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Acid Test of the Trade-Off Method of Attitude Measurement

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Results of a comparison of behavior predicted by a trade-off model with observed behavior under a radical change in the work environment of the employees of the New York State Department of Transportation are reported. The change, a shift from a fixed workday to a set of five alternative work schedules among which employees could choose, is analyzed. Before-and-after surveys conducted in 1977 and 1979 to test the model showed that the observed shifts by employees were within the predicted range for potential shifts. A comparison of the utilities calculated from the 1977 sample and those from the 1979 sample was inconclusive, but no major shift seems to have occurred. Although respondents in the 1977 survey rated the benefits of the alternative work-hour program higher than did those in the 1979 survey, more respondents in the 1979 survey actually prefer alternative work hours to the old fixed schedule.

Much attention has been focused on assessing the properties of conjoint attitude measurement procedures from a theoretical point of view (1-3).

Figure 1. Comparisons.

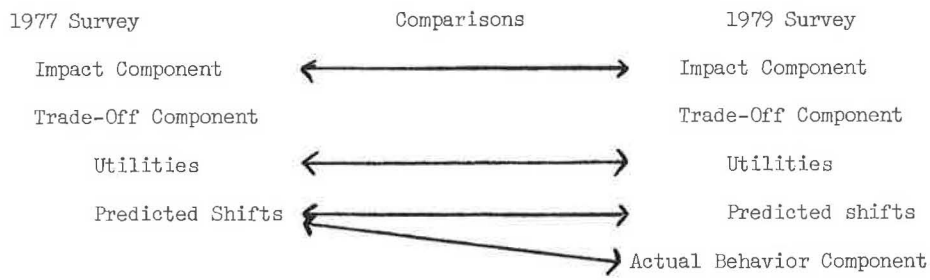

Figure 2. Hypothetical trade-off matrix.

		Workdays		
		Monday-Thursday	Tuesday - Friday	Monday-Friday
Work Schedule	Fixed	1	3	6
	Variable	2	5	4

However, the comparison between predicted and observed behavior, as well as conclusions drawn as to the validity of the measurement procedures, usually rely on laboratory settings (2,4,5).

Trade-off analysis, a multidimensional, abstract-choice, attitude-scaling procedure, was first developed by R.M. Johnson (6). Subsequently, the Planning Research Unit (PRU) of the New York State Department of Transportation (NYSDOT) developed its own version of this procedure (7). NYSDOT's version has been used in a variety of settings (8-17).

Most recently, the procedure was used in a survey of NYSDOT's Main Office employees, repeating a survey taken in 1977 on attitudes toward alternative work schedules (13,15). Since the earlier study, NYSDOT has introduced an alternative-work-hour program for its Main Office employees (December 1978). The old schedule set the work hours at 8:00 a.m. to 4:10 p.m. (7.5 h/day plus breaks) for virtually all employees. The new program offers five alternative starting times (7:00, 7:30, 8:00, 8:30, and 9:00 a.m.) but requires all employees to spend 7.5 h in the office each day. Each employee has the choice of selecting any one of these schedules at the beginning of each calendar quarter.

Because the 1977 survey focused on staggered-work-hour programs, one of which is essentially the same as the adopted program, we are now able to compare behavior predicted by the trade-off model with observed behavior in a real-world setting. To expand this comparison, the PRU, with the cooperation of the Personnel Bureau of NYSDOT, conducted a resurvey in May 1979 and not only included questions on actual work-hour choice but also repeated the trade-off part of the 1977 survey and added a series of questions measuring the perceived impacts of the alternative-work-hour program.

Thus, we are in the fortunate position to be able to conduct a series of comparisons:

1. The impacts of alternative work hours as anticipated in 1977 and perceived in 1979,
2. Utilities as estimated in 1977 and 1979,
3. Predicted potential for shifts from 8:00 a.m. starting time to other starting times as of 1977 versus actual shifts in 1979, and
4. Predicted potential for shifts as of 1977 versus predicted potential for shifts as of 1979.

These comparisons are discussed in this paper and are illustrated in Figure 1.

SAMPLE DESCRIPTION

The 1977 survey is documented in Wilkie and Pessemier (1). A total of 70 out of 1771 employees received the trade-off questionnaire; 51 of these were returned, of which 50 were usable. The sample, as well as the returned questionnaires, were statistically representative of the department's employees on the variables of sex, salary grade, and bargaining unit.

The 1979 survey covered 140 out of 1735 employees; it provided 92 usable trade-off returns and 100 usable actual behavior returns. The sample is again representative of the department's employees on the same variables as the first sample. A detailed description of the sample selection procedure and returns is given in a companion paper (18).

TRADE-OFF: A BRIEF DESCRIPTION

The trade-off approach may be viewed as a disaggregate abstract-choice procedure. It focuses on the attributes of policies, rather than on the policies themselves. Based on the responses provided by each respondent, a utility structure is established for each individual. This utility structure is then used to predict the respondent's reaction (preference or choice) to various hypothetical policies constructed from the attributes contained in the original questionnaire.

The questionnaire itself consists of a series of matrices, in which each matrix pairs off all levels of two attributes. The respondent is then asked to enter his or her preference rank order over the combinations contained in each matrix in the cells of this matrix. A sample matrix that shows a hypothetical rank order is shown in Figure 2 (1 = highest rank and 6 = lowest rank).

The trade-off procedure estimates a set of utilities that will reflect the observed rank orders in all of a respondent's matrices as closely as possible. Details of this procedure are described elsewhere (8,19,20).

COMPARISONS OF OBSERVED AND PREDICTED BEHAVIOR

Method

If we take into account that the former work-hour arrangement is subsumed by the new work-hour

Table 1. Predicted versus observed split for alternative work hours by demographic group.

Demographic Group	1977 Prediction N	1977 Prediction %	1979 Actual N	1979 Actual %	Z-Statistic
Age					
19-34	16	69	33	63	0.4
35-54	26	69	55	53	1.4
55 and over	8	63	12	41	0.96
Sex					
Male	42	71	77	61	1.1
Female	8	50	23	35	0.75
Bargaining unit[a]					
Administrative and Operational Services	15	60	29	42	1.1
Professional, Scientific, and Technical Services and Management and Confidential Service	34	74	71	61	1.3
Commuting mode					
Drive	41	68	60	53	1.5
Car passenger	8	75	14	50	1.1
Bus	1	NS	6	34	NS
Carpool to work[a]					
Yes	7	43	29	48	-0.2
No	34	68	58	60	0.8
Sometimes	8	89	6	50	1.6
Number of cars in household					
0 or 1	25	60	42	48	0.95
2 or more	25	76	58	60	1.4
Household size					
1 or 2	26	46	38	52	-0.5
3 or 4	17	19	43	53	-2.4
5 or more	7	86	19	63	1.1
Total	50	68	100	54	1.6

[a]One respondent not identified by this demographic.

Table 2. Comparison of 1977 and 1979 utilities.

Attribute	1977 Mean Utility	1977 Rank	1979 Mean Utility	1979 Rank
Workweek				
Monday-Thursday	0.39	1	0.39	1
Tuesday-Friday	0.37	2	0.33	2
Monday-Friday[a,b]	0.24	3	0.28	3
Work hours				
7 h/day	0.46	1	0.33	2
8 h/day[a,b]	0.32	2	0.32	3
9 h/day	0.22	3	0.35	1
Work schedule				
Fixed[a]	0.28	3	0.24	3
Individual specific[b]	0.30	2	0.36	2
Variable	0.42	1	0.40	1
Parking				
Unassigned[a,b]	0.41	1	0.43	1
Specific for carpool	0.26	3	0.28	3
Assigned	0.33	2	0.29	2

[a]Policy in force in 1977. [b]Policy in force in 1979.

arrangement, we are faced with the situation that a respondent could prefer the alternative work-hour program to the fixed work-hour program but still select 8:00 a.m. as his or her starting time. Thus, in statistical terms, rather than providing a point (or two-sided interval) estimate for the numbers of persons shifting their work hours, the forecast made with the trade-off procedure in this particular case will provide an upper-limit (or one-sided interval) estimate for the number of employees selecting a work schedule different from the old 8:00 a.m.-4:10 p.m. schedule. Since the 1977 and 1979 samples were both random and are statistically independent, we can use the one-sided z-test for the difference in the proportion of the occurrence of an event as measured by two samples in order to evaluate the difference between observed and predicted behavior (comparison 3 previously cited) (21).

Comparison 4, predicted shifts as of 1977 versus predicted shifts as of 1979, can be performed by using a two-sided test for the difference in proportions. Here, the two-sided test is appropriate, since we are comparing two points, either of which could validly be higher or lower than the other.

Results

The splits as predicted by the 1977 and 1979 surveys and as observed by the 1979 survey are shown below:

Category	N	Fixed Hours (%)	Alternative Work Hours (%)
Trade-off predictions			
1977 survey	50	32	68
1979 survey	92	16	84
Observed shifts, 1979 survey	100	46	54

The z-statistics were 1.64 for the comparison between the 1977 prediction and the 1979 actual and 2.2 for the comparison between the 1977 prediction and the 1979 prediction.

In view of the relative sizes of the samples and their respective populations, it could be argued that the finite-population correction should be included. However, with few exceptions, the size of population subgroups (e.g., family size, age, commuting mode) is not known. Thus, the finite-population correction was not applied. When tested for the complete samples, a z-test statistic of 2.6 was obtained.

Obviously the 1979 actual falls well within the range of the 1977 prediction. The 1979 actual is lower than the 1979 prediction, which again is well in line with the desired result. However, the 1979 prediction is significantly higher than the 1977 prediction.

Similarly, when we compare the 1977 predicted shifts with actual shifts by demographics (Table 1), we find only one instance in which we are led to reject the hypothesis that the trade-off procedure estimates the observable, real-world behavior correctly. Thus, we conclude that the trade-off model provides valid predictions for real-world behavior even under severe changes in the environment. It is also evident that more employees support alternative work hours after having been exposed to them than did in 1977, prior to actual experience with such an arrangement.

COMPARISON OF UTILITIES

Whereas utilities for the earlier sample were calculated and reported (16), subsequent investigations of the properties of the trade-off procedure resulted in modifications of the procedure itself. After the modifications, the calculated utilities changed only slightly. The difference between the two sets of utilities is not significant for most practical purposes (19). For the purpose of comparison with the 1979 sample utilities, a new set of utilities for the 1977 sample was calculated. The two sets of utilities are given in Table 2.

The first result of the comparison is that in only one case did the rank order of levels within attributes change. At the same time, we find that in a number of instances the spacing of the mean utilities within an attribute changed. The critical question is whether these changes are significant.

Since no theory of aggregation for the trade-off

utilities has yet been established that would allow us to derive a statistical test for the difference between the mean utilities between two samples, we cannot give a definitive answer to this question. One might consider the application of a test for the difference between two proportions; however, this test is not entirely appropriate since the utilities, when interpreted as probabilities, will tend to follow a distribution centered around 1/n (where n = number of levels in a given attribute) rather than a binomial distribution. The effect of this centering is that differences that are nonsignificant under the binomial model may indeed be significant under the appropriate model, whatever it may be. Thus, we find it impossible to determine with any degree of confidence whether there are any significant changes between the utilities.

We believe, however, that the change in the mean utility for workday length is significant. In conjunction with the fact that the four-day workweek of Monday through Thursday received the strongest support of all workweek arrangements, the change could well mean a growing support for a workweek of four 9-h days. Still, we could not exclude the possibility that the change is artificial if the 1977 sample underestimated this particular utility because of inherent random fluctuation. In summary, it appears that there are no major shifts in utilities, with the possible exception of the work-hours attribute.

COMPARISON OF IMPACTS

Both the 1977 and 1979 surveys contained a section requesting the respondent to rate how several aspects of his or her personal life and work environment are affected by the alternative-work-hours arrangement. The respondents ranked each impact from 1 = very negative to 5 = very positive. The two sets of impacts and their respective mean ratings are given below [note that Tannir (17) used only the term "leave time" rather than specifying "vacation time", "personal leave time", and "sick time"]:

	Average Score	
Impact	1979 Survey	Tannir (17)
Opportunity to spend more time with family	3.75	4.16
Leisure time	3.73	4.25
Ability to accomplish shopping or errands	3.70	NA
Having to commute during rush hours	3.54	3.27
Job productivity	3.52	3.60
Use of vacation time	3.44	3.49
Job satisfaction	3.43	3.71
Use of personal leave time	3.41	3.49
Saving gasoline while commuting	3.39	3.50
Use of sick time	3.27	3.49
Communication with other employees and the public	3.10	3.08
Fatigue	3.08	3.03
Opportunity for a second job	3.06	2.70
Child-care arrangements	3.04	NA
Ability to form carpool	2.96	NA

As a first observation, the arrangement of the impacts did not change much: impacts rated high retained a high rating; impacts rated low stayed low. There remains a clear grouping of impacts. In both surveys, family time and leisure time are seen as affected positively, the last five items are neutral in their impact, and the rest are affected somewhat positively. Within each of these groups, changes occur in the order of impact ratings, but even without statistical analysis it appears doubtful whether any of these changes is significant.

Most important for our analysis is the fact that the range of the mean ratings overall shrank: In 1977, the range from highest to lowest mean rating was 4.25 to 2.70; in 1979, the range was 3.75 to 2.96. A careful inspection of the table shows that the impacts rated positive or very positive in 1977 are rated lower almost uniformly in 1979 (exception: having to commute during rush hour), whereas only those in the lowest class showed an increase in their rating. This could be interpreted to mean that employees overestimated the strength of the impact of alternative work hours in 1977. Only the improvement in traffic congestion was underestimated in 1977.

At first glance, the lower ratings of the impacts in the 1979 survey could be taken to mean less support for alternative work hours, which contrasts with the higher share of persons preferring this arrangement to fixed work hours. However, this contradiction disappears if we reconsider the two statements properly: As was stated above, more people prefer alternative work hours in 1979 than did in 1977; we find here that, on the average, these people find the arrangement somewhat less positive than they thought it would be, but overall it is still rated positively. Thus, the support base has broadened, though the enthusiasm for alternative work hours has been reduced somewhat.

SUMMARY

NYSDOT was able to conduct a real-world test of its trade-off procedure, a multidimensional attitude-measurement procedure. This test was not based on a small incremental change but rather on a severe change in the department's employees' work hours: a shift from fixed to alternative work hours. Based on a before-and-after survey, we found that

1. The observable behavior supports the use of trade-off analysis as a valid tool to predict people's reactions to major changes in their environment;
2. There is no conclusive evidence at present as to the stability or instability of the utilities calculated, but it appears that no major shifts occurred between 1977 and 1979;
3. Employees tended to overrate the benefits of future alternative-work-hour programs in 1977 compared with 1979; and
4. The alternative-work-hour program has gathered broader support since 1977, even though the support seems somewhat less enthusiastic in 1979 than it was in 1977.

ACKNOWLEDGMENT

The cooperation of Stephen P. Daly of NYSDOT in the conduct of the survey is greatly appreciated. David T. Hartgen provided overall guidance. Linda Unangst skillfully transformed a sometimes illegible manuscript into a finished paper.

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Travel-Choice Behavior: Models of Perceptions, Feelings, Preference, and Choice

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This paper reports on research designed to develop practical methods to assist transportation planners to understand and respond to consumer needs and desires for local travel services. Models that describe the process by which consumers select means of travel based on perceptions, feelings, and preferences are presented and analyzed. These models are operationalized by using factor analysis and multinomial logit estimation. The resultant models describe consumer travel-choice behavior based on perceptions of and feelings toward transit modes and situational constraints. This structure provides diagnostic information that transportation planners can use to modify local service to better serve travel needs and desires.

Effective planning and design of transportation services to meet consumer needs depends on the planner's understanding of consumer travel-choice behavior. This research draws on state-of-the-art knowledge in travel-demand forecasting, consumer behavior theory, and marketing research techniques to develop practical methods that assist transportation planners to understand and respond to consumer needs and desires for travel services. The integration of the knowledge from these disciplines leads to methods of consumer-oriented transportation service planning. This approach provides transportation planners and managers with important diagnostic information about travel behavior that can be used as a guide to formulate strategies that can influence consumers' travel behavior.

The research reported here was conducted in Evanston, Illinois. The transit problems of Evanston are typical of many suburban cities. Significant excess capacity exists on the local public transit system, especially during off-peak hours, and an annual subsidy of $300 000 is required to maintain the transit system. The city of Evanston provides a good context for this research because of its similarity to numerous other suburban communities in the United States.

This research has three main results. First, it