The Influence of Real Time Travel Information on Route Choice Behaviors of Road Users on Freeway

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Abstract: The purpose of this research is to discuss the effects of display of travel information and radio traffic reports on the routes choice behaviors of drivers. Questionnaires are distributed in the Taian rest area, then, basic statistics are shown first, furthermore, binary logistic regressions are established on six topics respectively: (1) ever seeing a display of travel information or not, (2) changing route to third freeway or not when seeing a display of only travel time, (3) changing route to third freeway or not when seeing a display of both travel time and distance, (4) changing route to third freeway or not when seeing a display of travel time and distance as well as speed (5) changing route or not when seeing all alternative displays of travel information, (6) changing route or not due to traffic news from radio or travel information display from CMS, in order to help discuss separately whether relevant factors affect route choices of drivers.

Key words: information of travel time, route change, binary logistic regression

1. INTRODUCTION

1.1 Research motives
Following economic growth and increasing number of automobiles on roadways, traffic congestion problem is getting worse in recent years. In order to relieve delay of travel time, advanced traveler information systems have been promoted in Taiwan for the purpose of getting real time accurate traffic conditions, and based on that, road users can make better en-route decisions, by the way, traffic volumes can also be equally distributed on roadways to improve the effectiveness of whole transportation system. Through provision of traffic information drivers would have avoided going in bottleneck road areas by detouring to alternative route, or otherwise, avoided involving in rush hours by changing departure time. Whether safe and economic trip purpose can be obtained or not depends on travel behaviors under real time travel news.

Before getting on road, travelers use TV or radio broadcasting to search for traffic situation
and make pre-trip plans, while during trip, relay on radio or VMS (variable message sign) to
guide their en-route directions, even more frequently, start to collect surrounding information
after facing traffic jams. Therefore, if agencies of traffic management or control could support
precise roadway news from VMS, highway advisory radio or service telephone numbers (e.g.
authorized traffic news number 1968), travelers will make better choices of routes to reduce
their trip time and outcomes on relevant bottlenecks will be improved as well.
The current questions of providing traffic conditions are incompleteness and late response due
to insufficient vehicle detectors or reporting delay, as well as missing of important news such
as precise occurrence time of incident and lack of reporting experience among some weekend
broadcasting program speakers. Those questions result in not being able to assist drivers with
enough network information, thus, fewer road users would re-arrange their routes, and then,
traffic congestion remains continuing. In fact, real time traffic broadcasting news has a certain
effects on behaviors of en-route travelers according to several papers, such as the studies by
Chen, Chen and Woung (2003), Huang (1999) and Feng and Kuo (2007a), these papers refer
to higher rate of use and acceptance toward radios, hence, which in turn stimulates intention
of route changes under congested conditions, especially by providing with objective
quantitative data in terms of travel speed or travel time along a specific route connecting an
origin to a destination. Therefore, this research aims at exploring the effects of offering travel
time information and descriptive messages of congestion on route choices, in order to
understand how to relieve traffic delay problems.

1.2 Literature reviews
Through literature review the important variables influencing route choice behaviors of
drivers could be summarized, among them there are four aspects of interested contents such
as human characteristics, trip attributes, perception toward trip features and quality of real
time traffic information.
Speaking of human characteristics, Shu (2000) and Zhao (1996) mentions trip experience, the
latter one indicates more e.g. age and gender, while Chen, Chen and Woung (2003) and Chen,
Chou and Liu (2006) also refer to age, Khattak, Schofer and Koppelman (1993) uses gender
and personality, Emmerink et al. (1996) also uses gender, Hato et al. (1999) tries experience
and personal attributes.
As respect to trip attributes, Shu (2000) uses travel distance, travel cost and route type, and
Chang (2003) and Khattak, Schofer and Koppelman (1993) both also use travel length, while
Chang (2003) considers more as location of decision point and network environment,
alternatively, Emmerink et al. (1996) and Hato et al. (1999) both include distance of an
alternative route, Doun and Chen (2006) proposes area feature of decision point, Chen, Chou
and Liu (2006) and Emmerink et al. (1996) both thinks of trip purpose, Emmerink et al. (1996)
mentions more on status of commuters and type of alternative route.
About literature of perception toward trip features, most of papers reveal route or network
familiarity, e.g. studies from Shu (2000), Chen, Chou and Liu (2006) and Doun and Chen
(2006), by the way, Shu (2000) lists more on levels of traffic congestion and tendency to
changing route before start of a trip, then, Doun and Chen (2006) mentions the attitudes and
perception of drivers, Feng and Kuo (2007a) thinks of the value of information and uses
attitudes against real time traffic news as well as acceptance on content of information, finally,
Khattak, Schofer and Koppelman (1993) uses the traveling frequency of alternative routes,
and Emmerink et al. (1996) uses degree of satisfaction on alternative routes.
Regarding quality of real time traffic information, a few researches indicate detailed items of
these information, such as those from Huang (1999) and Feng and Kuo (2007b), then, Zhao
(1996) points out quantity of information.
Review results on all of the above 4 aspects can be selected and applied in the stages of
questionnaire design, namely, the first part in characteristics of driver participants, the second one in trip attributes and travel experience, and the third and the last ones in scenario specification. The purpose of this study aims at exploring the effects of those aspects on route choices under a certain network condition.

2. DATA COLLECTION AND QUESTIONNAIRE DESIGN

The target survey participants of this study are those drivers who travel northbound on Freeway One and pass by Chang-Hwa Interchange System (CHIS) where Freeway Three also meets, but their selected original route is all the way up on Freeway One, hence, during their trips, they possibly get congested between Nantwen and Tayia section located 10 to 18 kilometers north of CHIS on Freeway One. The major contents of the questionnaire include personal characteristics, trip attributes or experiences, and temporal spatial scenarios under situational conditions, such as qualitative or quantitative description about degree of traffic delay between Nantwen and Tayia section in terms of average speeds between two exits or travel time for a specific distance.

2.1 Research scope and subject
According to data provided by National Freeway Bureau in Taiwan, serious congestion happens between Nantwen and Tayia section two days before the end of lunar new year holidays when northbound traffic increases as a result of return work trips, hence, this certain location during this day is the interested study scope, and the plans of these included trips should be directed all the way up on Freeway One in order to examine the effects of traffic delays in the defined section, since the interchange system jointing Freeway Three is available for detour, then these subject trips would still have gone on Freeway One if there had been no dense traffic problem here, however, merely events from high traffic volumes are considered, incidents caused by roadwork or accidents are not included.

2.2 Sampling method, location and time
In order to effectively collect data from drivers traveling along defined location during prefixed time intervals, investigators are sent to a service area of Freeway One and proceed in person interviews and record necessary information by questionnaire. Prior to field survey, the relative ratio of the number of male to female drivers is estimated by data from agencies of household administration, and so is the ratio of the number between each arbitrarily classified age group, thus, the relevant ratios in samples can be approximately kept in the survey periods close to those in population.

The Tai An service area is selected as a place where survey is proceeded because it is the service area that is closest to the target road section mentioned above, and it is about 30 kilometers north, then drivers need 20 to 30 minutes to travel from target section to here. By the way, the sixth day of the Chinese Lunar New Year holidays in the year of 2008, i.e., two days before the end of holidays is selected as target day because the most dense traffic generates during 11:00 in the morning through 15:00 in the afternoon at this specific day according to records of past three years, thus, investigators are sent into the area from 10:00 to 16:00 to well prepare for the survey and work until the end of congested time intervals. After this first try is completed, results show that route change rates are more than expected due to insufficient provision of required information; therefore, the content of questionnaire is modified to account for this reason, especially saving time could be obtained at the price of traveling more distance and spending more money of gasoline, and new tries are attempted at the same place during the same 6 hours (time of day) on a weekday and a weekend near one month after the holidays.
2.3 Questionnaire design and its content

Since the surveys are tried twice, one at the holiday, another at the normal days, then the questionnaires are designed a little different to make sure that the latter try can collect more precise data, besides, the first one is tried in the half way of trip, then, some data provided by drivers are stated, while the second one is tried when trips were finished one month before, therefore, all data are revealed. Hence, the contents of questionnaires are designed into two outcomes, the first one involves (1) attributes of current trips, (2) scenarios of route conditions and route choice decisions and (3) personal characteristics, but the second one consists of (1) trip experiences at the holiday, (2) revised scenarios of route conditions and route choice decisions and (3) personal characteristics.

2.3.1 Trip attributes or trip experiences

The items of trip attributes for the first questionnaire include the entrance and exit of freeways, the origin and destination, estimated total travel time from origin to destination, estimated travel time on freeways, planned routes of trip, whether or not congestion is experienced in the trip, whether or not the trip is time constrained, trip purpose, if the driver is used to planning a trip or not; on the other hand, the items of trip experiences for the second questionnaire are identification of a finished trip at the holiday, the entrance and exit of freeways, the origin and destination, experienced total travel time from origin to destination, experienced travel time on freeways, experienced routes of trip, whether or not congestion was experienced in the trip, whether or not the trip was time constrained, trip purpose, if the driver is used to planning a trip or not.

2.3.2 Scenarios of route conditions and route choice decisions

Since the contents of scenarios have been revised, only those of the second edition are listed here. The scenarios are focused on the degrees of congestion levels between Nantwen and Tayia section northbound at the specified holiday while drivers get the location a couple of kilometers upstream of the interchange system where Freeway One joins Freeway Three, by the way, they are supposed to hear traffic news or see travel time messages in terms of only one out of 4 different conditions or only one from different time values compared to the free flow condition which allows drivers to select their own speeds or spend travel time least, these four conditions may be described by qualitative text or by quantitative values of travel speeds. Based on previous data, the time elapsed for 8 kilometers distance between Nan-Twen and Ta-Yia section during dense traffic situations ranges from 30 to 120 minutes, and the time required to travel freely is about 5 minutes, which is approximately equal to the ratio of 8 kilometers to free flow speed 100 kilometers per hour (the same as speed limit) multiplied by 60 minutes per hour, thus, this study assumes the value of 30 minutes to account for more frequent conditions of congestion; besides, the costs at which drivers needs to consider includes extra distance and then more gasoline expenditure if they choose to detour in order to prevent congestion on Freeway One.

In conclusion, there are 7 questions in this scenario section, i.e., (1) familiarity toward alternative route, (2) perception about the text description in broadcasting news in terms of quantitative values of speeds, (3) the price at which a driver chooses to change route, (4) the extra distance and gasoline expense when detour is chosen, (5) the various traffic conditions under which route change becomes necessary, (6) the experience whether or not a travel time display is observed, and (7) the usefulness of added contents, such as travel distance or speed between an assumed location and an indicated exit in travel time display.

2.3.3 Personal characteristics

The characteristics selected from literature reviews and included in this background section
are (1) gender, (2) years of driving experience, (3) the status of whether a driver is professional or not, (4) years of age, (5) monthly income, (6) occupation, and (7) levels of education.

3. BASIC STATISTICS

The number of questionnaires collected at the sixth day of the Chinese Lunar Year Holiday is 150, and 126 of which are effective, while one month later, the number of collected questionnaires are still 150, and 14 more, i.e., 140 ones are useful in terms of whether or not the participants of interviews have the experience of driving on specified road section northbound of Freeway One at the sixth day of the holiday, and the planned trip is not first on Freeway One connected to Freeway Three unless traffic condition forces them to do so.

3.1 Basic statistics for trip attributes or experiences

The basic statistics for trip attributes at the sixth day of holiday are as followings: the percentages for the planned routes consisting of Freeway One only, Freeway One connected with Freeway Three, and Freeway Three jointed with Freeway One are 74.52, 20.75, and 4.72 respectively; the average of estimated travel time on Freeways is 242.3 minutes, and standard deviation is 99.53 minutes; the percentages for different degrees of familiarity with alternative routes are 46.23, 32.08, 13.21, 8.49, and 0 for being familiar, very familiar, normal, unfamiliar, and very unfamiliar respectively; most (78.3 %) of trips are not time constrained because of a need to get destination at certain time; the percentages for a variety of trip purposes are 49.06, 21.69, 14.15, 7.55, 5.66, and 1.89 for returning home or work place, vacation, visiting relatives or friends, others, business, and commuting; most (73.58 %) of drivers have done pre-trip plan for routes; moreover, the percentage of listening to radios for traffic news while traveling between Nantwen and Tayia section is 74.53 %.

The basic statistics for trip experiences one month later are as followings: the percentages for the planned routes consisting of Freeway One only, Freeway One connected with Freeway Three, and Freeway Three jointed with Freeway One are 72.86, 21.43, and 5.71 respectively; the average of travel time on Freeways is 242.01 minutes, and standard deviation is 101.37 minutes; the percentages for different degrees of familiarity with alternative routes are 43.57, 35, 12.86, 8.57, and 0 for being familiar, very familiar, normal, unfamiliar, and very unfamiliar respectively; most (63.57 %) of trips are not time constrained because of a need to get destination at certain time; the percentages for a variety of trip purposes are 51.43, 20, 13.57, 7.86, 5.71, and 1.43 for returning home or work place, vacation, visiting relatives or friends, others, business, and commuting; most (73.57 %) of drivers have done pre-trip plan for routes; moreover, the percentage of listening to radios for traffic news while traveling between Nantwen and Tayia section is 75 %.

According to the above data, it is shown that the values between two surveys for most of items are quite similar except that more portion of drivers are time limited for the second survey, this probably because that memory against this item is a little affected by time elapsed for one month, and more drivers simply reply they are time limited when they forget the time schedule one month before; therefore, the results are fairly stable, only the latter statistics is used to interpret the trip features of drivers since the questionnaire is revised to better represent true behaviors of drivers.

3.2 Basic statistics for scenarios of route conditions and route choice decisions

Since the contents of scenarios have been revised, only the basic statistics for the second edition are list here.

The most percentage (31.43%) for degree of familiarity on a specific alternative route
Freeway Three is that of being familiar, most (63.81%) of drivers who listen to traffic news from a radio perceive saving time if the alternative route is taken instead of the original one, fair amount (43.81%) of listeners would like to change route to the Freeway Three because of saving time.

The percentages of ever seeing a changeable message of travel time at a place located a couple kilometers upstream to the Chang-Hwa Interchange System are 52.38%, some (25.71%) persons would like to change to the Freeway Three after looking to the changeable message of travel time (about 38 minutes from the place to a prefixed Tayia exit on Freeway One, the hidden information of distance on Freeway One is 20 kilometers, the hidden information of average speed on Freeway One is 32 kilometers per hour, the hidden information of time on alternative route is 30 minutes, the hidden information of distance on alternative route is 25 kilometers, the hidden information of average speed on alternative route is 50 kilometers per hour), the percentages increase up to 27.61% if distance is also shown besides travel time from the place to a prefixed Tayia exit (about 38 minutes on Freeway One, the distance on Freeway One is 20 kilometers, the hidden information of average speed on Freeway One is 32 kilometers per hour, the hidden information of time on alternative route is 30 minutes, the hidden information of distance on alternative route is 25 kilometers, the hidden information of average speed on alternative route is 50 kilometers per hour), and they grow up to 36.71% (since this last condition is even worse than the previous two) if travel speed is added along with time and distance (about 48 minutes on Freeway One, the distance on Freeway One is 20 kilometers, average speed on Freeway One is 25 kilometers per hour, the hidden information of time on alternative route is 30 minutes, the hidden information of distance on alternative route is 25 kilometers, the hidden information of average speed on alternative route is 50 kilometers per hour).

The variable traffic conditions in radio are assumed along the Nan-Twen to Ta-Yia section in terms of text contents, such as being seriously congested, stopped and gone, waved backward, and a few traffic, and the perceived speed values from survey for the variable conditions are 24, 37, 45, and 61 kilometers per hour respectively.

### 3.3 Basic statistics for personal characteristics

In the first try of survey, male drivers constitute 88.68% of participants; the average and standard deviation for years of driving experiences is 15.36 and 9.57; only 1.89% of drivers are professional; the distribution for different groups of ages are 36.79% for years aged between 31 and 40, 23.58% for years aged between 41 and 50, 21.7% for years aged between 21 and 30, 14.15% for years aged between 51 and 60, 3.77% for years aged greater than 60, and 0% for years aged between 18 through 20; the distribution for different levels of monthly incomes are 24.53% with 40 through 50 thousands New Taiwan Dollars (TNT$), 20.57% with 30 through 40 TNT$, 19.81% with 50 through 60 TNT$, 16.98% with 70 or more TNT$, 11.32% with less than 20 TNT$, 6.6% with 60 through 70 TNT$, 3.77% with 20 through 30 TNT$; the distribution for different classes of occupations are 28.30% for labors, 26.42% for service industries, 19.81% for business persons, 10.38% for soldiers or public servants or teachers, 7.55% for students, 7.55% for others; the distributions for different classes of education are 60.38% for college, 20.75% for graduate and above, 16.98% for senior high school, and 1.89% for junior high school.

In the second try of survey, male drivers constitute 83.57% of participants; the average and standard deviation for years of driving experiences is 15.8and 9.79; only 2.14% of drivers are professional; the distribution for different groups of ages are 35% for years aged between 31 and 40, 22.86% for years aged between 41 and 50, 21.43% for years aged between 21 and 30, 15% for years aged between 51 and 60, 4.29% for years aged greater than 60, and 1.43% for years aged between 18 and 20; the distribution for different levels of monthly incomes are...
23.57% with 40 through 50 TNT$, 21.43% with 30 through 40 TNT$, 15% with 50 through 60 TNT$, 17.85% with 60 through 70 TNT$, 2.86% with 20 through 30 TNT$; the distribution for different classes of occupations are 27.86% for labors, 24.29% for service industries, 20.71% for business persons, 11.43% for soldiers or public servants or teachers, 7.86% for others; the distribution for different classes of education are 60% for college, 22.14% for graduate and above, 15.71% for senior high school, and 2.14% for junior high school.

Therefore, the statistics of personal data between two surveys look quite similar, hence, only data from the latter survey is used to interpret the personal backgrounds of drivers in order to alleviate the problem of less sophisticated design of questionnaires.

4. MODEL FORMULATION AND INTERPRETATION

4.1 Research method

The 6 dependent variables which will be formulated with their affecting factors to set up applicable models in this study are all dichotomous, thus, binary logistic regression models are suitable, since the formulation of this model can be found quite often, that from Wong and Kuo (2004) is referenced as a basis to apply the formula of percentages to both outcomes and model validation for goodness of fit as well.

4.1.1 The formula of percentages for both outcomes

Let V be the tendency toward route change or not, V1 be the one toward change and V2 be the one toward unchange, while the latter be default as 0.

Let P be the percentage of route change or not, P1 be the one of change, P2 be the one of unchanged, and β1, β2, β3, … be the parameters associated with relevant levels of factors.

Suppose that there are only two affecting factors gender and trip purposes considered in a model and the dummy variables for two levels of gender are X11 and X12, those for six levels of trip purposes are X21, X22, X23, X24, X25 and X26, and Xij=0,1; the sub-fix i indicates the i-th among m variables, the sub-fix j indicates the j-th among n levels of a certain variable, and only one value from levels of each variable is 1 while others are 0; besides, the parameter for the last level of each factor is set to be 0 in order to avoid co-linearity among all levels of each factor; hence, the resultant formula for V1, V2, P1 and P2 are list as following:

\[
V_1 = \beta_0 + \beta_1 X_{11} + \beta_2 X_{12} + \beta_3 X_{21} + \beta_4 X_{22} + \beta_5 X_{23} + \beta_6 X_{24} + \beta_7 X_{25} + \beta_8 X_{26} \quad (1)
\]

\[
\text{Where } \beta_2=\beta_8=0 \quad \text{and } V_2=0
\]

\[
P_1 = \frac{1}{(1 + e^{-V_1})} \quad (3)
\]

\[
P_2 = 1 - P_1
\]

4.1.2 Model validation for binary logistic regression

There are two ways of evaluation about goodness of fit for a model, namely, by likelihood ratio index and percentage of correct prediction.

1. Likelihood ratio index

Let LL(β) be the value of logarithm of likelihood for a model with a parameter vector β, LL(0) be the value of logarithm of likelihood for a model with equal share, then, the index of likelihood ratio \( \rho^2 \) is equal to 1 subtracted by the ratio of LL(β) to LL(0) as following:

\[
\rho^2 = 1 - \frac{LL(\beta)}{LL(0)}
\]
\[ \rho^2 = 1 - \frac{LL(\beta)}{LL(0)} \]  \tag{5} 

The greater the value of likelihood ratio index the better the model will be in terms of goodness of fit, on one hand, when each contribution of likelihood value from a observation approaches 1 regarding a model, the global value of likelihood is close to 1, and then, the logarithm of the global value of likelihood \( LL(\beta) \) for the model is close to 0, thus, \( \rho^2 \) is near 1, on the other hand, \( \rho^2 \) is close to a minimum value 0 when \( LL(\beta) \) is almost the same as \( LL(0) \), i.e., the goodness of fit is extremely poor; thus, the value range of this index is between 0 and 1.

2. Percentage of correct prediction

The outcome of each estimation is called correct when the value of \( P_1 \) for a observation is greater than 0.5 and the choice of that observation is route change, or the value of \( P_1 \) for a observation is smaller than 0.5 and the choice of that observation is route un-change, moreover, the number of correct prediction is divided by the total number of observation to get a value of percentage of correct prediction, and this value is better while it gets bigger; of course, the range of this value is between 0 and 1.

4.2 Model results and interpretation

The models to be calibrated are all based on the data one month after the end of spring festive holidays, and the steps of selecting variables are, firstly, including all factors which possibly influence dependent variable such as seeing display or not and changing routes or not, secondly, from a list of significance levels among those factors the least significant one is deleted one by one until left ones are all significant, thirdly, the ever deleted ones are added once again one by one and certain factor is further included when it is significant at this moment until all deleted ones are all tried, thus, these steps are called moving forwards and backwards together.

4.2.1 Model 1: seeing a travel time display or not

The number of observations is 105, only data from drivers who have ever been listening to radio traffic news are considered since in the later analysis, the percentage of route changing will be compared between seeing a travel information display and listening to radio traffic news; in this model, the dependent variable is seeing a travel time display or not, and the baseline is not seeing a travel time display, following the above calibration steps ends up with 3 significant factors involving traveling with time constraint or not, gender and years of age from the result of Table 1; the direction of influence for each factor is (1) compared to a person without time constraint, the driver significantly tends to see a travel time display when he has time constraint (and the odds ratio of odds for seeing versus not seeing between with constraint versus without constraint is \( e^{1.913} = 6.77 \)), (2) compared to female drivers, male drivers significantly tend to see a travel time display (and the odds ratio is 4.19), (3) compared to the drivers with more than 50 years of age, drivers with less than 30 years of age significantly tend to see a travel time display (and the odds ratio is 8.36), and (4) compared to the drivers with more than 50 years of age, drivers with years of age between 30 and 50 significantly tend to see a travel time display (and the odds ratio is 10.4); the validation of this model indicates that \( \rho^2 \) is 0.2514 and the percentage of correct prediction is 71.4.
Table 1 Results for model 1

<table>
<thead>
<tr>
<th>Effects</th>
<th>β</th>
<th>Standard errors</th>
<th>P-Value</th>
<th>Significance</th>
</tr>
</thead>
<tbody>
<tr>
<td>intercept</td>
<td>-3.162</td>
<td>0.891</td>
<td>0.000</td>
<td>***</td>
</tr>
<tr>
<td>[with time constraint]</td>
<td>1.913</td>
<td>0.965</td>
<td>0.048</td>
<td>**</td>
</tr>
<tr>
<td>[without time constraint]</td>
<td>0</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
</tr>
<tr>
<td>[gender=male]</td>
<td>1.433</td>
<td>0.722</td>
<td>0.047</td>
<td>**</td>
</tr>
<tr>
<td>[gender=female]</td>
<td>0</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
</tr>
<tr>
<td>[years of age=less than 30]</td>
<td>2.123</td>
<td>0.849</td>
<td>0.012</td>
<td>**</td>
</tr>
<tr>
<td>[years of age=30~50]</td>
<td>2.338</td>
<td>0.686</td>
<td>0.001</td>
<td>***</td>
</tr>
<tr>
<td>[years of age=more than 50]</td>
<td>0</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
</tr>
</tbody>
</table>

Notes: ** means 0.01<P-Value<0.05, *** means P-Value<0.01. The number of observation is 105, $\rho^2 = 0.2514$, percentage of correct prediction = 71.4.

4.2.2 Model 2: changing route or not while seeing a travel information display only about time between the seeing location and a certain exit Ta-Yia

The number of observations is 55, only data from drivers who have both ever been listening to radio traffic news and seeing a travel information display are considered since in the later analysis, the percentage of route changing will be compared between seeing a travel information display and listening to radio traffic news; in this model, the dependent variable is changing route or not while seeing a travel information display only about time, and the baseline is not changing route, following the above calibration steps ends up with 3 significant factors involving ever experiencing congestion or not, traveling with time constraint or not and ever changing route plan of trip or not when facing congestion from the result of Table 2; the direction of influence for each factor is (1) compared to a person never experiencing congestion, the driver significantly tends to change route when he ever experiences congestion (and the odds ratio is 2.29), (2) compared to a person without time constraint, the driver significantly tends to change route when he has time constraint (and the odds ratio is 2.65), (3) compared to a person never changing route plan of trip, the driver significantly tends to change route when he ever changes route plan of trip (and the odds ratio is 3.09); the validation of this model indicates that $\rho^2$ is 0.1937 and the percentage of correct prediction is 58.2.
Table 2 Results for model 2

<table>
<thead>
<tr>
<th>Effects</th>
<th>β</th>
<th>Standard errors</th>
<th>P-Value</th>
<th>Significance</th>
</tr>
</thead>
<tbody>
<tr>
<td>intercept</td>
<td>-1.380</td>
<td>0.745</td>
<td>0.064</td>
<td>*</td>
</tr>
<tr>
<td>[ever experiencing congestion]</td>
<td>0.827</td>
<td>0.585</td>
<td>0.057</td>
<td>*</td>
</tr>
<tr>
<td>[never experiencing congestion]</td>
<td>0</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
</tr>
<tr>
<td>[with time constraint]</td>
<td>0.973</td>
<td>0.870</td>
<td>0.043</td>
<td>**</td>
</tr>
<tr>
<td>[without time constraint]</td>
<td>0</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
</tr>
<tr>
<td>[ever changing route pan]</td>
<td>1.127</td>
<td>0.714</td>
<td>0.014</td>
<td>**</td>
</tr>
<tr>
<td>[never changing route pan]</td>
<td>0</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
</tr>
</tbody>
</table>

Notes: * means 0.05<P-Value<0.1, ** means 0.01<P-Value<0.05. The number of observation is 55, \( \rho^2 = 0.1937 \), percentage of correct prediction = 58.2.

4.2.3 Model 3: changing route or not while seeing a travel information display about time and distance between the seeing location and a certain exit Ta-Yia

The number of observations is also 55, only data from drivers who have both ever been listening to radio traffic news and seeing a travel information display are considered since in the later analysis, the percentage of route changing will be compared between seeing a travel information display and listening to radio traffic news; in this model, the dependent variable is changing route or not while seeing a travel information display about time and extra distance stated, and the baseline is not changing route, following the above calibration steps ends up with 3 significant factors involving ever experiencing congestion or not, traveling with time constraint or not and level of monthly income from the result of Table 3; the direction of influence for each factor is (1) compared to a person never experiencing congestion, the driver significantly tends to change route when he ever experiences congestion (and the odds ratio is 2.97), (2) compared to a person without time constraint, the driver significantly tends to change route when he has time constraint (and the odds ratio is 7.58), (3) compared to a person with personal monthly income more than 60 thousands New Taiwan Dollars (TNT$), the driver significantly tends not to change route when he earns personal monthly income less than 30 TNT$ (and the odds ratio is 0.110), (4) compared to a person with personal monthly income more than 60 TNT$, the driver significantly tends not to change route when he earns personal monthly income between 30 and 60 TNT$ (and the odds ratio is 0.378); the validation of this model indicates that \( \rho^2 = 0.2753 \) and the percentage of correct prediction is 61.8.
Table 3 Results for model 3

<table>
<thead>
<tr>
<th>Effects</th>
<th>β</th>
<th>Standard errors</th>
<th>P-Value</th>
<th>Significance</th>
</tr>
</thead>
<tbody>
<tr>
<td>intercept</td>
<td>-0.322</td>
<td>1</td>
<td>0.048</td>
<td>**</td>
</tr>
<tr>
<td>[ever experiencing congestion]</td>
<td>1.088</td>
<td>0.665</td>
<td>0.042</td>
<td>**</td>
</tr>
<tr>
<td>[never experiencing congestion]</td>
<td>0</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
</tr>
<tr>
<td>[with time constraint]</td>
<td>2.026</td>
<td>1.261</td>
<td>0.048</td>
<td>**</td>
</tr>
<tr>
<td>[without time constraint]</td>
<td>0</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
</tr>
<tr>
<td>[income=less than 30 thousands]</td>
<td>-2.204</td>
<td>1.213</td>
<td>0.028</td>
<td>**</td>
</tr>
<tr>
<td>[income=30~60 thousands]</td>
<td>-0.972</td>
<td>0.805</td>
<td>0.063</td>
<td>*</td>
</tr>
<tr>
<td>[income=more than 60 thousands]</td>
<td>0</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
</tr>
</tbody>
</table>

Notes: * means 0.05<P-Value<0.1, ** means 0.01<P-Value<0.05. The number of observation is 55, $\rho^2 = 0.2753$, percentage of correct prediction = 61.8.

4.2.4 Model 4: changing route or not while seeing a travel information display about time and distance as well as average speed between the seeing location and a certain exit Ta-Yia

The number of observations is also 55, only data from drivers who have both ever been listening to radio traffic news and seeing a travel information display are considered since in the later analysis, the percentage of route changing will be compared between seeing a travel information display and listening to radio traffic news; in this model, the dependent variable is changing route or not while seeing a travel information display about time and extra distance as well as average speed stated, and the baseline is not changing route, following the above calibration steps ends up with 3 significant factors involving total travel time, ever changing route plan of trip or not when facing congestion and level of monthly income from the result of Table 4; the direction of influence for each factor is (1) a driver significantly tends to change route when he speeds more time on travel (and the odds ratio is 1.005 for each extra minute), (2) compared to a person never changing route plan of trip, the driver significantly tends to change route when he ever changes route plan of trip (and the odds ratio is 7.19), (3) compared to a person with personal monthly income more than 60 thousands New Taiwan Dollars (TNT$), the driver significantly tends not to change route when he earns personal monthly income less than 30 TNT$ (and the odds ratio is 0.504), (4) compared to a person with personal monthly income more than 60 TNT$, the driver significantly tends not to change route when he earns personal monthly income between 30 and 60 TNT$ (and the odds ratio is 0.808); the validation of this model indicates that $\rho^2$ is 0.3831 and the percentage of correct prediction is 75.2.
Table 4 Results for model 4

<table>
<thead>
<tr>
<th>Effects</th>
<th>β</th>
<th>Standard errors</th>
<th>P-Value</th>
<th>Significance</th>
</tr>
</thead>
<tbody>
<tr>
<td>intercept</td>
<td>1.618</td>
<td>1.288</td>
<td>0.209</td>
<td></td>
</tr>
<tr>
<td>total travel time</td>
<td>0.005</td>
<td>0.003</td>
<td>0.047 **</td>
<td></td>
</tr>
<tr>
<td>[ever changing route pan]</td>
<td>1.972</td>
<td>1.109</td>
<td>0.055 *</td>
<td></td>
</tr>
<tr>
<td>[never changing route pan]</td>
<td>0</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
</tr>
<tr>
<td>[income=less than 30 thousands]</td>
<td>-0.685</td>
<td>1.193</td>
<td>0.066 *</td>
<td></td>
</tr>
<tr>
<td>[income=30–60 thousands]</td>
<td>-0.213</td>
<td>0.811</td>
<td>0.093 *</td>
<td></td>
</tr>
<tr>
<td>[income=more than 60 thousands]</td>
<td>0</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
</tr>
</tbody>
</table>

Notes: * means 0.05<P-Value<0.1, ** means 0.01<P-Value<0.05. The number of observation is 55, $\rho^2 = 0.3831$, percentage of correct prediction = 75.2.

4.2.5 Model 5: a mixed model for changing route or not while seeing a travel information display about three alternative contents

In order to compare the effects on route changing among three travel information display alternatives, i.e., (1) only travel time, (2) both travel time and distance, and (3) travel time, distance and speed, the data in model 2, 3 and 4 are mixed together, thus, this mixed model ends up with 165 observations; in this model, the dependent variable is still changing route or not while seeing a travel information display from changeable message sign (CMS), and the baseline is still not changing route, following the above calibration steps ends up with only one significant factor display content from the result of Table 5; the direction of influence for this factor is (1) a driver significantly tends not to change route when he sees only travel time compared to seeing all possible information (and the odds ratio is 0.396), (2) significantly tends not to change route when he sees both travel time and distance compared to seeing all possible information (and the odds ratio is 0.457); the validation of this model indicates that $\rho^2$ is 0.137 and the percentage of correct prediction is 58.2.

Table 5 Results for model 5

<table>
<thead>
<tr>
<th>Effects</th>
<th>β</th>
<th>Standard errors</th>
<th>P-Value</th>
<th>Significance</th>
</tr>
</thead>
<tbody>
<tr>
<td>intercept</td>
<td>-0.891</td>
<td>0.297</td>
<td>0.003 ***</td>
<td></td>
</tr>
<tr>
<td>[CMS, travel time]</td>
<td>-0.927</td>
<td>0.401</td>
<td>0.021 **</td>
<td></td>
</tr>
<tr>
<td>[CMS, travel time and distance]</td>
<td>-0.782</td>
<td>0.401</td>
<td>0.051 *</td>
<td></td>
</tr>
<tr>
<td>[CMS, travel time and distance as well as speed]</td>
<td>0</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
</tr>
</tbody>
</table>
4.2.6 Model 6: a mixed model for route change due to traffic news from radio or travel information display from CMS

In order to compare the tendency of route change in congestion condition between listening to traffic news from radio and seeing travel information display from CMS (changeable message sign), in addition to data for model 5, more data of route change to Freeway Three (55 more data) or to local street (55 more data) after listening to radio are included (detailed analysis shows, while listening to radio, little difference is found between tendency of route change to Freeway Three and local street, then, data from these two questions are mixed as well), thus, the sixth model ends up with 275 observations.

Only data from drivers who have ever been listening to radio traffic news are considered since in the later analysis, the percentage of route changing are compared between seeing a travel time display and listening to radio traffic news; in this model, the dependent variable is changing route or not, and the baseline is not changing route, following the above calibration steps ends up with only one significant factor, i.e., information content from the result of Table 6, and the baseline independent dummy variable is seeing travel information including time, distance and speed; by comparing to the baseline independent variable, the direction of influence for this factor is (1) the drivers tend to change route when he hear radio news of seriously congested condition, (2) the drivers tend not to change route when he hear radio news of stopped and gone condition, (3) the drivers tend not to change route when he hear radio news of backward shock wave condition, (4) the drivers significantly tend not to change route when he hear radio news of a few traffic condition (and the odds ratio is 0.205), (5) the drivers tend to change route when he hear radio news of congested speed as 30 kilometers per hour, (6) the drivers tend not to change route when he hear radio news of congested speed as 40 kilometers per hour, (7) the drivers tend not to change route when he hear radio news of congested speed as 50 kilometers per hour, (8) the drivers significantly tend not to change route when he hear radio news of congested speed as 60 kilometers per hour (and the odds ratio is 0.0316), (9) the drivers significantly tend not to change route when he sees only display of travel time (and the odds ratio is 0.396), (10) the drivers significantly tend not to change route when he sees display of both travel time and distance (and the odds ratio is 0.457); the validation of this model indicates that $\rho^2 = 0.187$ and the percentage of correct prediction is 64.7.

If estimated parameters are compared directly across information content, the effect of hearing news of seriously congested condition is somewhere close to the effect of hearing news of congested speed as between 30 and 40 kph, and the effect of hearing news of stopped and gone condition or backward shock wave condition are somewhere close to the effect of hearing news of congested speed as between 40 and 50 kph, besides, the effect of hearing news of a few traffic condition is somewhere close to the effect of hearing news of congested speed as between 50 and 60 kph; while the effects of seeing display of travel time or both time and distance are somewhere close to the effect of hearing news of congested speed as between 40 and 50 kph, which departs a little form the hidden true information such as travel speeds between 30 and 40 kph, by the way, the effects of seeing display of time, distance and speed are somewhere close to the effect of hearing news of congested speed as between 30 and 40 kph, which departs a little form the hidden true information such as travel speeds 25 kph, these are possible because that figure itself in CMS may only plays a supplementary role of providing traffic information, but when it is accompanied with description about
congestion in radio, it is considered more reliable and can produce more effects on route change.

Table 6 Results for model 6

<table>
<thead>
<tr>
<th>Effects</th>
<th>$\beta$</th>
<th>Standard errors</th>
<th>P-Value</th>
<th>Significance</th>
</tr>
</thead>
<tbody>
<tr>
<td>intercept</td>
<td>0.891</td>
<td>0.297</td>
<td>0.003</td>
<td>***</td>
</tr>
<tr>
<td>[radio, seriously congested]</td>
<td>0.556</td>
<td>0.630</td>
<td>0.378</td>
<td></td>
</tr>
<tr>
<td>[radio, stopped and gone]</td>
<td>-0.439</td>
<td>0.567</td>
<td>0.439</td>
<td></td>
</tr>
<tr>
<td>[radio, backward shock wave]</td>
<td>-0.331</td>
<td>0.694</td>
<td>0.633</td>
<td></td>
</tr>
<tr>
<td>[radio, a few traffic]</td>
<td>-1.584</td>
<td>0.767</td>
<td>0.039</td>
<td>**</td>
</tr>
<tr>
<td>[radio, congested speed 30 kph]</td>
<td>1.748</td>
<td>1.077</td>
<td>0.105</td>
<td></td>
</tr>
<tr>
<td>[radio, congested speed 40 kph]</td>
<td>-0.080</td>
<td>0.670</td>
<td>0.905</td>
<td></td>
</tr>
<tr>
<td>[radio, congested speed 50 kph]</td>
<td>-1.114</td>
<td>0.734</td>
<td>0.129</td>
<td></td>
</tr>
<tr>
<td>[radio, congested speed 60 kph]</td>
<td>-3.456</td>
<td>1.079</td>
<td>0.001</td>
<td>***</td>
</tr>
<tr>
<td>[CMS, travel time]</td>
<td>-0.927</td>
<td>0.401</td>
<td>0.021</td>
<td>**</td>
</tr>
<tr>
<td>[CMS, travel time and distance]</td>
<td>-0.782</td>
<td>0.401</td>
<td>0.051</td>
<td>*</td>
</tr>
<tr>
<td>[CMS, travel time and distance as well as speed]</td>
<td>0</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
</tr>
</tbody>
</table>

Notes: * means $0.05<P-Value<0.1$, ** means $0.01<P-Value<0.05$, *** means $P-Value<0.01$. The number of observation is 275, $\rho^2 = 0.187$, percentage of correct prediction = 64.7.

5. CONCLUSION AND RECOMMENDATION

5.1 Conclusion
1. This research reviews literature about real time information and its effect on route choices, however, scarce studies mention content of information itself, since real time traffic information provides valuable support for drivers in congestion condition, and helps them choose a better alternative route, perhaps, can also relieves delay in the bottleneck, thus, it is a important tool for freeway administration agencies to manage traffic condition; hence, this study tries to estimate the proportion of on road drivers who sees a information display, and the percentage of route changing after seeing a CMS or listening to a radio traffic news.
2. In the literature reviews, some factors affecting reception of real time information and later on influencing route choice are selected in the questionnaire design stage, so are the variable real time information.
3. From basic statistics, during the travel process northbound on Freeway One, there are 52.38 percents of drivers ever seeing a display of traffic information about travel time between the seeing location and a predefined exit Ta-Yia, and 25.71 % of drivers who see a display of travel time would rather change route, while 27.61 % of drivers who see a display of
both travel time and distance reveal willingness to changing route, even 36.71% of drivers who see a display of travel time and distance as well as speed would choose a alternative route.

4. There are several points of conclusion from model results, especially those significant ones as followings: a driver tends to seeing a display of only travel time when this person has time constraint, is male, and at most 50 years of age when compared to a situation when this person does not have time constraint, is female, and more than 50 years of age; the driver tends to changing route while seeing a display of only travel time when this person ever encountered traffic jam, has time constraint, and ever changed route plan due to congestion when compared to a situation when this person never encountered traffic jam, has no time constraint, and never changed route plan due to congestion; the driver tends to changing route while seeing a display of both travel time and distance when this person ever encountered traffic jam, has time constraint, and earns more than 60 thousands new Taiwan dollars in each month when compared to a situation when this person never encountered traffic jam, has no time constraint, and earns at most 60 thousands new Taiwan dollars in each month; the driver tends to changing route while seeing a display of travel time and distance as well as speed when this person spends more total travel time for a trip, ever changed route plan due to congestion, and earns more than 60 thousands new Taiwan dollars in each month; finally, the driver tends to changing route while seeing a display of travel time, distance and speed when compared to a situation when this person sees a display of travel time, distance, or speed.

5.2 Recommendation
1. From the survey experiment of this study, current displays of travel information only show time, more percents of drivers to changing route can be expected if information of distance or speed are further provided.
2. This research only explores the scenarios under situation of heavy traffic conditions, other events, such as accidents or road works, can be considered in the future.
3. This study only conducts a driver investigation on a certain service area located about 30 kilometers north of interesting bottleneck roadway section, surveys from more service areas can provide a better opportunity of interpretation for the behaviors of general drivers’ population.
4. The driver participants in the service area may refuse to answer a questionnaire due to in a hurry to proceeding next schedule, or deceive not seeing a display nor listening to radio news in order to short cut the survey and save time of answering the questionnaire, hence, the percentage of seeing a display or listening to radio news can be underestimated, therefore, applying the results of this study requires caution in mind.

REFERENCES


