

EFFECT OF ATTRIBUTE PERCEPTION FACTORS ON MODE CHOICE
PREFERENCE AMONG PUBLIC TRANSPORT USERS

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DEDICATION

I dedicate this dissertation to my parents' and amiable wife;

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ABSTRACT

Users may form certain perceptions on the attributes of characteristics. This specific type of perception is referred to as attribute perception. Studies have shown that attribute perception influences travel decisions. Recently, in the field of transportation, there is an increased interest in exploring attribute perception and its impacts on users' decisions on the choice of transport mode. Previous studies have identified a range of travel factors influencing passenger's mode of choice, while there has been little effort on the exploration of the significance of these attribute perceptions. Hence, this study explored the impacts of attribute perception on the preferred choice of transport mode among public transport users in Dhaka, Bangladesh. To achieve this aim, a conceptual modelling framework was developed based on the Capability, Opportunity, and Motivation-Behavior (COM-B) model, which allows an extensive range of factors influencing mode choice to be considered. A self-administered survey was conducted to obtain users' perceptions on public transport attributes. Cronbach's alpha was used to identify reliability and internal consistency of the questionnaire and results showed that the questionnaire was found to have an adequate internal consistency. The Cronbach's alpha ranged from .81 to .91 for the six attributes instrument. The data were extracted from 773 respondents from the two busiest routes in Dhaka city, namely Uttara to Azimpur and Mirpur to Motijheel. This conceptual relationship model was investigated using modelling approaches. Initially, the explanatory factor analysis (EFA) was used to determine the attribute perception factors' underlying dimensions. Next, multiple linear regression analysis was used to investigate the relationship between attribute perception factors and travel behaviour. Finally, a multinomial logit model (MNL) was employed to explore the effect of attribute perception on the preferred choice of public transport users. The findings showed that the confidence level for regression model was 95% and its coefficient was defined as $\text{Sig} < 0.05$. Besides, the results showed that the attribute perception factors such as travel time, travel fare, waiting time, travel distance, comfort, and reliability had significant effects on passenger preference of travel modes among the different choices available. The results of this study have contributed to a better understanding of transport mode choice in Dhaka city and provided a foundation for future attribute perception-based mode choice research.

ABSTRAK

Pengguna mampu membentuk persepsi tertentu terhadap sesuatu sifat. Persepsi khas jenis ini dirujuk sebagai persepsi atribut. Kajian telah menunjukkan bahawa persepsi atribut mempengaruhi keputusan sesuatu perjalanan. Baru-baru ini, dalam bidang pengangkutan, terdapat peningkatan dalam minat untuk meneroka persepsi atribut dan impaknya terhadap keputusan pengguna mengenai pilihan mod pengangkutan. Kajian terdahulu telah mengenal pasti pelbagai faktor perjalanan yang mempengaruhi pilihan mod penumpang, sementara terdapat sedikit usaha untuk meneroka kepentingan persepsi atribut ini. Oleh itu, kajian ini meninjau kesan persepsi atribut ke atas pilihan pengangkutan dalam kalangan pengguna pengangkutan awam di Dhaka, Bangladesh. Untuk mencapai matlamat ini, rangka kerja pemodelan konseptual telah dibangunkan berdasarkan model Keupayaan, Peluang dan Motivasi-Perilaku (COM-B), yang membolehkan pelbagai faktor mempengaruhi pilihan mod untuk dipertimbangkan. Tinjauan secara individu dijalankan untuk mendapatkan persepsi pengguna terhadap atribut pengangkutan awam. Alfa Cronbach digunakan untuk mengenal pasti kebolehpercayaan dan konsistensi dalaman soal selidik dan keputusan menunjukkan bahawa soal selidik ini didapati mempunyai konsistensi dalaman yang mencukupi, Alfa Cronbach dari .81 hingga .91 untuk enam instrumen atribut. Data diperoleh daripada 773 responden dari dua laluan tersibuk di bandar Dhaka, iaitu Uttara ke Azimpur dan Mirpur ke Motijheel. Model hubungan konseptual ini dikaji menggunakan pendekatan pemodelan. Pada awalnya, analisis faktor penjelas (EFA) digunakan untuk menentukan dimensi asas faktor persepsi atribut. Seterusnya, analisis regresi linear berganda digunakan untuk mengkaji hubungan antara faktor persepsi atribut dan tingkah laku sesuatu perjalanan. Akhirnya, model multinomial logit (MNL) digunakan untuk meneroka kesan persepsi atribut ke atas pilihan pengguna pengangkutan awam. Dapatan menunjukkan bahawa tahap keyakinan bagi model regresi adalah 95% dan koefisiennya didefinisikan sebagai Sig <0.05. Selain itu, keputusan menunjukkan bahawa faktor persepsi atribut seperti masa perjalanan, tambang perjalanan, masa menunggu, jarak perjalanan, keselesaan, dan kebolehpercayaan memberi kesan yang signifikan terhadap keutamaan penumpang dalam mod perjalanan dalam kalangan pilihan yang berbeza. Hasil kajian ini telah menyumbang kepada pemahaman yang lebih mendalam mengenai pilihan mod pengangkutan di bandar Dhaka, dan menyediakan asas bagi penyelidikan pilihan mod berasaskan persepsi berdasarkan sifat untuk masa depan.

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LIST OF ABBREVIATIONS

ANOVA	-	Analysis of Variance
BBS	-	Bangladesh Bureau of Statistics
BDT	-	Bangladeshi Taka
BRTA	-	Bangladesh Road Transport Authority
CADM	-	Comprehensive Action Determination Model
COM-B	-	Capability Opportunity and Motivation-Behaviour
DCC	-	Dhaka City Corporation
DUTP	-	Dhaka Urban Transport Planning
LOS	-	Level of service
MOA	-	Motivation Opportunity and Ability
NDM	-	Normative Decision Making
NN	-	Neural Network
MNL	-	Multinomial Logistic Regression
PBC	-	Perceive Behavioural Control
PCA	-	Principal Component Analysis
PIA	-	Perception-Intention-Adaptation
PT	-	Public Transport
RP	-	Revealed Preference
SE	-	Standard error
SEA	-	South East Asia
SPSS	-	Statistical Package for Social Science
STP	-	Strategic Transportation Plan
TCQSM	-	Transit Capacity and Quality of Service Manual
TFP	-	Travel feedback programs
TPB	-	Theory of Planned Behaviour
TSI	-	Transit Service Indicator
UK	-	United Kingdom
VIF	-	Variance of Inflation

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CHAPTER 1

INTRODUCTION

1.1 Introduction

A growing concern among most large cities around the world is the increase in the dependency on private cars, thus creating critical environmental, economic and social sustainability challenges on the quality of urban life (Loo et al., 2015). One of the solutions to reduce car dependency is by enticing people to switch to public transportation as the travel mode of choice. However, Lai and Chen (2011) noted that it is very challenging to reduce dependency on private car usage and, at the same time, increase public transportation ridership. In fact, in most major cities, authorities have taken various steps to attract road users to choose public transport instead of the private car (Chee and Fernandez, 2013). However, promoting switching to a more sustainable travel mode, e.g. using public transportation, is difficult if the nature of transport demand is not fully understood (Taylor and Fink, 2012). It follows that, in order to understand transport demand, it is important to study the factors that affect individual passenger choice decision (Chen et al., 2015).

Closer to home, Asian cities are experiencing an increased rate of private motorization as compared to the Western cities, although the rates of development are still comparatively lower than the latter. This upward trend towards private motorized travel in Asian cities has contributed to problems such as traffic congestion and environmental pollution (Hayashi et al., 2004; Morichi, 2005; Elia and Shiftan, 2013). At these Asian cities, the frequent traffic congestions have caused the community to suffer efficiency loss in terms of idle time on the road. This has led the road users to seek better travel choices (Chee and Fernandez, 2013). Consequently, in cities where public transportation is available, road users face a decision choice on whether to make the switch to public transportation or not. In a study by Bekhor et al. (2006), it was found that this travel mode choice decision is influenced by, among others, users'

travel attributes such as travel time, travel cost, type of roadway and perceptions. Yilmaz and Celik (2008) and Habib et al. (2011) added the situational aspects of road users as another factor in considering the mode switch. Besides, Ji et al., (2016) mentioned that some indicators such as comfort, reliability also have significant impacts on travel mode choice. It follows that other factors such as the trip characteristics, socio-demographic characteristics, traveller's perceptions, attitudes and psychological factors also have a significant impact on choice behaviour (Bahamonde-Birke et al., 2017; Jahansson, 2006). As Han et al., (2018) explained, the passenger waiting time and travel distance influence the traveller mode choice decision. Hence, from these separate researches, mode choice was found to be influenced by many different factors. Yet, there is no single research that attempts to look at all these factors simultaneously and looks into how all these factors co-influence mode choice.

In Dhaka, Bangladesh, an Asian city of more than 10 million daily commuters, there was an attempt to analyse road users' mode choice using the four-step travel demand model. Unfortunately, the model considered only factors related to travel attributes (e.g. travel time, travel fare, etc.) and travel behaviour. The proposed model was oversimplified into a binomial choice model between private and public modes. The model ignored intervention programs that were developed to promote the mode switch. Inevitably, the findings focused only on restructuring the transportation system and management (STP, 2005; Habib, 2002). The final model, invariably, ignored the effect of user perceptions on mode choice preferences.

In other Asian cities, researchers have used several behavioural frameworks to understand public transport mode-choices. These frameworks include Normative Decision-Making (NDM) by Klöckner and Matthies (2004); Theory of Planned Behaviour (TPB) by Bamberg et al. (2003); and Motivation, Opportunity and Ability (MOA) by Thøgersen (2009). Independently of each other, these behavioural frameworks have identified some specific psychological constructs like pro-environment values, attitudes, subjective norms, perceived behavioural control, perceived moral obligation and intentions (Michie et al., 2011). These psychological constructs were found to determine travel mode choice decisions.

Recently, a new behavioural framework was developed by Michie et al. (2011) called the Capability, Opportunity and Motivation – Behaviour Model or only COM-B Model. The COM-B model broadly contemplates the relationships between a specific behaviour and psychological constructs (e.g. motivation), individual's characteristics (e.g. capability), and extrinsic factors (e.g. opportunity). The COM-B model is gaining acceptance in health and a couple of other areas, particularly concerning policy design. The advantage of the COM-B model is that the model is comprehensive, coherent and more importantly, is linked to behaviour (Michie et al., 2011).

1.2 Problem Statement

Perception is an important element of people's daily life as it influences natural behaviour. In transportation mode choice study, an individual's perception of a particular transportation mode may be influenced by an individual's experiences, memories, analytical ability and knowledge associated with that transportation mode (He and Thøgersen, 2017; Börjesson, 2014). This view (i.e. mode choice is influenced by perception) is undoubtedly different than the commonly held belief that mode choice (private versus public transportation) is primarily related to fares, service quality, income and availability of a car (Paulley et al., 2006). Although there were mode choice studies that considered individual's self-preference and perception, their findings show that these factors (preference and perception) have minimal predictive value in their final model (Banister 2011; Fujii and Kitamura 2003; Gärling and Axhausen, 2003; Mackett, 2003). Hence, their results are still inadequate to explore the relationships between perception and mode choice behaviour. As a result, the findings of these researches are hardly useful to predict mode choice behaviour based on the users' attribute perception of public transportation at cities other than those in the studies. Compounding to this issue of applying perception-based mode choice model at the city level is that these studies were mostly done in Western cities (Bergstad et al., 2011; Lois and López-Sáez, 2009). For studies done in Asian cities, they mostly focused on perception from an operational and instrumental perspective, not on the attribute of public transportation (Soehodho et al., 2012; Sutomo et al., 2003).

Dhaka, the capital city of Bangladesh, with a population of 20 million, as other major world cities, has been subjected to a high rate of urbanization and rapid development (The Daily Star, 6 September 2019). With the current urbanization level at around 30 percent, the population is expected to grow by 50 percent by the year 2050 (STP 2005). Consequently, Dhaka's transport sector is adversely affected by this rapid urbanization and economic development of the country. The city transportation modes are dominated by non-motorized rickshaws (34%), and buses (34%) with walking or other motorized vehicles constituting the remaining 30% (STP, 2005). With this modal split pattern, Hossain et al. (2003) concluded that the utilisation of the transit system could be further increased. It follows that the present relative importance of public transport does not commensurate with the growing travel demand in an expanding city like Dhaka. Lack of quality services in the form of extremely congested buses, long waiting times, lack of flexible transit points, insufficient stoppages, and long travel times are some of the reasons the public have shied away from using public buses and other public modes of transport (Hoque and Hossain, 2004; JBIC, 2000). Inadvertently, these service and operational issues have created an unfavourable perception among the public on the attributes of public transportation, especially buses. It follows that the perceived attribute of public transportation might influence the public's choice of transportation mode for their commuting trip. Hence, it is important to understand how these perceptions influence the choice of commuting mode among the public. This understanding is critical in Dhaka as currently, no satisfactory travel demand model has been developed yet.

According to Habib (2002), a four-step travel demand model was developed for Dhaka based on travel time and travel cost factors (STP, 2005). As the model overlooked the influence of respondent's perception on developing the travel demand model, it is rarely applied for planning purposes. As the model overlooked the influence of attribute perception, it is doubtful whether results from the analysis will be a valid measure of traveller's mode choice pattern. What is lacking in the Dhaka's four-step model is an explanation on the relationship between attribute perception on public transportation and travel behaviour of the individual traveller; and finally, how this relationship influences travel mode preferences leading to travel mode selection (i.e. mode choice). This is the problem that this research will attempt to solve.

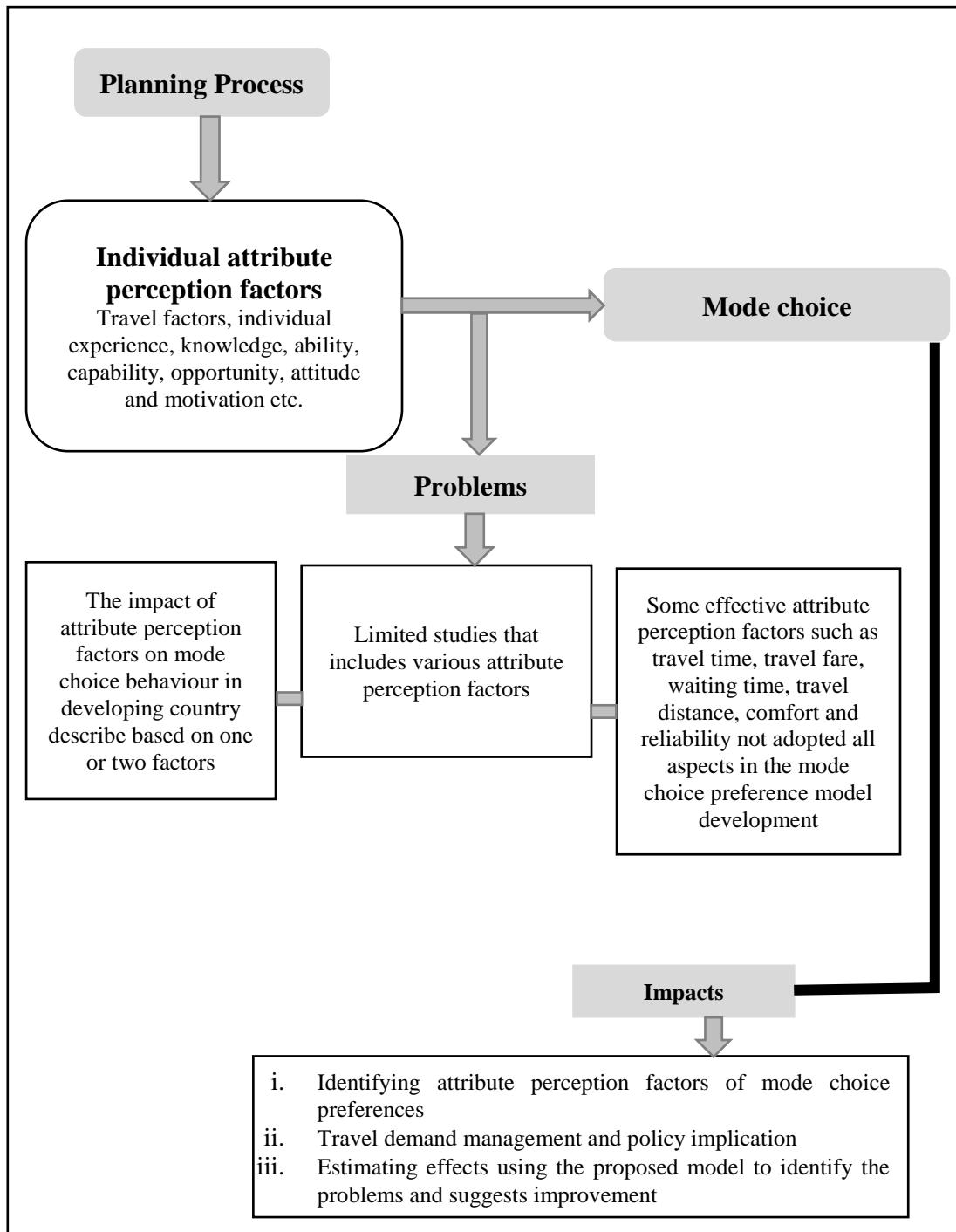


Figure 1.1 Pathway of the problem statement

1.3 Research Aim and Objectives

The research aims at identifying how attribute perception (i.e. perception towards the attributes of public transportation) influences mode choice preferences. To achieve this aim, this research has the following objectives:

- i. To determine the attribute perception factors among public transport users;
- ii. To investigate the relationship between attribute perception factors and travel behaviour of public transport users; and
- iii. To determine the effects of attribute perceptions on mode choice preferences among public transport users.

1.4 Research Question

To achieve the study objectives, several research questions must be answered, as listed below:

- i. What are the factors that may influence users' perception towards the attribute of public transport?
- ii. Is there a significant relationship between attribute perception factors and travel behaviour?
- iii. How to determine the effect of attribute perception factors on mode choice preferences among public transport users?

1.5 Research Design

This research is divided into four stages to achieve the research objectives and to find the answer to the research questions. The first stage involves conducting a literature review on attribute perception factors and a suitable method of analysis. The

second stage is about collecting socio-demographic, travel mode choice, attribute perception and attitudinal data from primary sources. The next stages cover data analysis, formulating findings and presentation of the conclusion. Figure 1.2 shows the overall research design of the study.

1.6 Research Scope

This study tries to estimate the effects of attribute perception on mode choice preferences among public transport users in Dhaka city, Bangladesh. A convenient sample survey was conducted. The target population was all the public transport users who travelled during the survey period. Capability, Opportunity and Motivation - Behaviour (COM-B) and Theory of Planned Behaviour (TPB) behavioural models were employed to extract the variables. A Multinomial Logit (MNL) model was employed to determine the effects of attribute perception on the predictor variables – mode choice (e.g. larger bus, small bus, human haulier, taxi and auto-rickshaw) and preferences.

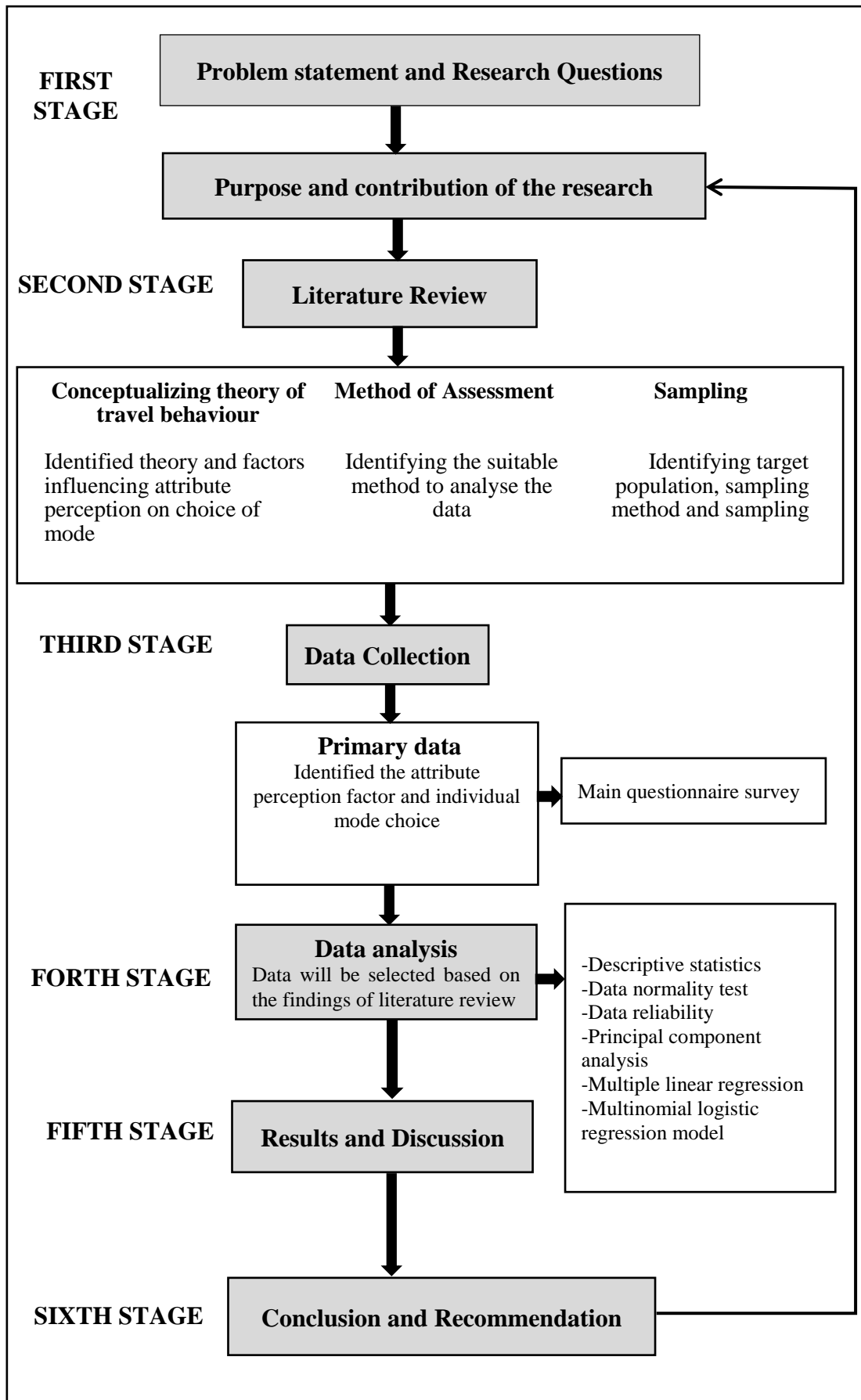


Figure 1.2 Research design of the study

1.7 Significance of the Study

It is becoming increasingly difficult to ignore the potential relationship between attribute perceptions and selection of travel mode (i.e. mode choice) of public transport users. Hence, this research attempts to establish the contribution of attributes perception towards mode choice preferences among public transport users of Dhaka. Another important contribution of this research is in the establishment of a Multinomial Logit (MNL) model using the COM-B (Capability, Opportunity and Motivation - Behaviour) and the TPB (Theory of Planned Behaviour) models to understand users' mode choice preferences. The proposed methodology and approach to studying user's mode choice preferences have made this study to be scholarly significant. As this study looks at a real-life issue in Dhaka, the findings of this study will also be significant in the city and transportation planning practices.

1.8 Organization of the Study

This thesis comprises of six chapters, as explained in Figure 1.3.

Chapter 1: This Chapter discusses the study and the concept of attribute perception and mode choice selection of public transport users. The importance of attribute perception and its brief background were discussed. Later, the problem statement, research aim and objectives, research scope in association with attribute perception, research design and significance of the study are stated. The Chapter provides the foundation for the literature review in Chapter 2.

Chapter 2: Reviews of the literature relevant to both the theories of behaviour and travel models. In terms of the theories of behavioural models, the theory of planned behaviour and the COM-B (capability, opportunity and motivation–Behaviour) model, and theoretical foundation. Besides, this study reviews the previous literature about factors affecting mode choice, which are categorized as capability, opportunity and motivation factors. Then, proposed a conceptual framework linking capability,

opportunity and motivation, and public transport mode-choice and methodology to be adopted in Chapter 3 of the study.

Chapter 3: Discusses the appropriate methodologies and datasets selection used in this study. In terms of methodologies, quantitative methods are adopted in this study. In connection of this, the perception measurement, population and sampling, and study area, research design strategic approach, method of data analysis and model selection.

Chapter 4: In connection of research methodology, this Chapter provides the interlinkages between the analysis of research data and tabulated the sequential analysis reports.

Chapter 5: Discusses specific results and discussion obtained from the analysis. A principal component analysis (PCA) is adopted to identify the construct variable strength. Multiple linear regression is used to investigate the complex relationship between attribute perception and mode choice behaviour and finally Multi-Nomial Logistic (MNL) regression is used to develop a mode-choice model.

Chapter 6: Finally, conclusions are drawn relative to the study goal with implication, limitation, recommendation as well as suggestions for future research.

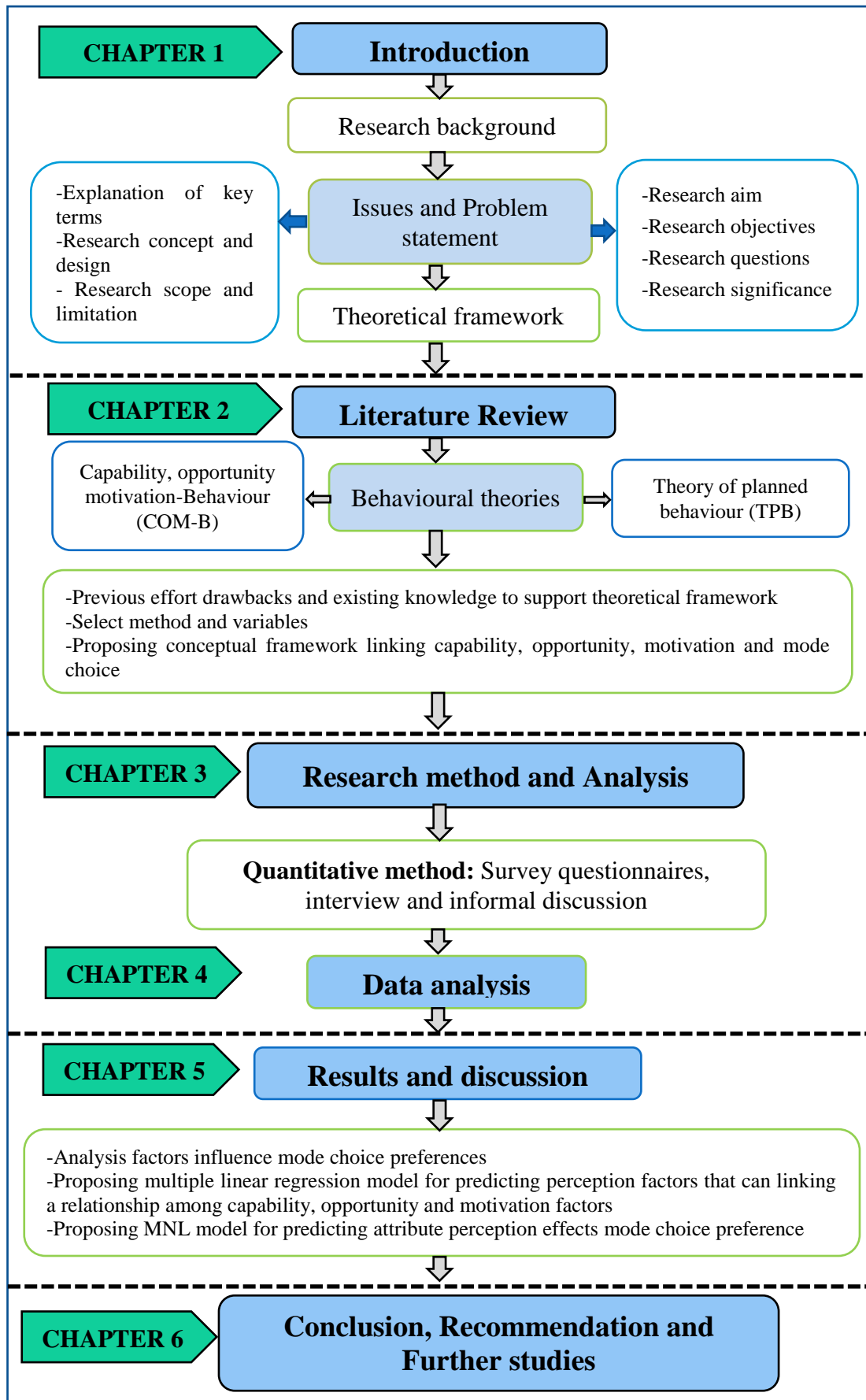


Figure 1.3 Thesis structure outline

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