USING GIS CAPABILITIES TO IMPROVE THE UNDERSTANDING OF ROUTE CHOICE BEHAVIOR

UCD-ITS-RR-97-
June 1997

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1. Introduction

It is important to determine the factors that influence drivers' route choice. Gaining an understanding of these factors will help improve network analysis and hence the transportation planning process. It will also be very critical in determining the type and content of traffic information that will help drivers in their route choice decisions.

Minimizing travel time is considered the most important criterion affecting drivers' route choice as found by Duffell and Kalombaris [1988], Huchingson [1977], and Wachs [1967]. Also, directness [Huchingson, 1977] and less congestion [Wachs, 1967] were among the important reasons. Wachs [1967] concluded that socioeconomic and demographic characteristics do not clearly relate to attitudes toward route choice criteria, while Jou and Mahmassani [1994] and Mannering et al. [1994] found that socioeconomic characteristics together with the traffic network were important determinants of route changing behavior.

The data collected from the third phase of route choice surveys (mail survey) is used in this effort. The survey probed the factors that lead a commuter to use his primary route. In the questionnaire the respondent was presented also by a customized minimum path route from his origin to his destination using a GIS, and questions related to his familiarity with the network and his perceptions followed (refer to Abdel-Aty et al., 1995 for

factors that enter in the decision to choose a particular route. Shorter distance, travel time reliability and traffic safety, were among the factors indicated by 37.8%, 37.1% and 28.7%, respectively.

Other factors also enter into some individuals' decision to use a particular route. Number of roadway segments, freeway use, trip chaining, neighborhood security, and familiarity were among the factors less frequently stated. Overall, 10.5% of the respondents indicated that the suggested minimum path route is the same as their primary route (they are already using the minimum path route).

The above result shows clearly that minimizing travel time is the primary reason for route choice. This agrees with many previous studies (see for example Duffell and Kalombaris [1988], Huchingson [1977] and Wachs [1967]). However this result illustrates that minimizing travel time is not the only factor, but there exist other very important reasons like the travel time reliability. Travel time reliability adds the measure of uncertainty to the route choice, and introduces the significance of an information system that may help reduce travel time by selecting routes adaptively. Also, this result points out that to use shortest path criteria (either time or distance) solely is indeed an unrealistic abstraction of individual driver behavior. It might be more realistic to include all the previous factors in determining drivers' route choice behavior, and giving each factor a weight that

Table 2: Reasons for not using the GIS-generated minimum path route

Reason	No. of respondents (percent)
Primary route is faster	90 (62.9%)
Primary route is shorter	54 (37.8%)
Travel time is unpredictable	53 (37.1%)
Primary route is safer	41 (28.7%)
Many short roadway segments	16 (11.2%)
Primary route involves more freeway segments	14 (9.8%)
Have to make stop on the way along the primary route	11 (7.7%)
Primary route does not include insecure neighborhoods	9 (6.3%)
Not completely familiar with this route	5 (3.5%)
Had a bad experience in the past with the suggested route	5 (3.5%)

Note: Multiple answers are allowed (respondents can choose more than one factor)

Figures 2 through 8 compares, for both the respondents' primary route and their GIS generated minimum path route, the distributions of commuters' perceptions of the traffic lights and stop signs, variation in traffic conditions, traffic conditions, traffic safety, neighborhood security, scenery, and travel time reliability, respectively.

The majority of the respondents (40.5%) perceived that their primary route has "some" traffic lights and stop signs, while the majority (40.3%) perceived that the generated route has "many" traffic lights and stop signs (Figure 2). About 61% of the respondents perceived traffic conditions on their primary route to be "about the same every day" versus 43% for the GIS generated route, while only 3.5% of the respondents indicated "substantial differences in traffic from day to day" versus 23% for the generated route (Figure 3).

About 43% of the respondents reported that traffic conditions on their primary routes are "excellent" or "good" versus 28% for the generated minimum path route, while only 15% indicated "bad" or "very bad" traffic conditions for their primary route versus 32% for the minimum path route (Figure 4). The same trend holds for traffic safety and travel time reliability (Figures 5 & 8): more respondents perceive these attributes to be "excellent" or "good" on the primary route and "bad" or "very bad" on the minimum path route. Neighborhood security and scenery were to a large extent similarly perceived by the respondents for both routes.

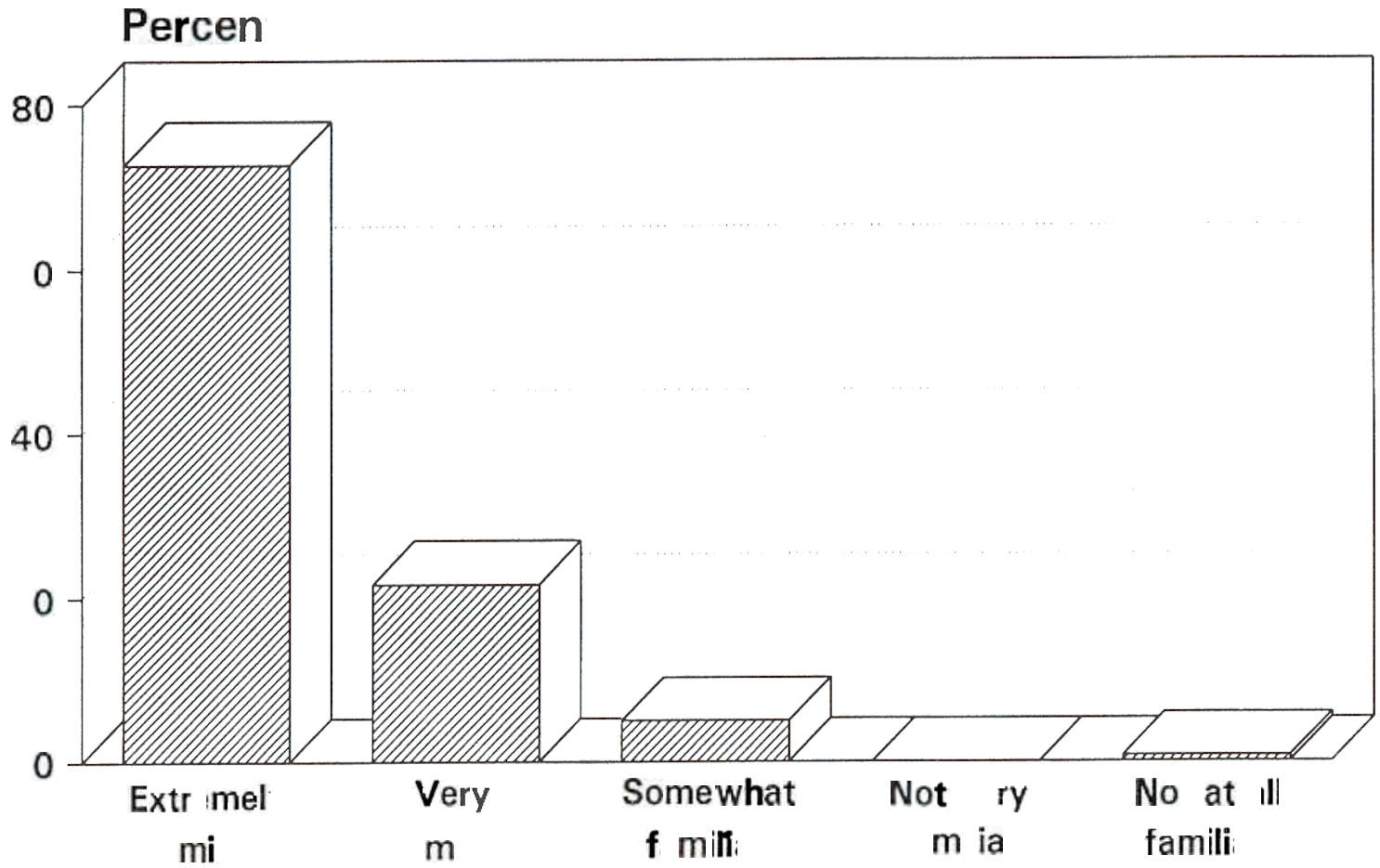
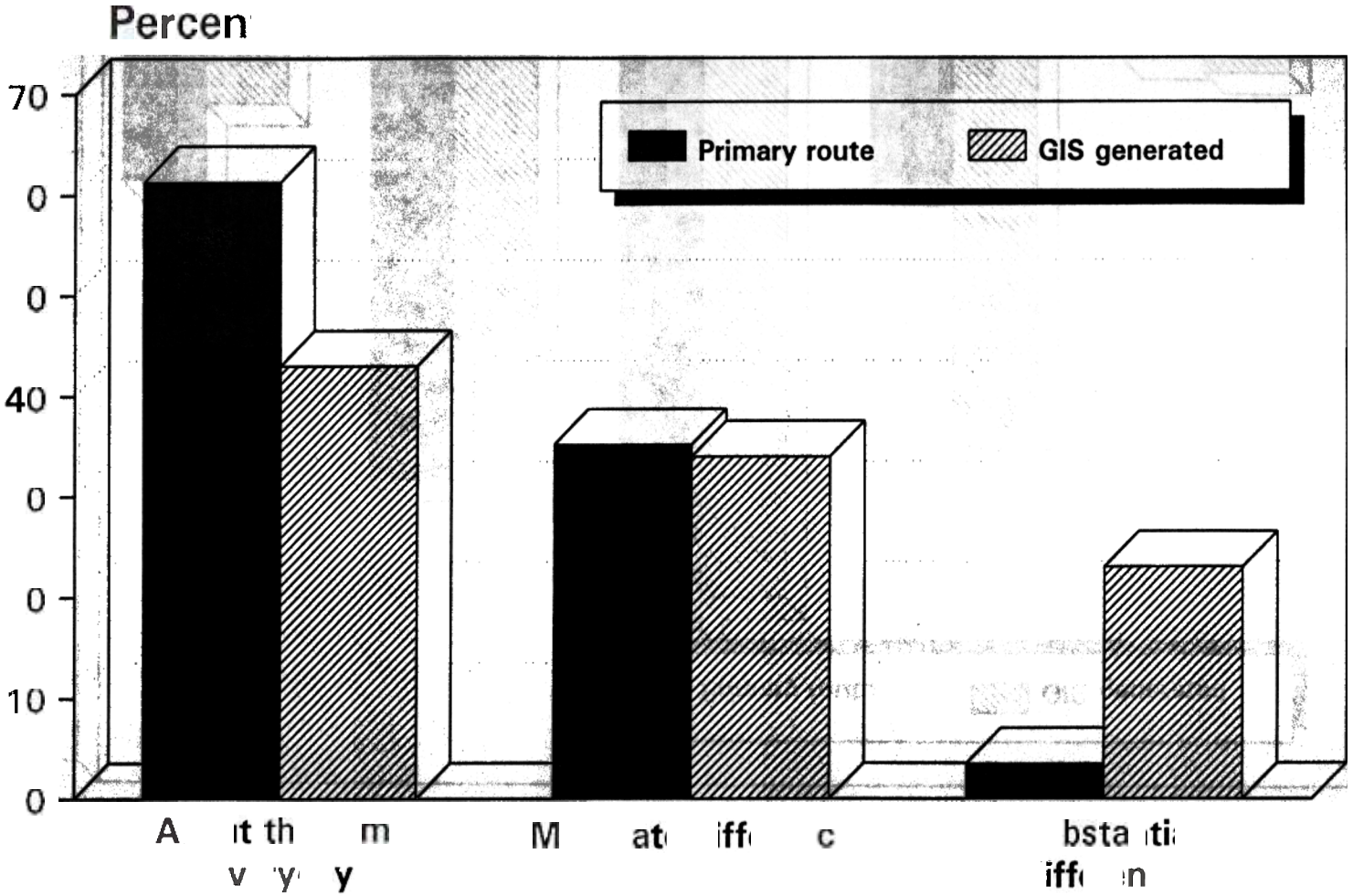


Figure Re pondents am arity with the G S-gene ated route



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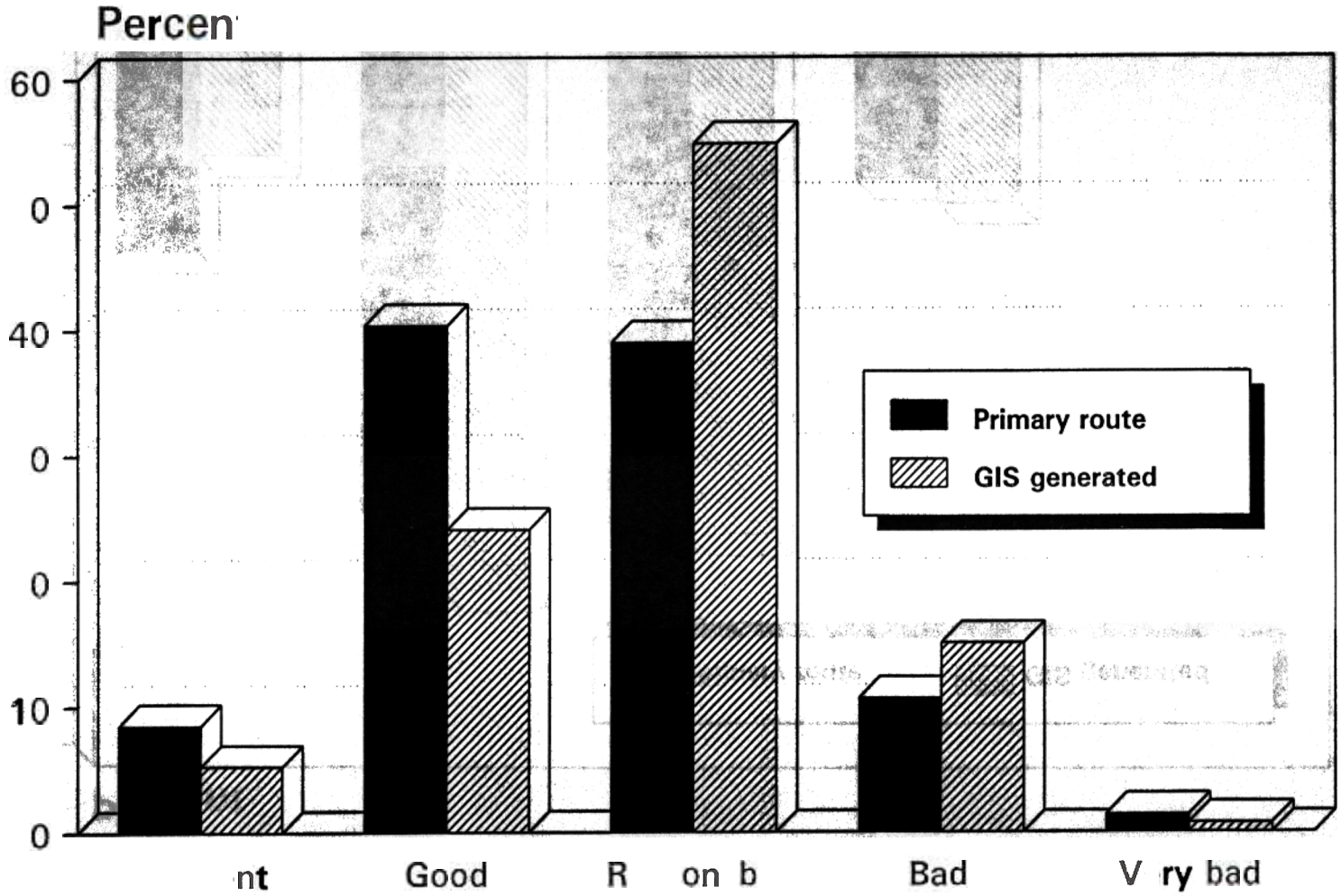
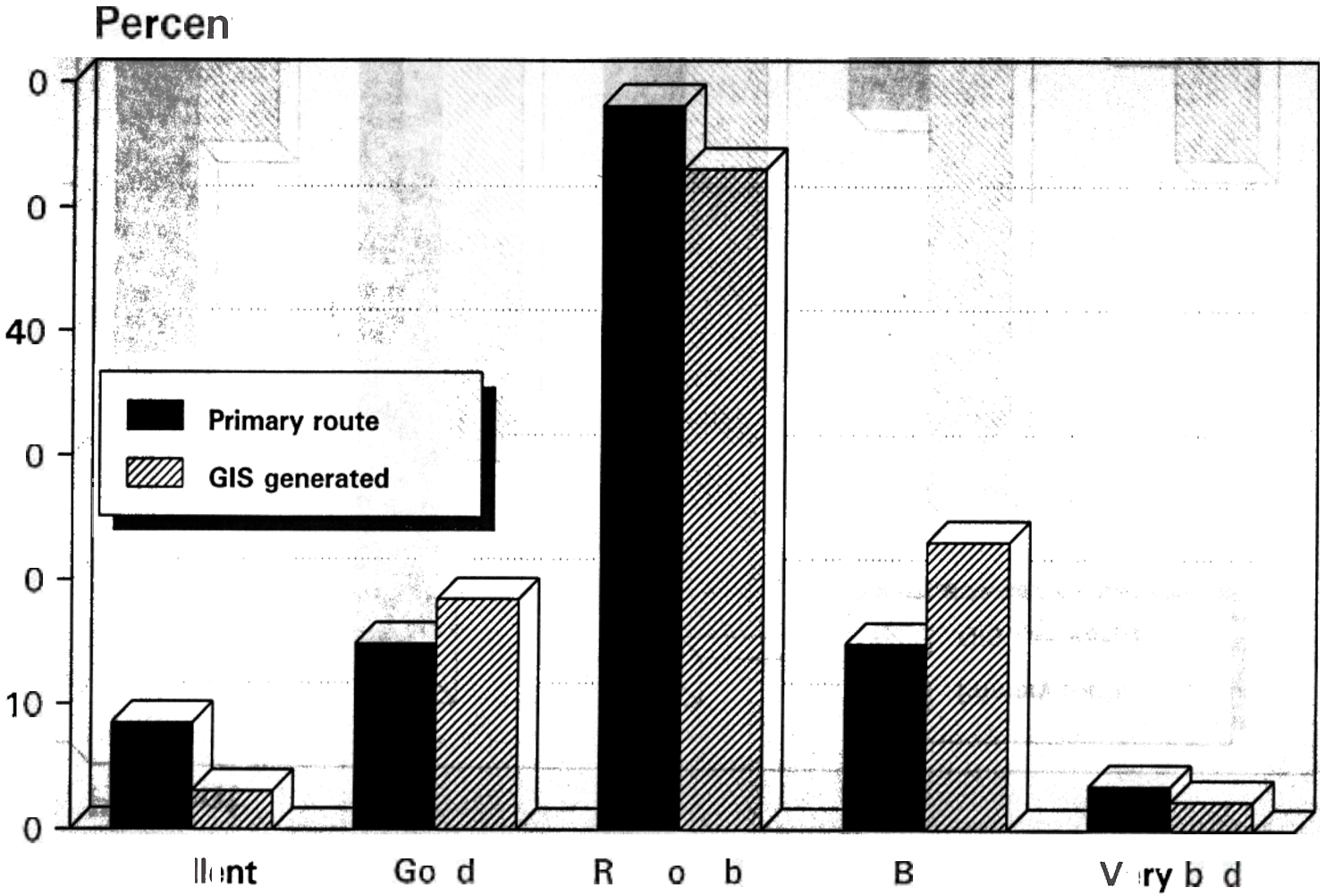


Figure 5 Perc ption o r fic safety



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4. Route Choice Models Using Objective and Subjective Data

The majority of, if not all, empirical route choice studies use data collected from surveys These data could provide the researcher with detailed information on the reasons a driver chooses a particular route, and the factors that influence his decision for this choice. These data are subjective because it represent that subject's responses, ratings, or perceptions regarding several commute characteristics.

This study collects very detailed information on commuters' attitudes, perceptions and factors that influence route choice using three survey waves. The study also investigates the objective attributes of the respondents' routes. This approach is very significant to understand the actual factors that influence route choice. To my knowledge none of the route choice studies have attempted examining the objective route attributes. This is because of the complexity associated with collecting the objective attributes. Routes are usually constructed from several roadway segments, each segment consisting of numerous links. This makes collecting information on a route very difficult and time consuming.

In this study, a GIS system is used to collect objectively measured route attributes. makes the process easier than collecting some of the information in the field or using paper maps. However, the process required extensive work in order to follow each link on the computer screen and record its information.

The aim of this effort is to develop route choice models based on the objectively measured attributes of the routes taken by survey respondents and those of alternative routes

attributes determined for both the primary and the minimum path routes are

1. Commute distance miles.
2. Average travel time (minutes).
3 Percent of freeways on the route by distance.
4. Number of roadway segments.
5. Number of links (as a surrogate to the number of intersections, i.e., the numbers of links could give a rough estimation of the number of intersections).

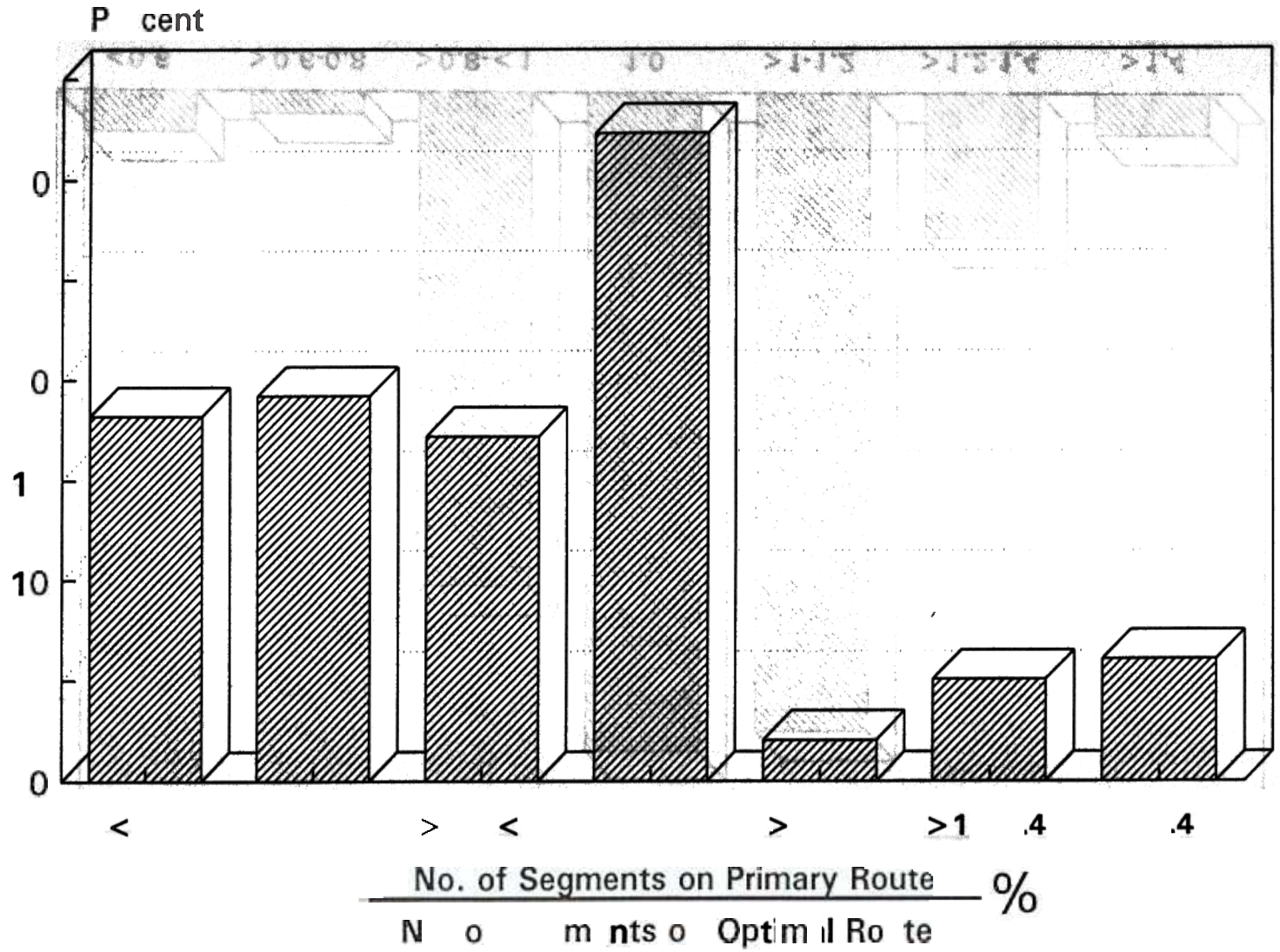
4.2. Results

In all, the primary and the minimum path routes for 99 respondents of the route choice CATI surveys were successfully identified using the GIS system, and 32 (32.3%) of the respondents were already using the minimum path route (the primary and the minimum path route are exactly or almost the same).

Table 3 presents statistics of the objectively measured route attributes and shows that the average number of roadway segments on the primary routes is less than that of the minimum path routes. The table also shows that the average commute distance, travel time, and number of links on the minimum path routes respectively, are less than that of the primary routes. The average length of freeway segments on the minimum path routes is more than that of the primary route

Figure 9 shows the ratio of the number of roadway segments on the primary route to the number for the minimum path route As mentioned above about 32% of the respondents

Figu e 9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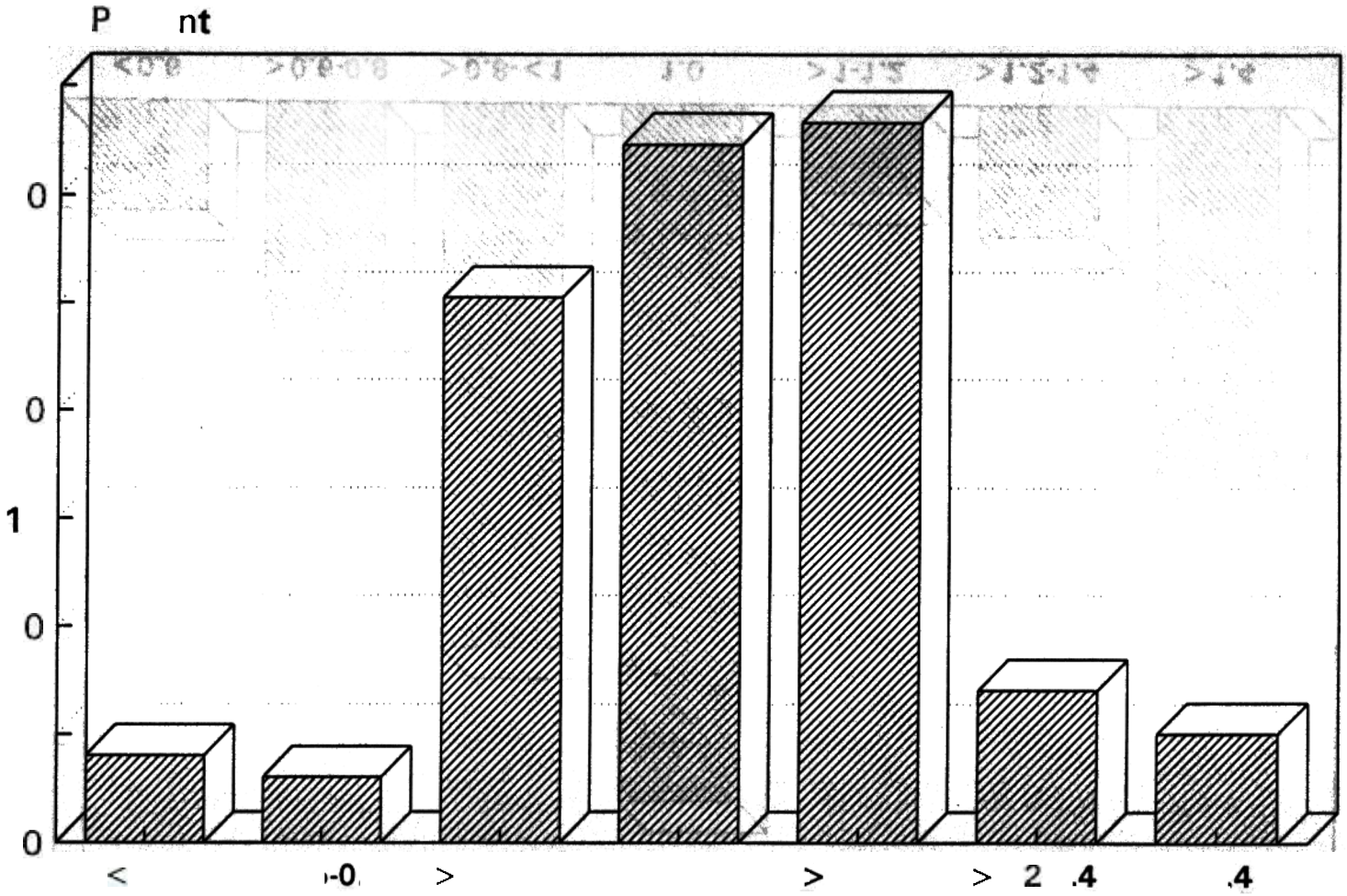
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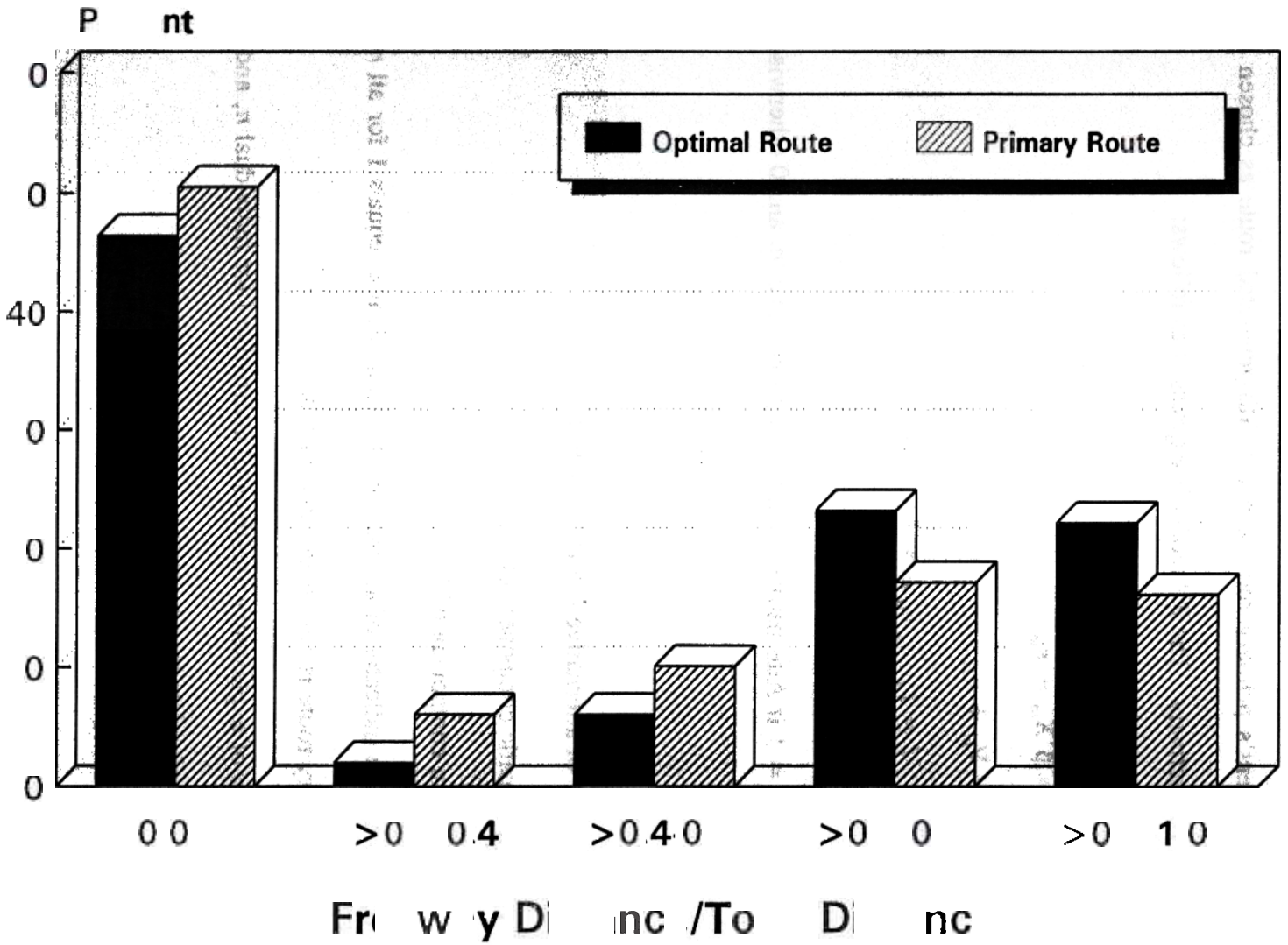

$$P_n(i) = \exp(V_{in}) / [\exp(V_{in}) + \exp(V_{jn})] \quad (3)$$

Estimation Results

Three route choice binary logit models are estimated and presented in Table 4. The first model uses only subjectively measured data, the second uses only objectively measured attributes, and the last uses both data types.

The first model underscores the significance of travel time and travel time reliability on route choice. It is clear that commuters try to minimize their travel time, the variable has a negative coefficient indicating that as travel time on a route increases the less likely a commuter will choose the route. If travel time reliability is perceived to be good or excellent on a route this increases the likelihood of this route being chosen. Traffic conditions are also found to affect route choice. Respondents who perceive substantial or moderate differences from day to day (traffic conditions that are not the same every day) on a route are less likely to choose this route. Also, as the number of different roadway segments increases the utility of the route decreases. This indicates commuters' preferences for a route that consists of a small number of different street/highway segments.

The second model which uses only the objectively measured routes' attributes shows two significant variables. Increasing the percent of freeway distance on a route reduces the likelihood of this route being chosen. This result might not be intuitive as many people prefer freeways because they are faster, but if we considered, as mentioned above, that freeways in the study area are congested then a possible interpretation is that people try to avoid them as much as possible. Also it is possible that the algorithm used to generate the minimum path route in the GIS framework includes freeways as much as possible because of their high average speed which makes the minimum path route shorter by time. The other significant variable is the number of segments of the route. This variable was also found significant subjectively. Commuters tend to try to minimize the number of different roadway segments used.

Commute distance and travel time had positive coefficients indicating that the primary routes were longer in most cases than the minimum path routes. This result indicates that commuters, other than those who actually use the minimum path route, are either not familiar with the minimum path route or that there exist other factors that deter them from using this route, e.g., the number of roadway segments. Both variables are not statistically significant. The coefficient of the number of intersections has a negative sign indicating that commuters try to minimize them, however the variable is not statistically significant.

The third model which uses both data types shows that the subjective variables follow very much the same trend presented in the first model. The objective variables were not

Mannering F., S-G Kim, W. Barfield and L. Ng (1994) Statistical Analysis of Commuters' Route, Mode and Departure Time Flexibility, *Transportation Research*, Vol. 2C, No. 1, pp. 35-47.

Wachs M. (1967) Relationships Between Drivers' Attitudes Toward Alternate Routes and Driver and Route Characteristics, *Highway Research Record*, No. 197, pp. 70-87.