



# Analysis of Mode Choice Behavior under Adverse Weather Conditions Using RA and SA Surveys - A Case Study from Ho Chi Minh City (HCMC), Vietnam

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**Abstract.** This paper analyzes mode choice behavior in different weather conditions, with population groups, on travel purposes and travel distances to support the formulation of weather responsive traffic management measures. Revealed and stated adaptation surveys are carried out with 400 respondents and 100 respondents, respectively. The survey shows that the rate of mode change due to adverse weathers is much smaller than the figure in developed countries. The major patterns of mode change are shifts from motorcycle to car or taxi, accounted nearly half of mode changes, thus causing severer traffic congestions. The mode choice modeling show travel time, travel cost, gender, income, specific jobs, motorcycle ownership, bus ticket holding, provision of weather information prior to the trip are significant factors to mode choice decision under bad weather conditions. The results suggest focusing on “avoid or reduce unnecessary mobility demand” and “improve public transport” measures.

**Keywords:** mode choice, adverse weather, road flood, revealed and stated adaptation survey, Ho Chi Minh City (HCMC).

## 1 Introduction

Traffic congestion in Ho Chi Minh City jointly caused by recurrent traffic and road flooding might cause a loss of 97 billion USD for the period of 2015-2045 (ARUP and Siemens, 2014). Therefore, city-wide flooding mitigation and traffic management have become crucially important for alike cities. Traffic management strategies include advisory, control and treatment measures to help address road congestions caused adverse weathers [1]. Among these, data collection and analysis of behavioral mechanisms or human factors are essential for formulating weather-responsive traffic management strategies. Unfortunately, Vietnam has a lack of practice and research on adverse weather responsive traffic management. Control measures at network and road section levels are implemented manually by policemen. As a result, proper and timely responses to incidents including adverse weathers are often very limited. Pre-

liminary observations show that during a heavy rain the number of cars and taxis may increase by up to 70-80%, meanwhile, the number of motorcycles might decrease by 30-40% as compared to a normal condition. It is interesting to understand how and why people change travel mode when an adverse weather event happens. Such understanding is necessary to help predict and evaluate the impacts of bad weather events on transport system, and determine the benefits of implementing advisory, control and treatment strategies [3]. This paper is aimed to present the results of a deep research on mode choice behavior and decision-making factors under adverse weathers and flooding conditions. This paper is structured in five chapters. The first chapter presents the need of understanding mode choice changes. The second chapter describes a methodology and data collection. The third chapter presents the results of analysis on mode change patterns. The fourth chapter presents the results of binary logit mode choice model workable under adverse weathers. The fifth chapter concludes with solution recommendations and further works.

## 2 Methodology and Data Collection

Based on literature review and focus group discussions, two questionnaires were designed. One was for a revealed adaption (RA) survey to capture mode choice behavior changes in response to adverse weather conditions. Another was for a stated adaptation (SA) survey, to prepare data for modeling of mode choice behavior. The RA survey wasn't designed for modeling, but capturing the mode choice changes and the SA survey was to model mode choice behavior.

Which option do you like to choose in each of the following scenarios?			
No Trip purpose	Circumstance	Options	
1 Commuting	Road flood during the trip	<input type="checkbox"/> motorcycle	26,000 VND 36 minutes
		<input type="checkbox"/> taxi	192,000 VND 28 minutes
2 Shopping	Congestion just before departure time	<input type="checkbox"/> motorcycle	13,000 VND 18 minutes
		<input type="checkbox"/> taxi	100,000 VND 14 minutes
3 Leisure	Congestion during the trip	<input type="checkbox"/> motorcycle	38,000 VND 52 minutes
		<input type="checkbox"/> car	189,000 VND 43 minutes
4 Other	Heavy rain just before departure time	<input type="checkbox"/> bus	19,000 VND 62 minutes
		<input type="checkbox"/> mc taxi	112,000 VND 42 minutes

Fig. 1. A sample questionnaire in the stated adaptation survey

**Revealed Adaptation (RA) Survey:** Each respondent was asked to reveal how they would eventually change their travel in four cases, namely (1) encountering a heavy rainfall just before the trip, (2) encountering a heavy rainfall during the trip, (3) encountering a road flood just before the trip, and (4) encountering a road flood during the trip. For each trip purpose (e.g., commuting, shopping, leisure, and other), each respondent is given a number of choices, including (1) cancelation, (2) postponement, (3) destination change, (4) route change, (5) mode change to car, motorcycle, bicycle, e-bike, and bus, and (6) no change. About 400 respondents were successfully interviewed, including 160 motorcyclists and e-bike riders, 80 car drivers, 80 bus riders and 80 cyclists. To ensure an optimal correspondence between the surveyed