.

Age and Sex

The average ages of 23 for bicyclists and 22 for moped users were not found to be different at the 0.05 level of significance. The two groups also exhibited similar profiles with respect to sex, but these were found to be quite different from the characteristics of the overall enrollment. The table below indicates that men have a greater propensity than women to use either device; the computed confidence intervals at the 0.95 level revealed that the proportion of male bicyclists ranges from 62 to 88 percent and the proportion of male moped users from 60 to 84 percent in contrast to their 50.4 percent representation in the overall population of 20 051 students. Women make up 49.6 percent of the overall population.

Mode	Percentage of Use	
	Men	Women
Bicycle (N = 40)	75	25
Moped (N = 50)	72	28

Previous Mode

The responses to a question that elicited the mode used prior to shifting to the currently used device are given below. A considerable shift from bicycles to mopeds is evident; 28 percent of current moped users came from bicycles. As stated earlier, this finding raised the question of why other bicyclists were not shifting to mopeds, which led to the conduct of the second survey.

Previous Mode	Bicycle (N = 40)		Moped (N = 50)	
	No.	Percent	No.	Percent
Walking	26	65	13	26
Bicycle	1	3	14	28
City bus	8	20	7	14
Automobile	5	12	16	32

By using the proportions implicit above, the hypothesis that the proportions of the two groups that had shifted from buses were the same could not be rejected. On the other hand, a similar hypothesis regarding previous automobile users was rejected at the 0.05 level but could not be rejected at the 0.01 level of significance. Consequently, further investigation of this question is warranted. Because a much greater number of bicyclists have shifted from the automobile, the effect of this device on the reduction of car use is much greater in comparison with mopeds.

Of the 21 students who reported that they shifted to their respective devices from the automobile, 11 had been riders and 10 indicated that they used to drive to school. A comparison of these responses with the overall driver/passenger split tabulated earlier reveal that automobile passengers are more likely to be attracted by either bicycles or mopeds. This finding carries important implications regarding the ability of the two types of devices to affect a reduction in the use of automobiles.

Reasons for Current Modal Choice

Both bicyclists and moped users were asked to give the reasons for their choice of mode. The responses to this open-ended question are summarized below. The categories shown in the table were established during the analysis phase of the project, and this necessitated a certain amount of judgment. For example, responses relating to the cost of gasoline were placed under the economy category, whereas those that emphasized the need to conserve energy on grounds of principle or philosophy were considered to constitute environmental concerns. This classification also applies to the information contained in the next three tabulations.

Reason	Bicycle	Moped
Speed	23	17
Economy	20	25
Exercise	18	—
Comfort	17	19
Environmental concern	2	4
Total	80	65

With respect to the principal reasons that encouraged their current mode choices, both groups emphasized speed, economy, and comfort. Speed was cited more frequently by bicyclists and economy headed the moped users' list. Environmental con-

cerns were found to be relatively unimportant as incentives for the choice of device. It is interesting to note that environmental concerns emerged as reasons given for the decision not to use a given mode (see below). The bicycle was frequently cited as a means for physical exercise.

As mentioned earlier, a significant number of moped users had shifted from bicycles. The reasons given by the 13 respondents as underlying this trend are listed below:

Reason	Frequency
Speed	7
Comfort	5
Economy	2
Other	2
Total	16

Again speed, comfort, and economy were the main reasons for this decision. In order to discover the factors that inhibited other bicyclists from shifting to mopeds, the bicycle survey inquired about the respondents' plans relating to the acquisition of a moped. Only two bicyclists indicated that they were contemplating this move. The vast majority of bicyclists said that they had no plans whatsoever to obtain a moped. When asked the reasons for this, 34 respondents specified cost as the most prevalent reason followed by the lack of opportunity to exercise and environmental considerations:

Reason	Frequency
Cost	16
Exercise	11
Environmental concern	10
Availability of other mode	7
Other	10
Total	54

Recall that economy was ranked second following speed as an incentive for obtaining a bicycle and that exercise was one of the major reasons favoring this mode. Environmental concerns, especially noise, which were not cited as major reasons supporting the use of bicycles, came to the respondents' minds quite often as a reason against the use of mopeds. This finding implies that students are more concerned with maximizing their mobility and level of service (speed, comfort) within their economic constraints and less concerned with indirect effects such as environmental pollution.

Those who did shift to mopeds were consistent with the entire moped group in identifying economy, comfort, and speed, although the order in which these factors were ranked was reversed. Finally, the availability of alternative modes for their total travel needs, including the bicycle, contributed to the decision not to invest in a moped.

Other Modal Shifts

The matrix of the table below presents the two most frequently cited reasons given for all modal shifts observed in the samples:

Mode Shifted From	Reason for Shift to	
	Bicycle	Moped
Walking	Speed, exercise	Speed, economy
Bicycle	Not applicable	Speed, comfort
City bus	Economy, speed	Economy, speed
Automobile	Economy, exercise	Economy, comfort

It is noteworthy that intermodal movements from walking to bicycle and moped as well as from bicycle to moped consistently give priority to service improvement (i.e., speed). In contrast with this phe-

nomenon, shifts from buses and automobiles consistently rank economy first. Taken together, these two attributes imply that there exists a general trend toward the better level of service provided by modes of higher technology subject to cost constraints. Consequently, a campaign by public authorities to induce a reduction in automobile use, at least on the part of college students, would stand a better chance of succeeding by emphasizing cost savings rather than other considerations such as environmental impacts or congestion, even though the latter may be the motives for the campaign. In the case of the decision between bicycle and moped, a trade-off between exercise and comfort is also evident.

Impact on Other Modes

The table below represents a preliminary estimate (based on limited data) of the collective effect of bicycles and mopeds on the utilization of other modes in the case of school trips by college students.

Mode	Diversion (%)	Approximate Round Trips per Day
Walking	20	1200
City bus	9	370
Automobile (passenger)	4	150
Automobile (driver)	2	150

Walking was affected to the highest degree both in terms of the percentage of walkers diverted and the total amount of trip reduction. Bus ridership among students showed a 9 percent reduction due to bicycles and mopeds. The corresponding reductions among automobile passengers and drivers were found to be 4 and 2 percent, respectively, each corresponding to about 150 round trips between home and school per day.

Trip Length

The preceding discussion does not pinpoint other trip attributes that may be central to the modal preferences identified. For example, it is reasonable to expect that trip length is closely related to the need for improving speed, the highest-ranked incentive for shifting from bicycles to mopeds.

Figure 1 shows the cumulative trip length and frequency distributions corresponding to bicyclists and moped users derived from information regarding the residential location of interviewees. Also shown with dashed lines is the distribution corresponding to those who have shifted from bicycles to mopeds and are also included among all moped users.

Figure 1. Distributions of trip length and frequency.

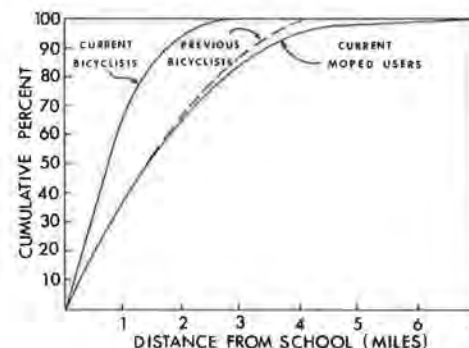


Figure 1 shows the size of the tributary areas from which bicyclists and moped users are drawn. This information may be of assistance to those in charge of providing the physical facilities for these devices. Bicyclists appear to be drawn from a maximum distance of approximately 3 miles from their school destination. On the other hand, moped use is seen to extend to a distance of 7 miles. The 85th percentiles corresponding to the two modes are found to be 1.5 miles for bicycles and 3.2 miles for mopeds. It is also of interest to note that the trip lengths of those who had shifted to mopeds exhibited a closer resemblance to the moped distribution than to the distribution corresponding to bicyclists. About 25 percent of those who shifted modes reside outside the 3-mile radius that defines the bicycle tributary area and about half reside at a distance farther than the 85th percentile. Thus trip length is an important determinant that should be used judiciously to interpret the more general responses discussed earlier. The above quantification of this attribute can offer guidance to those responsible for providing special facilities for bicycles and mopeds, at least in terms of project sequencing.

Problem Areas

The responses to an open-ended question that elicited suggestions for the improvement of the travel experience of the interviewees are summarized below:

Problem	Percentage of Answers	
	Bicyclists (N = 79)	Moped Users (M = 82)
Bikeways		
(more, wider, separate)	46	49
Road surface		
(bumps, drainage)	26	33
Inconsiderate motorists		
(car, bus, taxi)	14	6
None	3	1
Other	11	11

The two groups were found to be in general agreement with respect to the top-ranked problem areas, i.e., the need for additional and better-designed facilities, the improvement of roadway surfaces, and the need to make other motorists more sensitive to bicyclists and moped users. Only a small percentage of respondents found the transportation system adequate. These findings agree with those discovered by a study of moped renters reported by Papacostas and Yoshioka in this Record.

SUMMARY AND CONCLUSIONS

The analysis of responses to two user surveys aug-

mented by normalizing data where available revealed the following about the use of bicycles and mopeds by college students in Honolulu for their school trips.

A little more than 9 percent of the student body (or about 1850 students) travel between home and school by either bicycle or moped; bicyclists outnumber moped users by a ratio of 9 to 1.

Preliminary estimates of the resultant reductions in the use of other modes show a 20 percent reduction in the case of walking to school, a 9 percent decrease in bus use by college students, a 4 percent reduction in automobile ridership, and a 2 percent decrease in automobile driving. These percentages represent about 1200, 370, 150, and 150 students, respectively, out of a total enrollment of 20 000.

A higher proportion of previous walkers was found among the current bicyclists as compared to moped users and a significant proportion of the latter had switched from bicycles. Both groups considered speed, economy, and comfort to be the major incentives for their choice of mode. The opportunity to exercise was also ranked high by bicyclists. These findings must be viewed in relation to the attributes of the mode used previously.

Speed, comfort, and economy (in that order) were the major reasons cited by those who shifted from bicycles to mopeds. On the other hand, cost, the opportunity to exercise, environmental concerns, and the availability of other modes of travel were given most frequently as the reasons inhibiting the purchase of a moped.

The maximum trip lengths for bicycles and mopeds were found to be 3 and 7 miles, respectively, and the corresponding 85th percentiles were 1.5 and 3.2 miles. Trip length appears to be an important criterion for mode choice in general and the choice between bicycles and mopeds in particular.

Level of service (i.e., speed) was the major factor favoring higher-technology modes, whereas cost was found to exert an opposing influence. In the case of the choice of bicycles vis-à-vis mopeds, a secondary trade-off between physical exercise on one hand and comfort on the other was detected. As stated earlier, trip length played a part in this phenomenon.

Finally, the two groups agreed that the lack of special facilities, the condition of roadway surfaces, and insensitivity on the part of motorists are major problems faced by bicyclists and moped users.

Publication of this paper sponsored by Committee on Motorcycles and Mopeds.