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# Choosing Information Sources: A Modeling Framework

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**Abstract**: This paper proposes the modelling framework developed to study the travellers' choice of information sources and their subsequent travel mode choice decisions. The motivation behind this research is to investigate the factors that people consider in selecting different sources of information in today's information rich atmosphere of travel. The goal of this study is to develop a comprehensive choice model that can capture the information acquisition process by predicting the choice of information sources together with its effects on travel choices of the travellers. Information acquisition process for the travel decisions is considered especially when a user first decides to acquire the information and is not satisfied with his present level of knowledge/belief. It is important to explicitly model the abstract terms involved in the whole process of information acquisition and subsequent travel decisions. The developed modelling framework, based on the complicated decision making process, is expected to cope with it. Utility function is formulated in the Nested Logit Model framework.

**Keywords:** Developed To Study, Choice Of Information Sources, Choice Decisions

## 1. INTRODUCTION

Traveller information is being widely used to improve the traffic and network efficiency. Many types of information services and products are already in market and research is continued to introduce second generation of these systems by using portable devices of personal communication. It has been widely acknowledged that providing travellers the information about their travel choices influences their behaviour in ways that are beneficial for the efficiency and use of the transport system (Koppelman and Pas, 1980, Kanninen, 1996). An abundant body of literature is available on the impacts of new technologies since the last decade or so (see among many others, Ben-Akiva *et al.* 1991; Mahmassani and Jayakrishan 1991; Emmerink *et al.* 1995 a,b; Bonsall 1995; Al-Deek *et al.* 1998; Mahmassani and Liu 1999; Stough 2001).

The studies carried out so far largely deal with only few information sources notably and the effect of one rather powerful and common source, i.e. the internet, is rather ignored. There had been few attempts to study information gain in an ICT rich environment. However, there are certain gaps in the study of all sources considered in choice set not just partial studies on the determinants of some en-route or pre-trip sources. Furthermore most of the studies were inclined towards the linking of above mentioned determinants with the route choice decisions. It is surprising to see that literature is lacking the studies that comprehensively link the various sources of information with the mode choice decisions of the travelers. There are numerous sources of information which provide information about the different modes of travel alternatives and it is important to study the influence of these information sources in the mode choice decisions of the travelers under various circumstances.

Researchers in the past have done extensive research about the influence of different message contents upon travel decisions. However, the new information sources have different other attributes including their special design, advertisements, and graphics which have their own influence on the traveler and his travel decisions. Effects of these important determinants must be studied in order to improve the understanding of the influence of these sources on the overall modal shift which is rather ignored in the previous research.

The issue of credibility as mentioned above was dealt by a number of researchers. But the researchers focused the reliability of the information for only the information source under study (mostly VMS signs). It is anticipated that there is a gap in the literature respecting the variation of the credibility from one source to another. Moreover, the issue about the treatment of the sources with low credibility by travelers and what are the determinants that affect the credibility of the sources is also not fully understood in the past.

In the light of the discussion made above, the following research questions/hypotheses are found that must be treated for better understanding and the usages of the present day information sources.

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Hypothesis 1: The information sources and their characteristics influence mode choice decisions.
Hypothesis 2: The presentation, design, credibility, capability and cost are important attributes in the selection of the information sources.

**Conceptual Model**

The process of information acquisition for a traveller, who is planning or executing a trip, starts with the behavioural intent and stimulus which enforce her to start the decision process.

If the traveller has the prior knowledge and experience, as an ideal case, she is aware of every alternative and their attributes she may not decide to gain the available information or otherwise if she is satisfied with the available information, she will not consider the value of obtaining additional information. So the search process will not start at all. However, decision to acquire information primarily depends on the external circumstances for example if she thinks that network is not congested at all she wont value the available information but on the other hand she may think to obtain the information in the bad weather conditions. Secondly, it depends upon the individual preferences and attitudes of the traveller. For example if she is influenced with the habit of using a particular route and this habit will influence him to put in less efforts of obtaining information. Thirdly it also depends upon personal circumstances about the traffic and driving tasks. And these personal circumstances and individual preferences/attitudes may vary with personal characteristics and segmentations.

The above mentioned ideal situation is unrealistic; one deviation could be that traveller is not aware of all available travel alternatives and hence if she decides to acquire information the aim of that information will be alternative generation (Chorus *et.al.,* 2006), similarly other rift can be when traveller has incomplete information about characteristics of alternatives and she requires information about alternate assessment. Here it must be noted that the randomness is not only in the environment but also there is uncertainty in the perception of the traveller about the non-stationary environment **(Fig.1).**

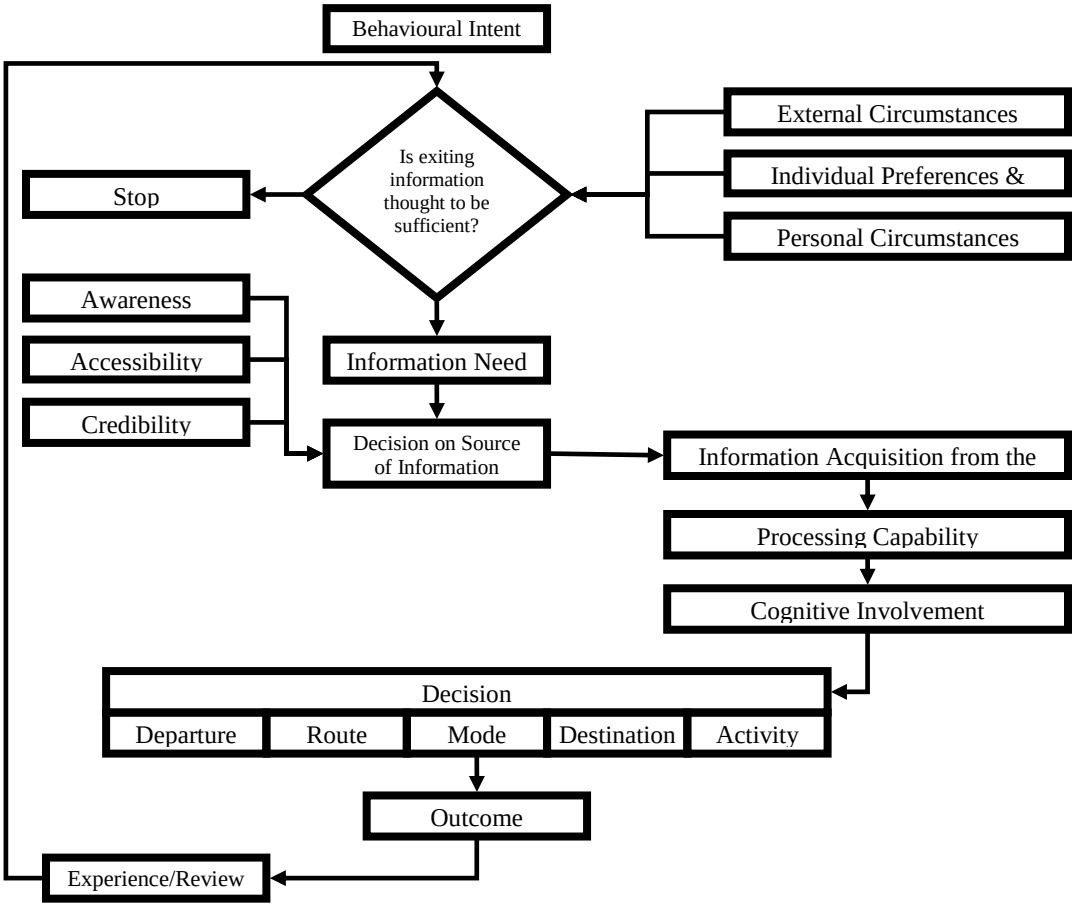



**Fig. 1 Conceptual Model**

Once the traveller decides to acquire information and recognizes its value, she tries to search available potential sources of the information. From these sources she will decide to acquire information from a particular source depending upon awareness, its credibility, and accessibility and degree of understanding of the person. Awareness corresponds to the possibility of knowing the presence of a particular source and degree of success in understanding the information offered by that source. Traveller considers the information credible if it is provided by a trusted and reliable source, her experience with that particular source, reasonability of the information matching the intuitive believes of the traveller, suspiciousness in the motif of the information and the degree of its authentication by other reliable sources. In addition, accessibility corresponds to how financially viable this particular source is and its easiness wit which it can be accessed and used. Whereas, after gathering new information from a selected source the traveller tries to understand the acquired knowledge and rethinks the credibility of the new information and processes it as per her needs. She also synthesizes the new information with her beliefs and experiences prior to acquisition. If the acquired information is satisfying/optimizing her travel aspiration level she will use this information in her route or departure time decision. Otherwise she will try to acquire more information if the cost of acquisition is less than the disutility of delay and uncertainty.

At last the user forms beliefs and add/update her experiences about her travel and this particular information source. The process of information acquisition explained in Fig. 1.

## 2. RESEARCH METHOD

Revealed preference (RP) information relates to actual preference and behaviour of the travelers under the influence of information. However, sometimes it becomes very difficult if not impossible to be used simply because there is very limited control in understanding response to different travel situation. In this study the main information source to be studied is internet and is widely used nowadays, which gives good opportunity to use RP data in addition to Stated Preference (SP) data to examine the research objectives.

SP techniques involve studying individual's preference, behaviour and possible action in response to different hypothetical travel situations. These are characterized by important attributes which are likely to affect the preference and behavior. This method together with RP was considered most appropriate for the study as they both can achieve all the criteria listed above. This also minimizes some of the biases inherent in the SP data as first the respondent is examined with the real journey made in the recent past.

### Analytical Issues

An analytical method used for explaining choice behaviour is discrete choice analysis based on random utility theory (Domencich, and McFadden, 1975). An individual's choice is assumed to depend on 'utility' representing the satisfaction or benefits to the person from each alternative. If individuals act rationally, they are assumed to always choose the option with the highest utility to them. In this research maximization principle has been selected for analysis of the study. The reason for this selection is based on the strong footings of this theory's acceptability in wide range of disciplines. Furthermore, Utility maximization theory is easier to implement in the current context as other methods would complicate an already complicated model structure. Utility maximization provides a way by which choice probabilities can be estimated.

### Modeling Structure

In this study in order to study the effect for information sources on their mode and departure time decisions a Nested Logit (NL) model is proposed with following structure as shown in **(Fig. 2)**. The reason for choosing NL instead of other modeling frameworks i.e. Multinomial Logit (MNL) was that it was anticipated that that there would be correlation within the choice of information sources and within choice of modes.

The above model structure suggests that there are essentially three elemental alternatives that are to be modeled. These include,

- The choice of mode without the information source,
- Choice of mode and with choice of information source not including website
- Choice of mode, choice of information source as website and choice of a particular website.

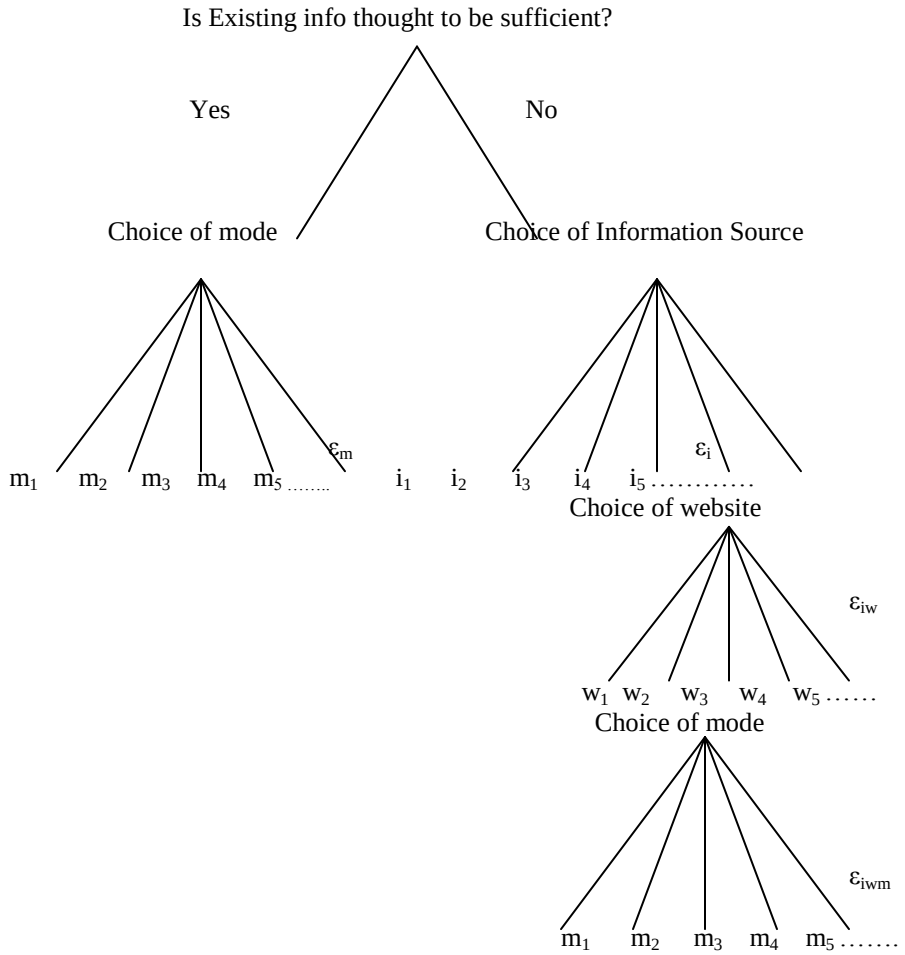



**Fig. 2 Model Structure**

***Choice of mode without information source***

In this elemental case, the utility function only includes the choice of mode when the respondent doesn't need information from any source and is aware of the alternatives. This means the only choice made would be choice of mode. Equation (1) presents the utility function for the choice of mode without the use of information sources and Equation (2) shows the systematic utility of the choice of mode,

$$U_m=V_m+\varepsilon_m \quad ---(1)$$

$$\text{where, } V_m=\beta_m x_m \quad ---(2)$$

***Choice of mode and with choice of information source not including website***

In this elemental case, the utility function includes the choice of mode when the respondent needs information from any source excluding website. Here the choice variables would be the choice of a source of information (choice set is labelled as $I_n$ and is denoted by any element i of $I_n$) and mode choice (choice set is labelled as $M_n$ and is denoted by any element m of $M_n$).

The total random utility is equal $\varepsilon_i+\varepsilon_m+\varepsilon_{im}$. Equation (3) presents the nested choice model as

$$P_n(im)=P_n(m|i)P_n(i) \quad ---(3)$$

where $P_n(im)$ is probability of an individual n choosing mode m and information i, and $P_n(i)$ is the probability of an individual choosing information source i.

The utility of an alternative in $C_n$ is expressed in Equation (4) as,

$$U_{im}=V_i+V_m+V_{im}+\varepsilon_i+\varepsilon_m+\varepsilon_{im} \quad ---(4)$$

Here,

$$V_i=\beta_i x_i \quad --(5)$$

$$V_m=\beta_m x_m \quad ---(6)$$

$$V_{im}=\beta_{im} x_{im} \quad ---(7)$$

Where $x_i, x_m, x_{im}$ correspond to attributes of information source, modes, and combination of information sources and modes respectively. Whereas, $\beta_i, \beta_m$ and $\beta_{im,}$ are vectors of corresponding parameters and Equations (5) to (7) present their systematic utility functions respectively.

***Choice of mode and with choice of information source which is a website***

In this elemental case, the utility function includes the choice of mode when the respondent needs information from a website. Here the choice variables would be the choice of a source of information (choice set is labeled as $I_n$ and is denoted by any element i of $I_n$), choice of website (choice set is labeled as $W_n$ and is denoted by any element w of $W_n$, and mode choice (choice set is labeled as $M_n$ and is denoted by any element m of $M_n$).

The total random utility is equal $\varepsilon_i+\varepsilon_m+\varepsilon_{im}+\varepsilon_{iw}+\varepsilon_{iwm}$. Equation (8) presents the nested choice model as

$$P_n(iwm)=P_n(m|iw)P_n(w|i)P_n(i) \qquad (8)$$

where $P_n(iwm)$ is probability of an individual n choosing mode m, information i, and website w, $P_n(m|iw)$ is probability of individual n choosing mode m conditional to her choice of information source i and website w, $P_n(w|i)$ is probability of individual n choosing mode website w conditional to her choice of information source i, and $P_n(i)$ is the probability of an individual choosing information source i.

The utility of an alternative in $C_n$ is expressed in Equation (9) as

$$U_{iwm}=V_i+V_m+V_w+V_{iw}+V_{im}+V_{wm}+V_{iwm}+\varepsilon_i+\varepsilon_m+\varepsilon_{im}+\varepsilon_{iw}+\varepsilon_{iwm}+\varepsilon_{iwm} \qquad ---(9)$$

Now,

$$V_i=\beta_i x_i \qquad ---(10)$$

$$V_m=\beta_m x_m \qquad ---(11)$$

$$V_w=\beta_w x_w \qquad ---(12)$$

$$V_{iw}=\beta_{iw} x_{iw} \qquad ---(13)$$

$$V_{im}=\beta_{im} x_{im} \qquad ---(14)$$

$$V_{wm}=\beta_{wm} x_{wm} \qquad ---(15)$$

$$V_{iwm}=\beta_{iwm} x_{iwm} \qquad ---(16)$$

Where $x_i, x_m, x_t, x_w, x_{iw}, x_{im}, x_{wm}, x_{iwm,}$ correspond to attributes of information source, websites (if internet user), modes, and combination of information sources and modes respectively. Whereas $\beta_i, \beta_m, \beta_w, \beta_{iw}, \beta_{im}, \beta_{wm}, \beta_{iwm,}$ are vectors of corresponding parameters and Equations (10) to (16) present their systematic utility functions respectively.

The above modelling framework would be estimated through commercially available discrete choice modelling packages such as Alogit and Biogeme. These software would be used to estimate the models and the results would be compared after the correction of the repeated measurement problems of the SP data and individually specific taste variations of the respondents.

## 3. CONCLUSION

This study proposes a modelling framework to study the effect for information sources on travellers' mode and departure time decisions. A Nested Logit (NL) model is proposed because it was anticipated that that there would be correlation within the choice of information sources and within choice of modes. The data collection for the main survey is currently underway and respondents are being recruited at train station and bus station in order to have reasonable spread between different modes of transport. The collected data would be used in the proposed modelling framework. The proposed model would contribute in the literature by exploring traveller behaviour, particularly with regard to influence of information use on mode choice decisions. The generality of these insights would be fully explored after the completion of the main survey.

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