MSc Programme in Urban Management and Development

Rotterdam, the Netherlands

September 2019

Thesis title: Travel behaviour of work commuters in Thimphu.

Name: Yangchen Lhamu

Supervisor: Somesh Sharma

Specialisation: Urban Environment, Sustainability and Climate Change (UESC)

Country: Bhutan

Report number: 1252

UMD 15

IHS Making cities work Erasmus

Institute for Housing and Urban Development Studies of Erasmus University Rotterdam

Summary

The aim of this thesis is to explore the life situation and travel habit of the residents, and social norms spillover to be utilized as an instrument for mode shift towards low carbon mobile society and to direct policy to alter ingrained habits and behaviour. It is driven by the current situation of a car-dominated city, which not only causes inconvenience of work commuters but also has an immense negative effect on the environment and air condition. Besides, Bhutan has committed to remain carbon neutral in NDCs Paris agreement and transport being the major fossil fuel consumer in Bhutan, it is critical to amend the business as usual scenario. A transition in behaviour change is the key answer in achieving various sustainable development goals for which understanding the attributes that drive individual travel behaviour is essential to assimilate primarily.

The focus was on understanding the determinates that construct the mode choice habit with the theory of planned behaviour and the role of policy that affect the mode choice behaviour of the work commuters. A framework on mode choice behaviour is observed within a complex system occurred due to multiple causes as per the surrounding environment, situation, social group (friends or family) and the individual personal characteristics. The behaviour observation reveals the strength and weaknesses of an individual or a society and the theories suggest that the determinants of modal choice would primarily influence the psychological construct of the mode choice. The determinants are tested for direct effect and the effect when mediated by psychological factors. The results reveal that individual personal capabilities better-predicted mode choice without psychological mediation. The social norm and policy approach excels in predicting mode choice when intervened by the psychological cognition. The personal capabilities of ownership, travel expenditure and the distance parameters significantly affects individual mode choice to commute to work. Psychological factors (attitude, personal norm and intention) when intervened for the infrastructure change policy perception instigates car use while the economy change policy and social expectation to use non-motorized transport mode instigate for car reduction. The sustainability and environmental concerns computed for pro-environment travel behaviour, predict an intention for car reduction, however, not statistically significant in predicting mode choice directly.

The statistical result of the study is based upon the raw survey data responded by 335 employed population residing in Thimphu. The recommendations and analysis are further supplemented by the interviews and open-ended survey question.

The transport policies are either at infant stage or lack specific guidelines/regulations for separate transport modes and policy formulation would require moving from a top-down, technocratic and driven by technical expertise involving only a few stakeholders towards facilitating a transition to sustainable contemporary mobility practice. The low popularity of PT is majorly due to the inadequacy and lack of e-services causing inconvenience of the schedule and these interventions are deemed possible to intervene promptly. The municipality would require to enhance non-motorized transport infrastructure to promote walking and cycling as per the vision of the Thimphu structure plan. The study recommends future research on sociotechnical transition, economy estimates of travel habit and experimental research on travel behaviour.

Keywords:

Travel behaviour, psychological factors, theory of planned behaviour, policy, carbon emission, car, work commuters, social norm, Thimphu, mode choice.

Acknowledgements

I would like to express my deepest gratitude to my research supervisor Mr. Somesh Sharma for his valuable and constructive suggestions, encouragement and useful critiques from the planning development until the very end of the research work. His willingness to extend his support and give his time so generously has been very much appreciated. My second reader (supervisor) Dr. Lorenzo Chelleri has supported me with major constructive feedback in strengthening the base of the thesis and I would like to convey much appreciation for his support.

Secondly, I would like to extend my special thanks to Dr. Alberto Gianoli the course coordinator of UESC (urban environment, sustainability and climate change) specialization at IHS, without whom I would not have explored the outlook on this thesis topic. I would also like to thank him for all the constructive criticism on every stage of the thesis progress.

Thirdly, I would like to thank the Executive Secretary of Thimphu Thromde (municipality), Mr. Karma Namgyel for his kind support and the enthusiasm he showed for the research beyond responding to the interview questions. Similarly, I would personally would like to thank all seven interviewee's, the expertise in the field of transport planning policy and implementation sectors in the Royal Government of Bhutan as well as warm gratitude to all the survey respondents.

Finally, I would like to thank the IHS staff and the institution for providing various assistance in every difficult juncture. Special gratefulness for the friends of the UMD 15 master's course who were there in every phase in creating a clam research environment.

My love and gratitude to my parents and my sister who believed in me at all times.

Abbreviations

ADB	Asian development bank
CT	Carbon trading
DV	Dependent variable
EV(s)	Electric vehicle(s)
GHG	Greenhouse gas
ICT	Information, communication and technology
IHS	Institute for Housing and Urban Development
ITS	Intelligent transport system
IV	Independent variable
LEVs	Low-emission vehicles
MoIC	Ministry of Information and Communication
MV	Mediating variable
NMT	Non-motorized transport
NAM	Norm activation model
PT	Public transport
RGoB	Royal Government of Bhutan
RRM	Random regret minimization
RSTA	Road safety and transport authority
RUM	Random utility maximization
TOD	Transit-oriented development
TPB	Theory of planned behaviour
TRA	Theory of reasoned action
TSP	Thimphu structure plan

Table of Contents

List of Charts

List of Figures

List of Graphs

List of Maps

List of Photographs

List of Tables

Chapter 1: Introduction

1.1 Background

The world moves on wheels, not just the people and goods but culture, capital and ideas move along with it (Givoni and Banister, 2013) as the transport sector has introduced sweeping changes in the livelihood pattern allowing global economic and social interaction. Yet the growth is alarming as the global mobility is projected to grow three times by 2050 (IPCC, 2011) along with the growth of population and Nation's GDP. Despite the technological evolution on cleaner fuel, the growth of fossil fuel vehicles perpetuates, which contributes to the global increase in greenhouse gas (GHG) emission, posing much threat to the environment and human health (Bamberg, Fujii, et al., 2011). This has led to strenuous mobility policy interventions with an attempt to make travel practice a sustainable pattern because the mobility policies so far are designed to meet the increasing number of cars, travel demand and to reduce travel time, which has influenced societal practice and dependency on personal cars to a larger extent (Williams, Spotswood, et al., 2019). Personal car use is influenced by varying factors which builds up as a habit, therefore, the recent policy focus has been shifted to influence behaviour to voluntarily switch to low carbon mobility alternatives (Bamberg, Fujii, et al., 2011). This study attempts to explain the psychological construct that influences travel behavioural factors and perception towards transport policies of work commuters in Thimphu, the capital of Bhutan.

Bhutan remained an obscure country for decades until 1950's, the road transport system in Bhutan was developed only in the 1960s, television and internet were explored to the country only in 1990s (Phuntsho, 2013). Bhutan's recent transformation from a closed society to the rational open economy is based upon the philosophy and concept of Gross National Happiness (GNH), which is also an obligatory policy-screening tool for all the national policies in Bhutan. With exceptional cultural practices and the diverse societal speculation, Bhutan is exclusively unique, however, it is hustling towards the developing stage as it is amongst the least developed countries. The country's economy is dependent on two major sectors; export of hydropower and tourism, thus, transport system and road network form an essential part of the country's economy. Transport system targets to achieve eight out of 17 sustainable development goals (SDGs) and so, it is also vital in achieving the SDGs (Ministry of Information and Communications, 2017b).

Bhutan, a small developing country which is currently a carbon sink nation with an ambitious goal of remaining carbon neutral is challenged by the rapid growth of transport system as a major emitter of GHG (National Environment Commission, 2015). The country is at a booming economic stage and it will be graduating from a least developed country (LDC) by 2023 (UN, 2017). On contrary, the commitment to remain carbon-neutral nation as declared at the UNFCCC 15th session of Conference of Parties (COP15) in Copenhagen, December 2009, (National Environment Commission, 2015) reiterated in the Paris agreement 2015 poise further challenges for a low GDP nation like Bhutan. The complexity of pursuing carbon-neutral policy as highlighted by Yangka (2018) states that it is a challenge for a developing country to balance its economic growth and maintaining carbon neutrality on the other hand. His study on inside (stakeholder) view and current situation of carbon-neutral policy specify transport and

industry as a major GHG emitter in Bhutan and that the stakeholders are positive to strengthen the policies in these sectors.

The current status of Bhutan as the net sink of GHG is mainly due to the existing 70.46% of forest coverage (National Environment Commission, 2016)which sequestrate 6.3 million tons of CO_2. The country's total emission is 2.2 million tons of CO_2 in 2011 which has increased from 1.6 million tons of CO_2 in 2000 as per the second national GHG inventory (National Environment Commission, 2011). Although the agriculture activities emit higher GHG than energy associated activities, the growth trend in the agriculture sector has remained constant over a decade, however, the emission from energy associated activities has increased rapidly at the rate of 21.4% per year from 2000 till 2011. The emission from energy as represented in chart 1.1 is largely due to fossil fuel combustion used in transport sectors which accounts to 45% of the total emission from energy associated activities (World Bank, 2018) since the nation is completely dependent on the road transport for commuting. The dependence on fossil fuel and carbon emission from the transport sector is relatively higher in Bhutan as compared to the global average transport emission, which accounts for 23% (IEA, 2016). The revenue generated from exporting electricity to India is spent on importing fossil fuel of which transport sector consume 91% of fossil fuel (Department of Renewable Energy, 2015a). Given the high dependency of road transport on fossil fuel, the need to diversify fuel options to more renewable energy resources has been a potential driving force for directing various policy formulations.

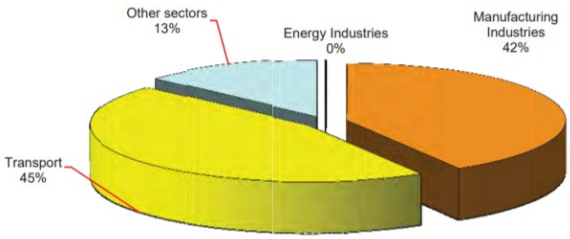


Chart 1. 1: GHG emission allied to energy activities in Bhutan for the year 2000
Source: National Environment Commission of Bhutan (2011)

Intergovernmental Panel on climate change (IPCC) emphasize on switching to the re-technology energy system as it equally satisfies the required travel demand. Developed countries were to reduce CO_2 overall by 5.2% however, emission in all countries are increasing particularly in the transport sector (Banister, Anderton, et al., 2011). Although the change in GHG emission scenario will depend upon the policy approaches, it will critically rely on the choices that society make and in understanding the trade-offs between potential alternatives would unfold future threats (UNEP, 2007). European Commission for climate change action confirms that the behaviour change in individual lifestyle and mobility choices can lead to a major reduction of GHG emission.

Growing income level and mass production of the conventional car and its affordability are the causes of the unsustainable trend associated with travel behaviour. Studies have found that driving personal car increases independence in mobility, and the lack of attractiveness for public transport are poised by low adequacy, comfort coupled with other spatial and infrastructural infeasibilities. Jaffe (2013) explains the 'car effect' as people's irrational bias towards cars affirmed through game experimental research that the rate of choosing a car as mode option is always higher even when mass transit is cost and time-efficient. Although the

observation on low rational calculation and low cognitive effort in modal choice would lack generalization, nonetheless, it highlights the requirement of policy incentives to switch to sustainable alternatives and behavioural change. It is, therefore, relevant to understand the individual perspective and to methodologically model travel behaviour to be able for the policies to pull the right string in shaping low carbon mode shift.

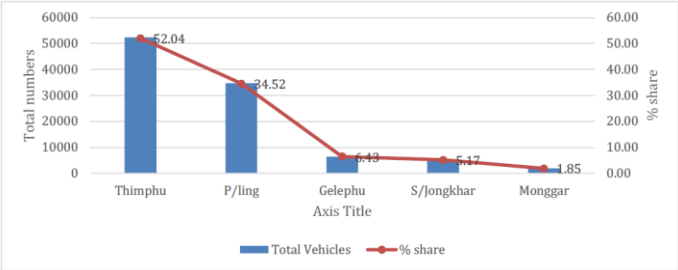
1.2 Problem statement

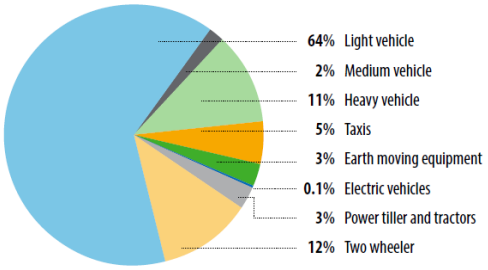
Bhutan's increase in economic growth has led to consumerism seeking for easy and fast livelihood options to commute to work and for other daily purposes. The government of Bhutan has initiated numerous measures and strategies to overcome the rising consumerism and related challenges in line with reducing transport oriented emissions. The efforts are being made through tax exemption and incentives on purchasing electric vehicles (EVs), and strategies of improving public transport and promoting EVs (Ministry of Information and Communications, 2017a). At the same time, 55% of tax is imposed on importing a conventional car from India and 100% tax from other countries. The electricity price in Bhutan is relatively cheaper compared to other south-east Asian countries, yet still, fossil fuel vehicles front runs the consumerism at an alarming growth rate of 9.2% on contrary to 0.01% growth of EV's. On the other hand, less than 30% of Thimphu's work commuters travel via public transport and/or shared taxi and more than 70% uses personal vehicle to commute to work/business (UNCRD, 2017). The nation-wide vehicle registration has increased more than five folds in less than 2 decades, out of which, more than 47% are registered in Thimphu as per the vehicle statistics of road safety and transport authority (2018) of Bhutan.

A city inhabiting 19% of nations population (National Statistics Bureau, 2017), and 47% of the total vehicle, raises concern over the social, economy and environmental degradation. Intervention for this un-proportionate distribution of population and vehicle clustered in the capital is a prerequisite as the mobility pattern in Thimphu is highly dominated by the use of personal car influenced by several factors including behavioural characteristics. Importance of subjective factors, attitudinal effects, comfort, safety with latent variable approach studies is fewer in developing countries as compared to US and Europe (Parthan and Srinivasan, 2013). The lack of travel behaviour inventory in developing cities like Thimphu defects the forecasting of travel models, spatial planning, transportation planning and policies both for shorter and longer-term.

Considering, 2.4 percent of the population growth rate per annum coupled with 9% of vehicle growth, the traffic movement in Thimphu would be at snail's pace after a few decades. A critical reason for fast-growing traffic congestion and vehicle populace is due to the nation's dependence on domestic transport on road system alone. An article in national newspaper highlights the prospects on subways (Kuensel, 2010) and cable cars in Thimphu although there are no governmental plans for subway system so far. A study on Thimphu's traffic congestion carried out by an international consultant with the support of the MoIC (2015) points out the traffic congestion in Thimphu is majorly occurred due to the poor service provided by the public transport system, on-street parking, poor pedestrian walkways and ultimately the high level of private car ownership and car usage swayed with the current land-use practices. The lack of prioritized lane for walking, bicycles and lane for public transport prompt people to drive a personal car even for short trips. The study highlights the behaviour of divers and road user stuck in old ways, disorderly and inconsiderate of others and since the congestion issue is observed during the peak hours, an urgent intervention in improving public transport and behaviour change requires prioritization.

The mode choice travel behaviour for this study is limited to the working population in Thimphu because commuting to work creates a universal pattern, a journey two times a day and within the limited study duration, it is feasible to survey a sample population which will enhance the reliability and validity of the study. It is also because Thimphu is the administrative centre of the country and has the highest number of employment rate. The working group are also the highest users of the personal car in the city. Graph 1.1 illustrates the number of vehicles registered in five regional administration of the country and chart 1.2 illustrates the predominance of the light vehicle registered in the country.





Graph 1. 1: Vehicles registered, by Region[1] and % share.
Source: Annual Info-Com and Transport Statistical Bulletin.

Chart 1. 2: Types of vehicles registered.
Source: (UNDP, 2016)

1.3 Research objective

Urban mobility is a complex issue whereby the policy alone cannot influence the consumption and travel choices that the residents and daily work commuters make (Lefèvre, 2009). There is more to explore on the social norms and spillover, lifestyle and travel habit of the residents to be utilized as an instrument for mode shift towards low carbon mobile society and to direct policy to alter ingrained habits and behaviour. The study aims to gain insight into the travel behaviour of the work commuters of Thimphu in understanding what instigates their choice of travel mode and travel behaviour. The focus is on the private and public transport along with the preferences of walking, cycling and choice of a conventional vehicle over electric. This will be carried out with a combination of an exploratory and explanatory method where the factors influencing the travel behaviour will be explored to explain the differences in low carbon mobility policy instrument towards maintaining Bhutan's status of carbon neutrality. Subsequently, the research question is formulated to achieve the objectives stated here and to seek solutions to the problem statement.

1.4 Research question

Which factors explain modal choices of working population for commuting to work in Thimphu?

Following sub-questions have been established to answer the central question;

[1] The percent share of vehicle for Thimphu region comprises of six western districts of the country, similarly other regions are combination of several districts all together representing the whole country.

1. What are the personal and social factors influencing preferences and attitude towards modal choice?

2. Which factors of mobility policies stimuli travel behaviour and model choice?

3. Which factors of build-environment influences travel behaviour and mode choice?

1.5 Significance

Khamrang (2018) stresses on the lack of academic engagement on urban spaces of the cities in Bhutan and emphasized on the need of inclusive policy by focusing on people as a prior development agenda to fulfil the "quest of making Thimphu a dream city". The cities in Bhutan lack studies related to travel activities, unlike several developed nations which carry out National household travel survey to observe travel-related activities for estimation and policy guidance. The research culture is fairly a new trend in Bhutan as the list of articles published in the journal of Bhutan studies has a record of journals published only since 1999 (Center for Bhutan Studies, 2017) but no studies related to travel behaviour or transport policies in Bhutanese cities have been recorded so far. Similarly, low carbon paradigm is a new concept to the societies in Bhutan and the low carbon transport policy of Bhutan is still in a draft stage, similar is the case with climate change policy. Therefore, this study is timely in the context of Bhutan and it would trigger to bridge the difference between low carbon transport policies and individual travel behaviour which tends to move in a different direction from what is expected.

1.6 Thesis structure

The thesis is divided into five chapters, following the background introduction chapter, the second chapter presents a literature review on the concepts of travel behaviour on mode choice. Further, the literature elaborates on policies measures that shapes travel behaviour and subsequently a relation between these determinants of travel behaviour is drawn to formulate a theoretical framework.

Chapter three consist of a research strategy and methodology for operationalizing the theoretical framework where the variables and indicators are unpacked to construct an instrument for further analysis. The chapter also provides data collection and sampling method along with data analysing techniques.

The fourth chapter elaborates on the context specifics, transport policy review and spatial observation of the contextual infrastructure supported by the interview responses, after which the descriptive analysis of the survey results are presented. The chapter concludes with the results and findings from the inferential analysis. The fifth chapter concludes with interpretation and assessment on the findings to answers the research questions as well as future study area and recommendations to policy guidelines from the findings.

Chapter 2: Literature Review

Introduction

The literature review in this chapter analyses various concept of travel behaviour and apprehension of mechanism shaping complex mobility behaviour. Theoretical grounding is an essential means to verify and ascertain the link between intervention and level of effectiveness (Bamberg, Fujii, et al., 2011). Travel behaviour and travel demand have been studied for decades to support transport planning, traffic management, economic growth as well as for marketing transportation machine, equipment's et cetera. Much of the research found in unpacking travel behaviour has endeavoured to reveal the psychological effect on travel behaviour but limited to policy intervention and not uncover the impacts of policy intervention on the behaviour itself. This study indicates that choice of mode is governed by the psychological factors while the psychological process is modelled by a range of intervening factors such as difference in socio-demographic characteristics, cultural and social norms, situational constraints of an individual, availability of infrastructure, and transport regulations governed by policies. The literature review in this chapter aims to uncover the theories to rationalize the behavioural aspects that drive an individual's motive of choosing a personal car, public transport or non-motorized transport to commute to work in Thimphu. Public transport in Thimphu is limited to bus, however, shared paratransit (taxi) is also commonly used by the residents.

2.2 Travel Behaviour

Traditionally, commuting behaviour was parameterized within the rational choice framework where time and cost were considered to be the impelling determinant of travel choice such as in Quarmby's (1967) findings on mode choice for the journey to work in Leed. In mid-nineties Bourdieu's practice theory set a foreground on societal behaviour proclaiming that people do not act as per the rational choice principle and, rather the actions were driven by individual perception and temperament (Guell, Panter, et al., 2012). Following, myriad psychologists have established several behavioural theories since the '90s and researchers of social science discipline have applied these theories in mobility and transport fields with an attempt to understand the complex travel behaviour and therefore to achieve sustainable mobility system.

An analysis and survey on pro-environmental and travel behaviour in Sweden verified that the attitude factors are more significant than the factual knowledge regarding the environmental concern for choosing low emission vehicles (Nilsson and Küller, 2000). Social psychological factors could alter travel decision to a larger extent particularly within a small interlinked society like Thimphu. The influential nature of human behaviour allows vast opportunity in strategizing plans and policies that could potentially change behaviour but first, it is essential to deep dive into the science of behaviour psychology to get the insight on how individual thought process influences travel behaviour. The term travel behaviour here is used to explain all aspects of travel that is anticipated from the choices one makes for travelling and associated destination choice, travel time and distance, and the term, 'mode choice' is applied when we want to empirically test the behaviour.

2.3 Psychological behavioural theories

Ajzen's theory of planned behaviour (TPB) and Schwatrz's norm-activation model (NAM) have been predominantly applied in explaining human behaviour in the domain of pro-environmentalism and travel behaviour (Klöckner, Christian A. and Blöbaum, 2010). Understanding the psychology of travel behaviour and choice for this study is generally based upon the TPB and NAM with the integration of habitual aspects.

The theory of planned behaviour

The theory of planned behaviour (TPB) is based on the principle that behavioural aggregation demonstrates general personal trait and attitude across different situations and actions to predict behaviour. The TPB is protracted from the theory of reasoned action (TRA) (Dijst, Farag, et al., 2008), and according to the TRA, intention is dependent on attitude and subjective norms, to determine if an individual would want to perform a behaviour (Dijst, Farag, et al., 2008). Subjective norm is the anticipated social pressure that influences behaviour (Ajzen, 1991). The TRA asserts that the intention to act could predict voluntary behaviour, however, most behaviours are not voluntary and the distinction between effective and evaluative response to a behaviour is blur (Eagly and Chaiken, 1993 as cited in Nilsson and Küller, 2000) for which Ajzen incorporated perceived behaviour control in the theory of planned behaviour.

An intention is a volitional control and motivational factor that directly influences a behaviour (Ajzen, 1991). The volitional control regulates with the availability of time, resource, skills, and the cooperation of others, also known as non-motivational factors of behavioural performance (Ajzen, 1991). Attitude and intention are highly correlated but attitude alone is limited to directly predict behaviour as it depends on circumstances and cognition (Ajzen and Fishbein, 2005). Eagly and Chaiken (1993 in Nilsson and Küller, 2000, p.212) defines attitude "as a psychological construct, composed of affective, cognitive and behavioural components, which may be used to describe human evaluative responses", and perceived ability determines behavioural choice in attitude theory. Attitude and subjective norm with perceived behaviour control (PBC) are antecedent or facilitating factor of intention in predicting behaviour as per Ajzen's TPB. For example, travelling via car is perceived to be comfortable which affects the attitude towards car use. Perceived behaviour control is the confidence and ability or 'self-efficiency belief' of an individual to perform a behaviour under a certain situation that concerns the expectancy and probability of success (Ajzen, 1985 as cited in Dijst, Farag, et al., 2008). The intention is considered to silently bear a component of belief such that individual belief affect attitude, the normative belief determines subjective norm and control belief provides a base for PBC (Ajzen, 1991). The TPB overlooks personal and moral norms, habitual and objective situational constraints (Klöckner, Christian A. and Blöbaum, 2010) and therefore extending these theories and integrating them have the potential to comprehend behavioural psychology in a comprehensive approach.

Norm activation theory

Social and personal norms in norm-activation model (NAM) determines norm-oriented behaviour and it is activated by the feeling of moral obligation when a person feels responsible for someone or something which has a casual relationship between the person's action and the consequences (Bamberg, Fujii, et al., 2011). Social norms are the arbitrary rules that guides/constrains social behaviour without standardized law enforcement but with a societal expectation of behaviour for reinforcement of culture. Descriptive norms are the behaviour of others that informs what is normal and shapes one's intuition to response for a given situation.

Social norms have the power to influence and motivate behaviour as it prescribes socially responsible behaviour (injunctive norm) and what most people (dis)approve (Cialdini and Trost, 2004). Social sanction increases the obligation towards fulfilling a condition which leads to 'status-seeking behaviour' that could have a positive effect on personal norm which builds positive intention (Mattauch, Ridgway, et al., 2016). A person's normative behaviour guided by either personal norm, descriptive norm or injunctive norm would depend upon the situation and person's focus of attention within an interconnected matrix of norms. It constructs individual to attain certain goals and commitment of being consistent, maintaining relationship and behaving effectively. The NAM overlooks the situational constraints, as well as the role of attitude and habit, are limited in predicting repetitive behaviour (Klöckner, Christian A. and Blöbaum, 2010), thus Bamberg (2011) suggest that the joint theory would efficiently explain mobility and pro-environmental travel behaviour. The moral norms and moral obligation components of NAM, it is often applied by conservationists in environmental campaigns to instigate ecological and pro-environmental travel behaviour. Myriad studies have indicated a personal norm to predict whether one can or cannot accept policy measures and then the extent of car use.

Habit

"Past behaviour is the best predictor of future behaviour" (Ajzen, 1991)

Based on the experiences an individual has on different modes for different circumstances, enable a person to arrive at rather mindless habitual pattern rather than reasoned action. Lanken, Aarts, et al., (1994) states that habit is rather a stable behavioural pattern, which is often executed without deliberate consideration on an automatic process rather than on conscious decision. Habits are developed by repetition and in the case of car use satisfactory reinforces the repetitive decision and alternative choices become less required. The predictive power of behaviour concerning habit, attitude and intention has been cumulated in a number of studies. In studying the use of a personal car, an extended model for goal-directed behaviour asserts 'habit' as a direct determinant of behaviour (Donald, Cooper, et al., 2014) and PBC have a direct influence in choosing public transport (PT) as one judges the difficulty or convenience in using PT. The PBC can predict habit to some extent as the pattern of behaviour is developed on belief and feasibility. Use of public transport is strongly linked with intention while car use for commuting to work becomes habitual because of its underlying concept of past behaviour. Habit here is defined as "a learned act that becomes an automatic response to a situation and can be functional in obtaining certain goal" (Verplanken et al, 1997 in (Dijst, Farag, et al., 2008, p.833). Stability of habit represents theory's predictability as habits are established by repeated performance without any mediating determinants (Ajzen, 1991) and it is crucial to understand the habit for behavioural change. The effect of strong habit could dominate intention, attitude and norm, however, to change the car use it is not efficient just to interrupt habit but with the motivational aspects of other psychological determinants needs to be implanted or should co-exist (Klöckner, Christian A. and Blöbaum, 2010).

An integrated model of psychological behaviour theory

Figure 2.1 illustrates the integration of the theory of planned behaviour, norm-activation model and habitual practices that steer the formation of socio-psychological behavioural pattern. Givoni (2013) asserts that the integrated model better describes travel mode choice and variation but are also affected by physical and objective situational constraints denoted as facilitating conditions in figure 2.1. Further, Bamberg (2011) confirms through his studies

carried out based on a meta-analysis that the integration of theories successfully predicts people's choice of public transport for car reduction.

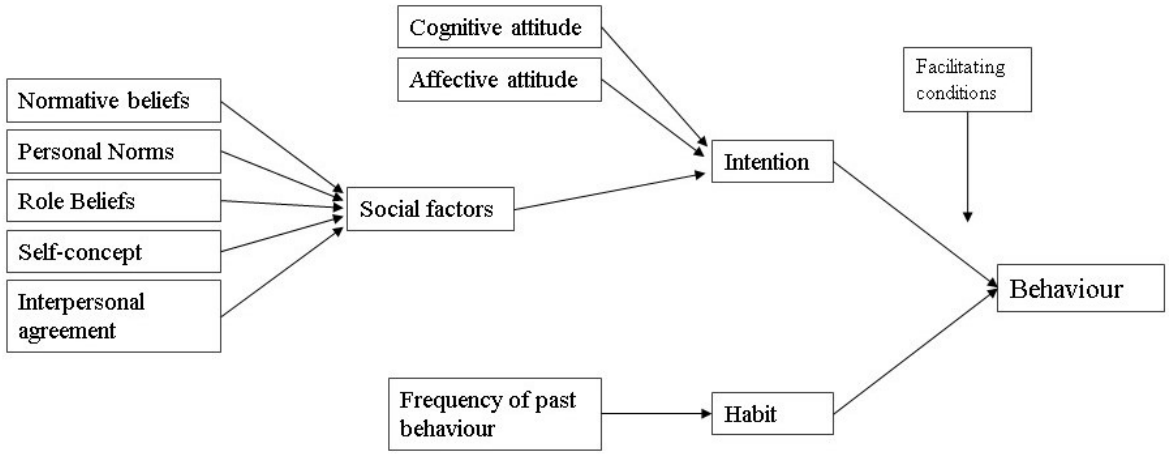


Figure 2. 1: Understanding behaviour based on intention and habit
Source: Schwanen and Lucas (2011), based on Triandis (1977) in Givoni (2013)

The theory of planned behaviour seeks to determine the causes in building an intention and therefore predict behaviour but limited to attitude, perceived behaviour control and subjective norm. The modification on TPB as shown in figure 2.1 incorporates the habitual aspects, NAM and facilitating conditions that are suitable to describe sustainable travel behaviour. The socio-cultural factor in the figure is represented by the normative belief, personal norms and self-concept together formulating the social factor which then affects one's intention. The features of socio-culture attributes and facilitating condition that intervenes in the process of building intentional behaviour and habitual aspects will be discussed in the following sections.

2.4 Socio-culture aspects of behaviour

Socio-culture is an intangible social aspect developed from norms, customs and beliefs transformed to a common societal behavioural pattern passed on from one generation to another among those who share similar historical background, location and language. Malinowski (1936) at the Harvard Tercentenary Conference of Arts and Sciences stated that "culture is the organized behaviour of man" that determines human behaviour, and Markus (2014) stated that culture dictates how to think, feel and act. Any behaviour inevitably includes a cultural factor that internalizes an earlier part of life but seldom one may perceive that one's behaviour is under his/her control. The proposed model of a cultural cycle by Markus and Conner (2013, Stephens, Markus, et al., 2014) denotes that human behaviour is driven by individual cognitive and emotional patterns developed from series of nested interactions along with personality traits and motivating characteristics. These characteristics have been developed from the association of one's immediate social environment such as family and friends who internalizes cultural institutions to respond to those in our social environment. The institutions include formal laws along with social rules of behaviour (informal) and its influences reflect the general ideas that create the overall structure of a culture.

Cultural values build human thoughts, shapes social relationships and since different places are evolved differently; cultural factors could explain the individual difference in behaviour to a larger extent. Behaviour is determined by the kind of roles an individual play and culture is

shaped by values and the rules of social norms collectively. The norm and normative as per Sherif and Pepitone (1936, 1976, Cialdini and Trost, 2004) state that norms are a jointly accepted rules for social behaviour and normative, a collective characteristic of sociocultural. Human's fondness for a company makes us a social creature but more importantly, we also need to meet our material needs, for which we have to follow certain social norms to maintain certain relationship and that social interaction is a central component of social influence process. The nested interactions build social norms or the rules of social network that influences one's attitude towards the certain notion, such that if the majority of the population believes in climate change and practices the sustainable way of life such as riding a bicycle to work, other co-workers are more likely to follow the same practice. Therefore, it is vital to recognise how socio-culture influence mediates the dynamics of attitude formation on the choice set in a specific context.

Culture creates expected norms of behaviour however, these norms differ among different cultural groups of which emerged the concept of individualism and collectivism. These concepts were compared by Markus and Kitayama (1991, Stephens, Markus, et al., 2014) in the 'role of the selves' in the US with that in Japan and identified the relationship between the individual and broader social work cultural group. The model was labelled as the 'independent view of the self' as reflected in US society and the 'interdependent view of the self' as reflected in Japanese society. The normative imperative of 'independent self' (individualism concept) is to become independent from others and to discover one's unique attributes and are often encouraged to peruse one's own goal independently from the surrounding social network. By contrast, the 'interdependent self' (collectivism), sees oneself as a part of and not separate from a broader cultural context. It is based on the fundamental connectedness of human beings to each other and therefore one's behaviour is determined to a larger extent by thoughts, feelings, acts and perception of others in the relationship. 'Interdependent self' works to attain what is best for the social group (family or the community) and tries to gain the sense of belonging and self-esteem by trying to fit in and by maintaining harmony. Myriad researchers suggest that there are class-based differences in perspectives on the individualism of those in Western and Asian or other parts of the world. The cultural differences also outspread based on gender, socioeconomic status, nationality/ethnicity and, based on these differences, culture demonstrates a clear pattern of what kind of behaviour is to be expected. The ethnic background in Bhutan can be differentiated by the different dialects, which is quite diverse for a small country, however, Van Driem (1994) states that the culture is not as diverse as a language due to the homogeneity in religion, dress and festivals that are celebrated as one.

2.5 Personal capabilities

This section considers individual life situation driven by demographic factors, social status, personal resources and locational aspects, since these determining factors, doubtlessly affect one's personal choice of travel. The significance of socio-demographic factor and situational aspects and its impact on psychological determinants has been emphasized in ecological and mobility impact studies (Hunecke et al., 2007, in Eriksson, 2008) and it is, therefore, to examine the extent of such differences and to draw possible causal relationship of these factors influencing the psychological perception and travel mode choice.

Socio-demographic factor

Travel behaviour differs between different people derived by demand and need of individual household, also known as intrapersonal variability. The multi-faceted nature of travel behaviour could be moulded by various internal and external (social factors) determinants of socio-demography as has been applied in most of the transport and behaviour related studies. Here, the attention is driven on the intrapersonal determinants related to an individual's life situation, lifestyle and household circumstances. Dijst, Farag, et al. (2008) asserts that socio-demographic factors explain the willingness of an individual via PBC and past behaviour which influences users perception of mode options. Socio-demographic variables as an antecedent of preferable mode choice include gender, age, marital status to household composition, education level and occupation. The socio-demographic attributes, therefore, illuminating one's life situation is examined to observe its influence on psychological preferences on mode choice and travel behaviour. While several researchers have found that women tend to travel less as compared to men and similar case with older people as compared to younger ones (Jing, Zhao, et al., 2018). It is also relevant in the choice forecast for evaluating travel plans and policies, as Anable (2006) asserts that policy measure requires different treatment for a different group as they are motivated by different factors.

Socio-economic factor

The socio-economic factor here refers to personal resource derived from one's income, ownership of movable property such as car and personal or household expenditure on travel. Socio-economic and demographic variables are intertwined at times, as the individual demographic attribute demonstrates household, occupation and social status. From psychological view, behaviour choice on decision-making is influenced by the attitude which is determined by motivation and affects (emotional state) and the choice theory rational is seldom applied in behavioural economics (Mattauch, Ridgway, et al., 2016). Based on the economic choice, the random utility maximization (RUM) assumes that one would seek for maximum function and price that lead to preferences. Similar ideology is applied in transport economy through observed mobility choice where Mattauch (2016) denotes that "mobility itself is a part of the desired consumption" and that traveller chooses a mode with the highest utility for a given modal alternative.

Travel behaviour studies have demonstrated a positive empirical relationship of car ownership and use of public transport to that of population density, household characteristics, income and fuel price. Irrespective of subjective factors, travel time, cost and safety were found to be a significant influencing attribute to travel behaviour (Jing, Zhao, et al., 2018). Every choice of travel comes with few dis-utility or negative consequence such as waiting, standing or spending money. This trade-off in time, cost and comfort influence the mode choice in utility theory whereby the commuters choose one with least dis-utility. Random regret minimization (RRM) is an approach based on regret theory and it assumes to minimize anticipated regret over the non-choose alternatives. Chorus (2008) findings on model choice based on RRM asserts that RRM compliments the operationalization efficacy of RUM model of decision-making process realistically. Utility-maximization helps practical operationalization inferring behaviour choice depending on the context and adaptability of motivation and perception. Short and medium-term policy on decreasing the travel time or improving services for travel choice is estimated depending on the availability of time and money. Utility maximization behaviour is derived from economists' theory of choice but undermines the cognitive and motivational psychology of travel behaviour since it interprets experience and alternatives as an unobservable random

factor (Mattauch, Ridgway, et al., 2016) and therefore, psychological reasoning are essential to elaborate mode choice.

Situational determinants

Ipsative theory of behaviour offers perspective on the situational determinants highlighting the objective and perceived situational constraints as a facilitator of individual behaviour. It is centred on economic theory with an assumption that objective situational constraints such as owning a car and residing in specific location possibly determines one's travel decision-making but does not consider habit or intention (Klöckner, C. A. and Blöbaum, 2010), however, a habit could be developed if situational constraints remain stable. Theory of planned behaviour as well stresses on situational constraints through perceived behaviour control (Bamberg, Fujii, et al., 2011) such that, when one chooses a mode it is not only the attitude towards certain mode but also the convenience in using them.

Residence locational aspects influences travel mode choice, and the choice of location is dependent on individual lifestyle and/or life situation. The locational choice is not always an individual's decision and therefore, the household structure could as well explain one's life situation. Individual finance and social resources determine the locational preference which is relative to distances and accessibility. The distance parameters of the locational situation influence the attitude of an individual (Scheiner and Holz-Rau, 2007) and in building a personal habit of travel (Mattauch, Ridgway, et al., 2016). Donald, Cooper, et al. (2014) asserts the significance of non-motorized travel or walking as largely influenced by the proximity of residence to the workplace with an average range of two miles. Car availability also depends on one's resource capacity which influences an individual's location choice.

For the residence proximity to workplace, McFadden (2000) survey of 827 respondents from North and south England categorized by gender age and location to understand the reasons for driving or using public transport to work acknowledged that employees residing within two miles from the workplace are more used to walking. The residence distance to the workplace as an influencing factor builds a habit of using a personal car which becomes a prospect for future choice. Anderson's (2010) study on mode choice and route choice for Danish travel habits based on frequency and distribution analysis concerning trip distance assert the use of non-motorized transport when the destination is within 5 kilometres reach, after which people tend to use car or PT. Thus, owning a car may have both a direct and indirect effect on one's travel behaviour by influencing the PBC and habitual aspects.

2.6 Built environment and Infrastructure

Built environment shapes one's preference and decision on mode choice such that a person moving from place A to B would be influenced to choose the type of mode that infrastructure favours. Similarly, if there are walking and cycling path or lane it would encourage people the use of non-motorized travel mode. Mode preference in a way is structured by the built environment one grows up or resides in, which eventually becomes a habit and therefore, preference over infrastructure impacts behaviour for a longer time scale, and so are the policy for infrastructure considered as a long-term decision which has an overarching influence on behaviour policy framework (Mattauch, Ridgway, et al., 2016).

In cities of the Netherlands, bicycle infrastructure in-terms of adequacy, priority, safety and convenience makes cycling more efficient. Land-use, infrastructure and economic as well

shapes one another and are key facilitators of urban growth and transport services. The transport demand in London grew disproportionately due to the change of land-use pattern in the eighteenth century. New infrastructures to reduce travel cost and time only resulted in an increase of urban growth and travel demand which not only impacted the environment and air quality but also moulded the lifestyle to be more travel dependent (Banister, Anderton, et al., 2011). Mode choice or preferences are conditional on availability of infrastructure and thus, different infrastructure leads to different preferences.

2.7 Policy related behavioural theoretical grounding

Having identified the travel behavioural concepts underlying within the psychological and objective determinants, we will now shift the lens to transport policy relative to behavioural theoretical grounding. Sustainable transport policies are the most talked about developmental issue and almost all the sectors have some roles in strategizing transport strategies either subjectively or objectively. Policies as a tool to guide and ensure better services to society are trifle if not efficient in creating an impact on society (Mattauch, Ridgway, et al., 2016). Behaviour change as policy objectives is narrow due to the conventional policy formulation methodologies which are limited to behavioural shift but fails to engage citizens and mostly overlooks the complex nature of behavioural components.

The conventional transport policies have been ever supporting car use with new infrastructures, vehicular ownership or property pattern and even car friendly buildings of the higher economic world. However, in the last decade behaviour change have been nudging in range of policy tools, such as in countries like the UK, they have behavioural insight team scrutinizing voluntary travel behavioural change policy whereby the decisions are made through behavioural economic lens for sustainable choice and behaviour (Williams, Spotswood, et al., 2019). Instigating voluntary car-use reduction in developing countries are yet far-sighted and thus, a move towards this shift would require an empirical assertion to integrate behavioural components in policy formulation.

The following section will uncover the policy instruments applied in policy formulation and implementation. Additionally, the transport policy measures that successfully instigate behaviour change will be reviewed.

Policy instruments

The transport policy measures for minimizing car use can be segregated into ‘hard’ and ‘soft’ policy measures. Improving built- environment, public transport services and infrastructure for NMT, which is considered a hard policy measure, is perceived to be time-consuming and ineffective on its own and it is difficult to implement because of social and political reasons (Bamberg, Fujii, et al., 2011). The attention, therefore, has been diverted towards soft measures through motivation and empowerment to directly influence the perception of sustainable mode choice and that the use of a car is reduced voluntarily. The soft measure uses techniques of marketing, information and psychological strategies of reframing the perception and the judgement of the objective environment through motivation to voluntarily shift to sustainable travel options (Bamberg, Fujii, et al., 2011). Hard and soft policy measures are not mutually exclusive, the objective attractiveness of hard measure complements the soft component in empowering and provoking sustainable travel choice (Mattauch, Ridgway, et al., 2016). Public’s opinion and attitude on the extent of acceptability can be considered towards policy measures to examine its effectiveness (Bamberg, Fujii, et al., 2011).

Framing

Framing is a process where one reconsiders and reorients a subject and exhibit it for the public to view it from different perspectives. 'Framing effect' occurs when a statement is reframed with changed connotation to provide a specific message and to set the right tone in public campaign. Individual perception or response is highly dependent on attitude, belief, values and various psychological considerations that is ingrained in one's culture. Cultural type plays a major role in predisposing individual level of receptiveness to frames (Lachapelle, Montpetit, et al., 2014). Prospect theory testifies that a person's choice can be influenced by how one frames the statement in a positive or negative connotation even though the options have the same value of gain or loss. This is due to the way people think, "losses hurt more than gains feel good" (Gelman and Cortina, 2009, p.288) people tries to avoid risk or the statement which has negative/loss connotations and they will always prefer the statement which is framed as a 'gain'. The convenient aspects of travel behaviour are ingrained as part of the culture and it is difficult for people to switch to alternatives even if it is beneficial to personal health, economy and environment but recent studies show that with some effort it is not very difficult to predispose cultural attitude. Scientific knowledge needs to be communicated and presented efficiently to form a policy basis for decision making and to change the perception and preferences. The scientific knowledge needs to be integrated with cultural aspects and right values, to manoeuvre opinion formation and shaping public perception towards certain risk or issues. Media interpretation is another factor that highly influences individual's receptivity to framing. Framing as a strategy for public advocacy campaign is essential to consider diverse perception, beliefs and norms for a given situation and culture. Creating an awareness of the adverse effect of individual behaviour on the environment would positively contribute to an individual's concern. Social preference via social and moral norms can provoke pro-environmental attitude and thus, voluntary reduction of car use. Framing as a social constructive policy mode based on rational facts can lead to a diverse understanding of a situation (Mattauch, Ridgway, et al., 2016). It is vital to understand how policies have been framed to increase the acceptance level of the general public and how scientific knowledge has been implied in strengthening low carbon transport policy formulation and for the behaviour shift.

Push and pull measures of policy

Effective policy measures are moulded by the range of acceptance by the general public. It is a common notion that people usually accept the pull measures such as incentives, subsidies and high invested infrastructure by the government however the tendency of acceptance towards push measures such as the increase of fuel tax are less accepted (Eriksson, 2008). The acceptance of push measures can be generally co-relate to environmental belief (personal/moral norm) and socio-economic factor as well as creating better awareness beforehand. Push measures are often implemented together with supportive measures such as improved infrastructure but with toll system. Multiple measures, when implemented successfully, may lead to car reduction which is complexly interlinked to the personal norm and pro-environmental behaviour. Table 2.1 provides an overview of policy measure classifications that are examined for in the literature review that would alternately shape the behaviour preferences in individual's mode choice.

Policy measures	Category	Push / Pull measure
Improved infrastructure	Physical change policy	Pull
Public transport services	Physical change policy	
Subsidies for low emission vehicles	Economic policy	
E-transport services	Information/ education measure	
Information awareness	Information/ education measure	
Tax on fossel fuel	Economic policy	Push
Charges	Economic policy	
Ristrictions	Physical change policy	

Table 2. 1: Classification of transport policy measures.

Physical change policies

A common trend that a policy response to congestion has often been resolved with the supply of more infrastructure (Banister, Anderton, et al., 2011) and such trend often feeds the growth of travel demand which is un-appropriate economically, socially and environmentally. Street transformed to free pedestrianization by closing it for car traffic has been a common trend in many European cities and this strategy of traffic exclusion has been socially accepted in general. Thus, policy instruments instigating travel behaviour shift that are socio-demographically co-beneficial can be achieved-with an integrated approach of hard and soft policy measures (Bamberg, Fujii, et al., 2011).

The strategies for reducing car are dependent on several niches and other attributes such as creating awareness and promoting pro-environmental behaviour and improving public transport (PT) system. The latter one is more tangible, measurable and can be observed in practical situations. It is, therefore, crucial to making PT favourable and user-friendly for all types of demographic groups. Guidance on providing quality public transit by KFH Group (2013) elaborates on PT service based on comfort, convenience, safety and security, cost and most essentially the information regarding travel duration, arrival or departure time, online payments are some of the services that would prompt people to use public transport. Quality and reliability in terms of waiting time and travel duration are significant components that change the perception of choosing public transport over other conventional options.

Soft measures (information and education)

The typical classification of behavioural policy instruments such as regulation, incentives and awareness commonly labeled as ‘stick, carrot and sermon’ (Mattauch, Ridgway, et al., 2016); Bemelmans-Videc et al., 1998) have been customized to promote low-carbon transport system by UNFCCC (WCTRS, 2010, Nakamura and Hayashi, 2013). This instrument was segregated to four categories of regulation, information, economy and technology confined within the strategies of ‘avoid’ ‘shift’ and ‘improve’[2]. Improvement to low-carbon personal modes of feeder transport such as motorcycle and bicycle could be promoted with the scheme of bicycle rental or hiring scheme as in some European cities. In China, one does not require a driving license for electric motorcycle and such initiatives have significantly contributed to reducing transport carbon emission (Nakamura and Hayashi, 2013). Public transport promotion through para-transit and mass-transit modes have higher potential for developing cities in Asia. Public

[2] The ‘avoid’ ‘shift’ and ‘improve’ strategies are referred as to reduce travel demand, shift to low-carbon modes and to improve emission intensity and fuel economy.

transport could form a component of green propulsion technology by introducing battery-electric, biofuel or fuel cell buses and also by prioritizing special bus lanes for public transport to enhance convenience.

Personalized travel planning (PTP) approach as a soft policy measure to voluntarily change the psychological determinants of car use based on self-regulation theoretical grounding, affirmed the causality of internal validity with a meta-analytic approach by Bamberg, Fujii, et al (2011). Moreover, information awareness, promoting goal setting on the sustainability of car use have revealed positive effect on sustainable travel choice perception.

Information and economy measures

An informational instrument such as advanced technologies and ICT's to manage demand, services and operations has been more effective than conventional infrastructure development in the public transport system (Nakamura and Hayashi, 2013). The soft measures of public transport such as information sharing, awareness campaigns, cycling initiatives are gradually creating momentum in influencing the travel behaviour and are more attractive to decision-makers due to less investment (Geels, 2012). Technological solutions of the intelligent transport system (ITS) to improve traffic flows, information panels and signs from a centralized control system is known to highly enhance transport system's efficiency as well as it is actively supported by decision-makers, traffic managers, technical helpers and even by the commercial sectors for economic benefits. ICT contribution towards teleworking, e-shopping has minimized travel demand to a larger extent (Geels, 2012).

The UK Department of transport carried out citizen's attitude to transport and climate change and their relationship were assessed with the respondent's knowledge on purchasing low emission vehicle and support towards policies related to transport and climate change. The citizens have a high acknowledgement of cars as the major contributor of change in air quality and as a cause of climate change in the UK, nonetheless, there still remains a misconception on cleaner fuel by a majority that unleaded petrol as 'greens fuel' over diesel. It was also acknowledged that the policy directives related to tax, penalties and fuel duty have a direct impact, whereas awareness campaign, personalized travel planning and energy labels have an indirect effect on behaviour change. Regarding the support/resistance on transport policies respondents are less supportive if the strategy would directly affect their finance such as the overall tax on fuel, however, positive support or willingness to pay was observed in congestion charging to make people use less car (Anable, Lane, et al., 2006). Road pricing through congestion charging, parking charging and pricing of carbon market or carbon trading,[3]a scheme that target vehicles with higher emissions are few economic instruments other than subsidies and tax reduction on low-emission vehicles (LEVs) purchase.

The policy instruments that target to break the habit by regulation, spatial and technological advancement with cost-effectiveness would be necessary as studies reflect that habit strongly influences car use. Similarly, incentives and awareness or educating the citizens to influence the intention and to instigate pro-environmental travel behaviour through policy measures are essential to promote 'avoid' 'shift' and 'improve' behavioural transport strategies. When applying theory to travel behaviour, studies suggest that TPB, NAM, value belief norm (VBN) when integrated compliments one another and offers unique insight to mode choice besides

[3] Carbon trading scheme has been first established in Australia as a Carbon Pollution Reduction Scheme (CPRS).

economic measure in predicting people's behaviour. The barrier to behaviour lies in the complex causal relationship between behaviour influencing travel choice such as finding causality, knowing the impacts, changes one's behaviour on travel choice and it differs from person to person based on other subjective and objective factors.

2.8 Theoritical framework

The frequency of mode choice forming a behavioural habit, and habit as a repetitive behavioural component is perceived to menavour mode choice (dependent variable). The psychological attributes of predicting travel behaviour are derived from integrated NAM and TPB which consist of motivational factor, subjective norms, belief, perceived behaviour control, intention and attitudinal factors including environmental and non-environmental attitudes for determining travel mode choice. The anticipated behaviour that is culturally accepted as well as a behaviour which is expected by the society (social group) forms the socio-culture norm, while personal norm and belief are driven by reasoning and reflection lead to perform certain behaviour that is morally right. The personal and social norm in NAM antecedents normative factor of the psychological attribute. Furthermore, an individual's perception towards policy measure forms an essential component of the framework as it explains the extent to which policies manoeuvre psychological factor and therefore affects travel behaviour. Driven by the theories reviewed a causal relationship have been derived as illustrated in figure 2.2. As has been explained by the integrated theory of planned behaviour, the psychological determinants influence mode choice, however, the process of gearing towards psychological determinants lies in the factors of individual capabilities, availability of infrastructure, socio-culture norms and policy determinants. The same is further unpacked with indicators and operationalized in chapter 3.

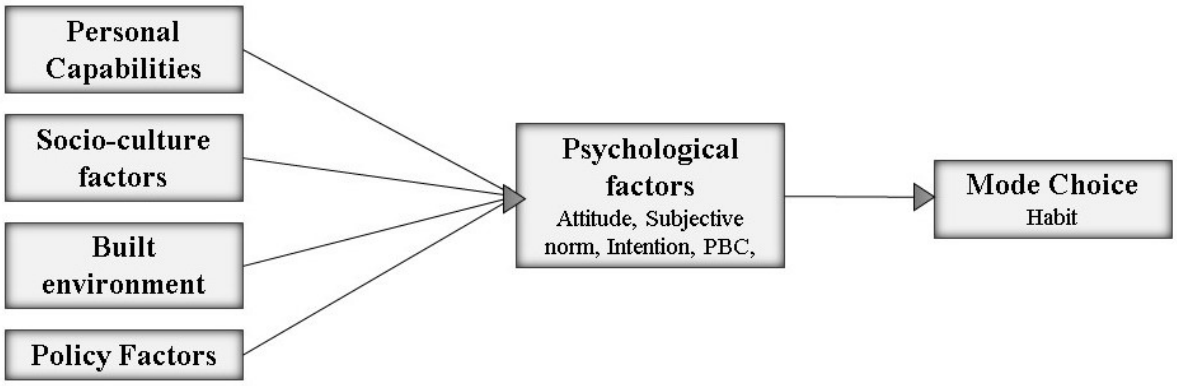


Figure 2. 2: Theoritical framework for travel mode choice.

Source: Author

Chapter 3: Research Design and Methods

3.1 Introduction

This chapter presents an overview of research design strategy and methodology applied for the study to anchor chapter one and the literature review to the rest of impending chapters. It consists of a research strategy, operationalization of variables to measurable indicators for examining the relationship between factors influencing mode choice for commuting to work in the case of Thimphu. Data collection method, population sampling technique are presented to facilitate data collection and data analysing techniques are concisely described. Furthermore, the validity and reliability will be addressed and simultaneously the limitations of the research strategy will be denoted.

3.2 Research Strategy

The research question is to explore and explain the factors influencing the daily travel behaviour and mode choice to commute to work, a primary quantitative survey approach is preferred, firstly, because are no studies carried out to assess travel behaviour of Thimphu citizens by any academia or institutions so far and there is no metadata to base the research upon. Secondly, the objective to unpack and rationalize the factors influencing the travel mode choice requires a large sample to generalize to the whole of Thimphu's population as well as other cities in Bhutan and also to gain the breadth of the study, survey strategy is seen as most relevant (Van Thiel, 2014). Furthermore, the research question aims to describe a phenomenon through a large number of variables which are indicated in operationalization and to draw a causal relationship between the variables, a survey data type is most appropriate due to the categorical and continuous nature of its data type. For the convenience of statistical analysis and to be able to generalize with a large number of respondents within a given time frame of one month for data collection, an online survey method is selected and it is based on the cross-sectional approach.

The study also focuses on policy measures that influence travel behaviour, therefore, desk study on existing policy measures was necessary before designing the strategy which is elaborated in chapter four. From the desk study, it was found that the transport policies in Bhutan are either new or in draft proposal stage, as the strategies contained in old policies were mostly not implemented due to lack of financial and human resource capacity. Additionally, old policies did not contain environmental and behaviour shift aspects. For this reasons, it was deemed necessary to acquire qualitative responses by interviewing bureaucrats in transport sector and municipality to understand the challenges and future policy interventions, implementation strategies and their perception towards Thimphu's individual and societal travel behaviour. The results acquired from interviews are used to complement and compare the perception towards policy measures between the decision-makers and commuters to acheive a comparative nested analysis and to minimize the bias and limitation of single method used for the multifaceted nature of travel behaviour characterized by substantial uncertainty.

3.3 Operationalization

Operationalization is an essential step for expressing the empirical part of the study. Here the theoretical concepts explored in the earlier chapter, the variables are translated in into measurable indicators. Van Thiel (2014) explains the three steps of operationalizing theoretical construct to express in the real world as to firstly, define the variables and indicators that are to be observed. It is crucial to demarcate the limitations as the abstract nature of theories can sometimes lead to unlimited entities. Further, the final step is the need to assign measurable values and score to the indicators to categorize the empirical observable entities in respective variables and also to simplify the phenomena.

The commuters to be observed as stated in the first chapter is confined to work commuters whose trips are defined within the residence to workplace made two times a day and five days a week. As illustrated in the theoretical framework, the study on mode choice and travel behaviour is based on the psychological factors which are influenced by four core determinants, namely; 1) personal capabilities, 2) normative factors, 3) built environment and 4) policy determinants. Theoretically, the four independent variables influence the intervening variable, 'psychological attribute' which further affects the travel mode choice behaviour. Table 3.1 exhibits the variables unpacked to sub-variables and its definition derived from the literature review in chapter.

Table 3. 1: Variables and it's description.

	Variable	Sub-variables	Description	Source
DV	Mode Choice	Frequency	Habit as a learned act that becomes an automatic response	Verplanken et al, 1997
IV (Independent variable)	Personal capabilities	Socio-demography	Gender, age, education, occupation.	N.A.
		Socio-economic	Personal resources and ownership.	Mattauch, Ridgway,et al.,16'
		Situational determinants	Location and distance of workplace from residence.	Scheiner and Holz-Rau, 2007
	Socio-culture and normative factor	Ethnicity	Regional ethnic background.	N.A.
		Self-concept	Independent and interdependent self.	Stephens, Markus, et al., 2015
		Social norm	What most people (dis)approve and the expectations from friends/family.	Cialdini and Trost, 2004)
		Moral norm	Personal moral obligations.	Bamberg, Fujii, et al., 2011
	Built Environment	Infrastructure	Availability of infrastructure for different forms of mobility	N.A.
	Policy determinants	Information and education	Awareness campaign and e-transport services.	Eriksson, 2008. Anable, Lane, et al., 2006. Nakamura and Hayashi, 2013. Bamberg, Fujii, et al., 2011
		Economic policy	Tax and charges.	
		Physical change policy	Infrastructure and restriction regulatory.	
Mediating variable	Psychological Factor	Attitude	A psychological construct for evaluative responses. Attitude towards different forms of mobility, environment, locational aspects etc.	Nilsson, 2000. Icek Ajzen
		Perceived behaviour control	self-efficiency belief, convenience, willingness and perception	Icek Ajzen

	Subjective norm	Social and moral norm.	Shahlom Schwartz
	Intention	Intention to increase or decreased use of different modes.	Icek Ajzen

Personal capability for this study includes personal information such as age, gender, marital status, working organization and information on income and expenditure for transportation. It also includes vehicle ownership, residential location and distance of workplace from the residence. The psychological or subjective factors influencing one's travel behavioural formulate the mediating component for operationalization and analysis as the psychological components can be related to personal life situation, normative belief, attitude towards transport policies and the habitual pattern. Table 3.1 specifies the theoretical framework of travel behaviour with four independent variables intervening a psychological construct. The variables are further unpacked with indicators for the dependent variable (DV), the independent variable (IV) and the indicators for mediating or intervening variable as detailed out in the operationalization table 3.2.

Table 3. 2: Operationalization table.

	Variable	Indicator	Data type	Psychological influence	Source
DV	**Mode Choice**	Most frequent mode choice Alternate frequent mode Least frequent mode	Nominal	Habit	Donald, Cooper, et al., 2014
IV (Independent variable)	**Personal capabilities**	Gender	Nominal	N.A.	
		Age	Continuous		N.A.
		Income			
		Travel expenditure			
		Distance		Attitude, PBC, Habit, Intention.	(Scheiner and Holz-Rau, 2007)
		Location			
		Occupation	Ordinal		N.A.
		Education			
		Household composition			(Scheiner and Holz-Rau, 2007)
		Ownership of car/s, bike/s			
	Socio-culture and normative factor	Ethnicity	Categorical	Social and moral norm, Attitude, Intention.	N.A.
		Social expectation			(Bamberg, Fujii, et al., 2011)
		Individual responsibility			
		Perception towards different mode use and environmental impact.			(Donald, Cooper, et al., 2014), (Nilsson and Kuller 2000)
		Perception on fuel efficient car			(Mattauch, Ridgway, et al., 2016)
	Built Environment	Bus stops	Categorical Spatial observation	Attitude, PBC, Habit.	
		Parking Space			(Mattauch, Ridgway, et al., 2016)
		Cycle lane			
		Bus route			

	Policy determinants	Information campaign Raised tax on fossil fuel Improved public transport Subsidies for renewable fuel E-transport services Improved infrastructure Charges Restrictions	Categorical	Attitude, PBC, Habit, Intention.	(Mattauch, Ridgway, et al., 2016), (Bamberg, Fujii, et al., 2011), (Anable, Lane, et al., 2006)
Mediating variable	**Psychological Factor**	Convenience, efficiency, satisfactory	Categorical	Attitude	(Dijst, Farag, et al., 2008)
		Increased or decreased use of different mode choice		Intention	(Bamberg, Fujii, et al., 2011)
		Pro-environmental and travel behaviour		Perception and intention	(Nilsson and Küller, 2000) (Bamberg, 2011)

3.4 Data Collection Method

The study particularly focuses on collecting primary quantitative data due to the absence of any existing meta-data on travel survey in Thimphu along with desk review on policy documents and interview of expertise in transport sectors. The primary quantitative data will be obtained through a cross-sectional survey and interviews will be conducted to the bureaucrats on the challenges and issues related to transport policy measures. The nature of primary quantitative data is mostly subjective related to travel behaviour and perception towards different travel modes, transport policies along with individual life situation and socio-demographic information. A sample survey questionnaire is attached in Annexure 1. Table 3.3 presents an overview of the data collection method and instrument.

Method	**Data type**	**Source**	**Data collection**
Quantitative	Socio-demographic Situational aspects Mode choice Policy support	Respondents from working population in Thimphu.	Online survey
Secondary	Transport policies	Low carbon transport policies of Bhutan	Desk research
	Built environment	Thimphu municipality.	
Qualitative	Policy measures	Bureaucrats/ expertise in the field	Interview

Table 3. 3: Data collection method and instrument

The survey questionnaire consisted of individual demographic and socioeconomic characters to fill up in addition to household members, educational background, working sectors, vehicle ownership gender, age and income. The second set of the questionnaire integrated the travel behaviour of the respondent regarding their modal preferences and perception towards each mode and policy measures and attitude formed by these measures. All respondents regardless of car users, public transport users or non-motorized transport (NMT) users were asked to respond all the questions as the questions were formatted as a statement and the respondents

were to indicate their level of agreement on seven-point Likert scale. The third set of questionnaire considered the socio-culture factors affecting the preference of mode choice and questions related to pro-environmental travel behavioural. It also included the locational situation along with the distance of residence from the workplace and the distances of bus stops from the workplace and residence. The last section of the questionnaire consisted of an open-ended comment box where the respondents were asked to leave their opinion related to the survey and relative to current transport and environmental situation and/or solution. The secondary data on land, infrastructure and existing policy measures were obtained through published official reports to support the primary quantitative data.

A structured online survey was distributed via e-mail as most of the agencies in Bhutan have company mail address where all the employees of the same company are clubbed to one mail address and this was deemed the most efficient tool to circulate survey questionnaire. Besides, the snowball technique via social media was also used to encourage participants to share the survey as 76.8% of residents in Thimphu have access to the internet (National Statistics Bureau, 2017). The raw survey data are then exported to excel sheet for statistical analysis and SPSS v24 software is employed for running factor analysis, computing and for regression analysis to perform causal path. To complement the survey, an optional open-ended opinionated comment section was provided for the respondents to raise suggestions relevant to the study and the open-ended remarks were then coded and thematised. An e-mail structured interviews of seven bureaucrats from five different transport sectors was performed to supplement the policy-related questions. The mail conversations are combined thematically and quoted to support the policy reviews and survey analysis to enhance internal validity. The information obtained from the interview includes the roles of the organization, challenges in formulating and implementing transport and environmental policies, and new policies in the pipeline. The key informants and general guidelines for the interview question are attached in annexure 2.

3.5 Sample Size

The working population of Thimphu is approximately 45,000 as indicated in the introduction chapter, a total survey size with the confidence level of 95% and 5.2% of margin error accounts for 350 employees, required to represent the working population of Thimphu. A stratified random sampling method based on probability was deemed appropriate for the understanding of travel behaviour and mode choice factor of Thimphu's work commuter as it enables generalization and statistical analysis. The sample was drawn based on the working population of Thimphu ranged in age from 18 to 65 who are currently employed and commute to work every day. The online survey questionnaire was distributed via email and social media apps to private and corporate and government organizations on a random basis to increase response rate as well as to increase the probability of every employee in Thimphu being selected.

Quota sampling and snowball technique were used for interviewing bureaucrats. The key figures of interviews were selected based on the organizations/sectors that formulate and implements transport policies as per the desk research on transport policies. Table 3.4 provides an overview of the key informants, organizations and their related role in transport and environmental policies.

Key Informats	Organization	Policy roles
1. Executive Secretary	Thimphu Municipality	Service provider, infrastructure
2. Engineer	Thimphu Municipality	implementating agency.
3. Planning officer	Thimphu Municipality	
4. Deputy Chief Planning officer	Ministry of Information and Communication	Formulating transport policies
5. Transportation engineer	Road Safety and Transport Authority	Traffic rules and regulations
6. Head of Operations and Maintenance	Bhutan Post	Public transport services
7. Deputy Chief, Environment Officers	National Environment Commission	Low carbon policies

Table 3. 4: List of interviewee organization.

3.6 Data analysis methods

The type of data collected for this study is primary quantitative data in continuous and categorical (7 points Likert scale) type for measuring perception and psychological factors. The data generated from the online survey were checked for consistency and completeness and then transferred to excel format, code and imported to statistical package SPSS for analysis. The use of SPSS software is preferred over other statistical software as it provides a complete statistical package for both descriptive and inferential statistical techniques for analysing survey data. Descriptive analysis methods of summarising the frequency distribution and tabulation interpret the characteristics of the respondents. Charts and graphs are created in Excel and online graph makers tools to enhance visual interpretation of the data and analysis.

Since the proposal contains questionnaire instruments with Likert scales, factor analysis of variance and covariance between sets of observed and unobserved variables is employed for computation of the variables. Example; behaviour is affected by attitude, and the same is true if reversed, however, both attitude and behaviour are still affected by other aspects such as belief (belief being the unobserved variable). A factor-analytic technique to reduce the original set of variables to a reliable variance is applied to represent several variables with an aggregated variable. The reliability of the data are checked using Cronbach's coefficient alpha to estimate the internal consistency of measurements. The strength of dichotomous variables (social expectation) influencing other factors are determined through binary logistic regression. Multiple linear regression method is used to cannibalize data set to obtain the patterns and relations between the factors influencing travel behaviour. Andy Haye's SAS PROCESS is applied for the indirect effect and mediation analysis. Further, the survey analysis and policy review are complemented by the structured interview of the expertise in the field of formulating and framing transport policies and its implementation.

3.7 Validity and Reliability

The validity of the survey result could effect if the measurements are not clearly defined and/or adequately operationalized (Van Thiel, 2014). Therefore, to outline the presupposed causal relationship between the dependent and independent variables, the operationalization section has been given much attention to drawing a precise measurement scale for multiple indicators. Prior to the actual distribution of the survey, a pilot survey was tested with five IHS master's student to avoid ambiguity and linguistic error, miss-interpretation of the question and to improve questionnaire format. The survey was completely anonymous and voluntary. Many studies indicate the reluctance of the general public to participate in an online survey and

therefore, to increase the number of respondents, snowball technique such as distributing the survey e-mail by people working in the same organization and social media apps were targeted along with the follow-up mail to participate in the survey. Questionnaire were all written in English since it is the second language and official language in Bhutan.

The online survey method is advantageous in achieving reliability as the administrator does not influence one's perception and response. The survey questions are predominantly subjective which is difficult to achieve a valid response and to validate consistency few subjective questions on attitude and habits were asked in several different ways. In addition, the interview of expertise in transport field is expected to increase the internal validity of the study as the qualitative data are used to supplement survey analysis.

3.8 Challenges and limitation on research design and method

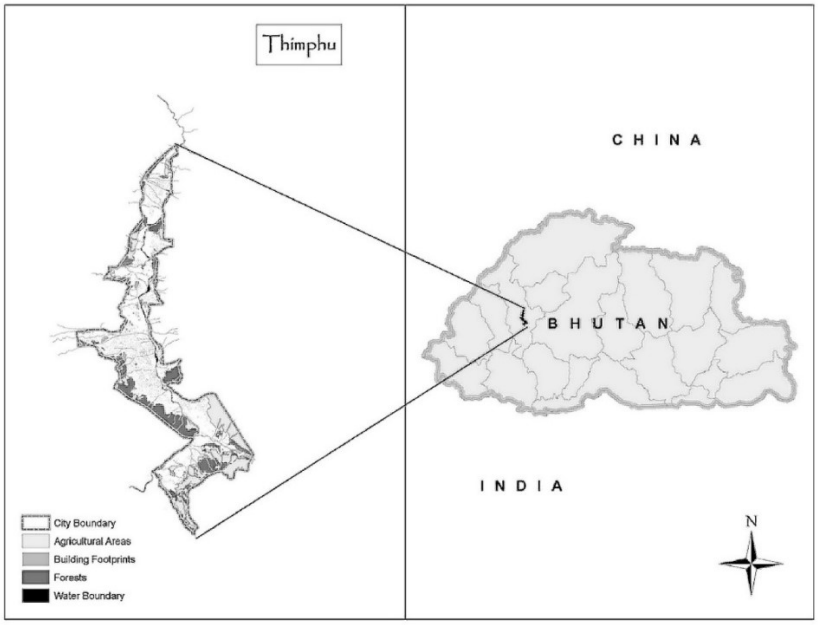
Depending upon the structure, survey method can be flexible to generate either qualitative and quantitative information, nonetheless, this method has certain constraint and challenges owing to the nature of ambiguity and biased interpretation of the respondents. However, Shaughnessy and Zechmeister (1990) in Nilsson and Kuller (2000) stated that the questionnaire survey approach provides the best method in analysing travel and mode choice attitude. Anable, Lane, et al. (2006) stresses the requirement of in-depth knowledge for behaviour studies due to the inconsistency and complexity of individual human behaviour which may affect generalization. Another challenge is that there could be a high over or under-representativeness of certain demographic group, in which case the data may need a careful adjustment and/or analyse non-response rate with specific tests. Desk research on policy and spatial aspects along with interviews of expertise in transport field was carried out for the purpose of triangulation. A month timeline for field survey having required to compile 350 responses and the getting right expertise for interview response was indeed a major challenge.

Chapter 4: Research Findings

This chapter encapsulates an overview of the study area and transport infrastructure followed by a review on low carbon transport policies of Bhutan and the interventions carried out in the city supplemented by the interviews gathered from the expertise of the transport sectors. The third section of the chapter describes the survey sample demographic characteristics and their choice of mode to commute to work. The fourth section labels the respondent's attitude towards different mode choice, social norms and their perception towards the existing and new policy interventions. The chapter concludes with the results and findings from the causality of independent variables to the dependent variable (mode choice) with and without mediating variable.

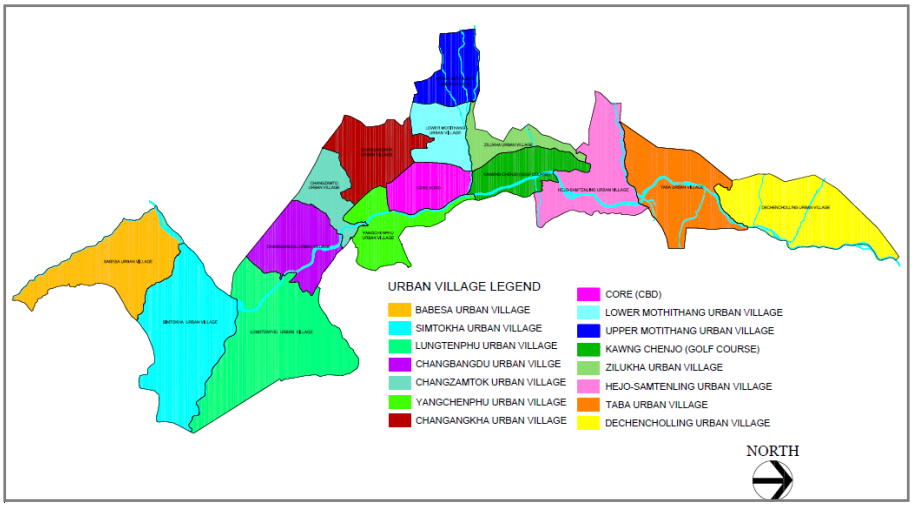
4.1. Overview of the study region

Walcott (2009) describes Thimphu as an urbanizing city but "calm and so uncharacteristic of other Asian capital cities". Thimphu is a primate city for its country; located in the central-western part and lies in an altitude of 2330 meters above sea level (Thimphu Dzongkhag Administration, 2018). The city extends linearly in north-south direction stretching for about 15 kilometres (Thimphu Thromde, 2019) along the river *wang chhu*. The east and west are largely hills and mountains of pine forest where the altitude exceeds 3700 meters (Fraser and Bhattacharya, 2001). Thimphu as a capital city of Bhutan was shifted from Punakha in 1952 by His Majesty the 3rd King of Bhutan however, only formalized in 1961 (Ministry of Works and Human Settlement Royal Government of Bhutan, 2008). It is the administrative and political centre of the nation and congregated all the central government agencies, parliament, national assembly, corporation headquarters and most private sectors/companies in an area of 26 square kilometres of the municipal boundary. As per population and housing census of Bhutan 2017 the labour force participation rate is 57.7% of Thimphu's population; 32.7% are dependent population and 6% unemployment rate from a total population of 138,736.



Map 4. 1: Regional location setting of Thimphu
Source: Susan M. Walcott, (2009) City profile Thimphu.

Thimphu city administered by Thimphu municipality (Thromde) is guided by the '*Thimphu Structure Plan*' (TSP) prepared in 2002-2003 forecasting the developmental activities until 2027. Thimphu thromde envisions the city to be vibrant, liveable, safe and progressive in providing equitable and efficient services and facilities, however, the city is challenged in providing services to the rapidly growing population and its demand. The fifteen local area plans (LAP, map 4.2) of TSP within the municipal boundary are under vigorous implementation with the financial support from the World Bank and Asian Development Bank (Thimphu Thromde, 2019).



Map 4. 2: Thimphu precinct plan, 14 urban villages and one urban core area.
Source: Thimphu structure plan (Thimphu Thromde, 2015)

Apart from the political centre, Thimphu is also the economic hub of the nation with the highest concentration of company headquarters, international agencies offices, national IT park, institutions, high-end tourist service industries and, mining and cottage industries located in outskirts of the city altogether contributes to 45% of the country's GNP. The growth of Bhutan's economy was ranked the second-fastest growing economy from 2005 to 2011 (Ministry of Economic Affairs, 2018) globally. This growth influenced a rapid migration of population in the capital city uplifting numerous construction and infrastructure development. Thimphu covers 5% of Bhutan's land area and accommodates 19.1% of nation's population out of which 85% of the population resides within the municipal boundary and rest 15% reside in the peri-urban and semi-urban areas of the district. The urban population increased by 45% from the first population and housing census in 2005 to 2017 (National Statistics Bureau, 2017). The population of Thimphu is projected to grow over 260,000 by 2047, accommodating an approximate of 30% of the nation's population (National Statistics Bureau, 2019) and the private vehicle is estimated to grow tenfold from the current number by 2040 (UNDP, 2016). Since the only means of transportation in the country is served by vehicular road, the rapid growth of economy and population has put high pressure on road infrastructure uprising to congestion issues, emission concerns and, deforestation and environmental degradation as numerous roads were constructed in the steep terrain to support the growth. Within the municipal boundary of 26 square kilometres, a total length of 281.8 kilometres of the urban road has been constructed (Thimphu Dzongkhag Administration, 2018). The only international airport is in Paro district, 54 kilometres from Thimphu city, nor does the city have domestic airport due to stiff valley terrains.

The capacity of existing road infrastructure cannot accommodate the increasing number of vehicle populace in terms of space for road extension and parking spaces. Intra-city bus, the service monopoly public transport of the capital city is limited in number and caters to one-tenth of the population of the city and if the efficiency of bus services does not improve in a few years the private vehicle will exponentiate to an alarming figure with the challenges that the city is not ready to face.

4.2. Infrastructure

The TSP forms a basis for all the infrastructure development formulated within the principle of 'Intelligent urbanism' similar to the 'Smart growth' principle in the U.S. plans. The principle of smart growth in the U.S. has been expanded based on the concept of transit-oriented development (TOD) in support of the economic development of the changing market demand and as an approach to revitalizing communities. Its objectives are to encourage ridership thereby generate revenue through the development of compact mixed-used development near transit facilities and enhancing the walking environment. A success of TOD in the U.S. over the years indicates that it is still very alive and will only grow, as there are more than 100 joint venture and PPP projects to be developed in the proximity to transit facilities (Dittmar and Ohland, 2012). Although the similar principle of intelligent urbanism in TSP sees transit system as a balanced integrated system not overshadowed by the automobiles but by promoting pedestrian dominated lanes (Ministry of Works and Human Settlement, 2004), the situation has rather a turnout in reverse order.

Photograph 4. 1: The usual traffic scenario in Thimphu core area

The image displays roadside parking, narrow pedestrian walkways, lack of cycling lane and the traffic controlled by traditional hand signal in the centre. Photo credit: Tandin Phubz.

The TSP also envisages integrated proximity of housing, retail and transportation of several urban village precincts with an urban hub to make the city low vehicular dependent (Walcott, 2009), however, the headquarters and offices are clustered in and around the core area. Because of the traditional monocentric form of the city, the 'less vehicle dependent lifestyle' as per the TSP has not been successful considering the residents from 14 other precincts have to travel to core area for work and, the swift increase of long hour traffic in peak hours has only irked the

work commuters of Thimphu residents. The success of TOD in the U.S. is defined by timeline as it was initiated for decades; Dittmer and Ohland (2012) states that TOD is a long-term initiative and it takes time to realize a successful outcome, so there is a lot to learn and process the concept of TOD in the case of cities in Bhutan.

Thimphu has developed along the corridor of every major road and there is hardly any room for expansion or widening of the road to accommodate the rising traffic congestion. In addition, the lack of parking space puts additional pressure to the limited space encroaching the pedestrian, however, multi-storied parking structures for the core area and pedestrianizing the core commercial zone are some of the municipality's focus priority plans (Thimphu Thromde, 2019). Guidelines and/or parking regulation to assess and monitor parking operation as a tool to manage congestion and car reduction is seen effective. The parking policies in relation to TOD have conflicting views, on one hand, parking is viewed as an effective tool while developing any project and on the other hand, allocating land for parking instead of recreational or other activities is a hustle (Dittmar and Ohland, 2012).

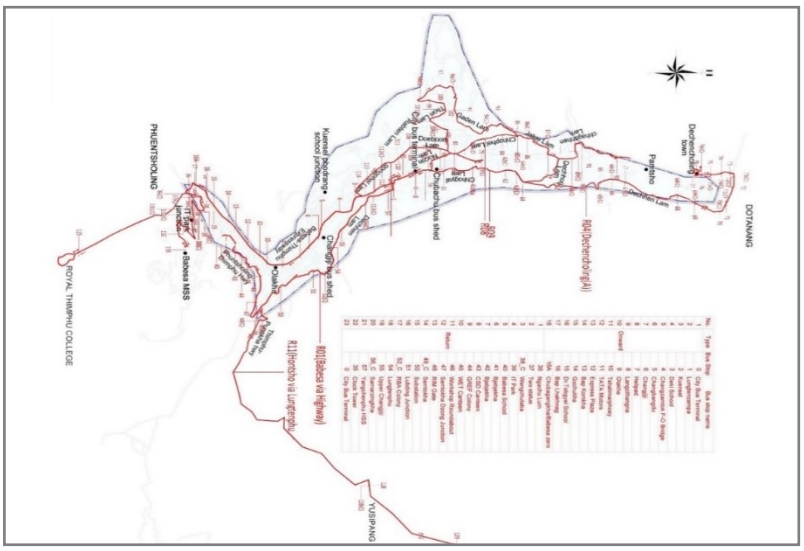
The TSP prepared in 2002 proposes cycling lane in several local area plans, however, the implemented plans do not have designated lane for biking or cycling as can be noticed in the photograph 4.1. The lack of infrastructure for other transport modes, topography and climatic challenges in addition to various socio-political reasons, the capital city has become a car-oriented city. According to the RSTA, the motor vehicles growth rate is currently 9% and the highest recorded was in 2015 with 14%. The inflated share of vehicle import adds to Thimphu's road traffic with one in every three people owning a car, whereas the ratio of a car to the country's population is one in every seven people.

Non-motorized transport such as walking has been steadily replaced by personal cars and on the other hand, cycling is not practised as a mode of commuting in Thimphu or elsewhere in Bhutan due to stiff terrain and lack of infrastructure (cycle lane and parking) however, mountain biking as a leisure and fitness have become a trend. Given the small size of the city and travel distance, cycling could have been the finest non-motorized option. Bhutan's tenth five-year plan proposed to encourage non-motorized transport, and it was restated in the 11th five-year governmental plan but not implemented (United Nation Development Program, 2016). Bhutan has recently started the twelfth five-year plan and such delays in implementation have only led people the use and purchase more personal cars. In liaise with NMT mode, the Deputy Chief of the department of transport under MoIC in an interview mentioned that;

"The priority for transport planning will be Non-Motorized Transport (NMT) which includes bicycle, however, implementation in terms of infrastructure; it is within the mandate of municipality and MoWHS" (Dorji, Sithar. e-mail. 17 July. 2019).

The engineer and the planning officer of Thimphu municipality stated that there are plans to develop bicycle tracks in Thimphu, however, there is a social stigma to use cycle as a transportation mode in Bhutan. Transport engineer from RSTA mentioned that;

" *the existing road infrastructure and the traffic rule does not favour vulnerable road users such as a bicyclist. However, we are planning to encourage and incentivise non-motorised transport soon*" (Norbu, Ugyen. e-mail. 19 July. 2019).



Map 4. 3: Bus service route (overlay of all the routes)
Source: Thimphu city bus social media page

Regarding the public transport infrastructure, currently, there is no separate bus lane in either core area or other parts of the city. The bus route is limited to the major urban roads and is not accessible to most of the residential zones (bus route in map 4.3). There are 105 bus stops and almost 90% of the bus stops does not have bus shelters but rather only 'bus stop' signposts (Kuensel, 2015). The question on inadequate bus route when inquired in the structured email interview with the head of operation and maintenance division of city bus service (under Bhutan post), the officer stated that;

"*…we have created a new route system and proposed for more buses to the Royal Government of Bhutan. Starting next year, we will have an adequate number of buses to solve the reliability issue which will increase the number of riders*" (Tshering, Passang. e-mail. 16 July. 2019).

The Thimphu municipal is responsible for providing public transport services in collaboration with the Bhutan postal corporation office and they also manage the imposed transport charges or fees to generate revenue for providing the services.

The details of the key informants and their agency date of interview correspondence and the interview responses combines thematically are encapsulated in annexure 3.

4.3. Transport policy interventions review

The draft transport policy estimated the current requirement of public buses to 76 numbers, however, the city has only 54 buses and this requirement is projected to reach more than 200 buses by 2040. The draft transport policy as well as several other strategic documents such as low-carbon development strategy, intended nationally determined contribution of Bhutan calls for an additional number of public transport as an answer to the current challenges and future repercussion on the city's economy, environment and climate change as a whole (UNDP, 2016). A proposal for institutional change and operational improvements related to bus service in Thimphu, formulated with the assistance of ADB (2017), recommends the improvement of transport through intelligent transport systems (ITS) such as smart ticketing, bus ridership by route, timing, parking information and toll systems, however the reports do not indicate any immediate plans that would/should be implementation.

A levy of 55% tax (45% sales tax and 10% green tax) on the import of conventional light vehicles from India and 100% tax if imported from other countries due to the 45% customs duty (Department of Revenue & Customs, 2010) are some of the efforts to reduce vehicle import in the country. Similarly, efforts have been put to promote electric vehicles through tax exemption but its growth has been limited due to insufficient services such as EV charging points and maintenance service centre in attrition to its high initial investment. Customs duty and sales tax exemptions for importing electric vehicles or hybrid vehicles was improvised (Department of Revenue & Customs, 2010), nonetheless, import of EVs is less than one percent as compared to the conventional fossil fuel oriented vehicles due to the low facilities for EVs. The ministry of information and communication has recently formulated 'Bhutan sustainable low-emission urban transport systems' to facilitate and promote low-carbon transition funded by green environment facility (GEF) (UNDP, 2016). The project aims to install several charging points in Thimphu and the target group is focused amongst taxi owners in providing subsidies for purchasing EVs as taxi operates throughout the day contributing most of the emission (Kuensel, 2019). This news report information on subsidizing 300 electric taxis was emphasized by the planning officer during the e-mail interview;

"*..government is working towards promoting the use of clean and eco-friendly vehicles. As a pilot project, 300 fossil fuel taxi will be replaced by electric taxi within two and a half year from now through subsidy on the capital cost and other incentives*" (Dorji, Sithar. Deputy Chief Planning officer. MoIC. 17 July. 2019).

Given the transport sector's enormous dependence on fossil fuel and the unbalanced ratio of EV's, the government of Bhutan proposed various alternatives in several policies one of which is the biofuel. Although the feasibility and production of biofuel as an alternative to petroleum has not been developed, the low emission development strategy for the transport sector (2016) highlights the potential of planting biofuel, which would aid 60 percent GHG reduction.

Fuel tax as a way to reduce trip distance has been a contradictory story since fossil fuel is highly subsidized by the Indian government to promote economic growth (Department of Renewable Energy, 2015b). The fuel price in Bhutan is relatively lower (GPP, 2019) as compared to other south-east Asian neighbouring countries such as India, Pakistan, Nepal and Bangladesh. In the Netherlands, fuel price is second highest in Europe, withstanding sixth highest globally (GPP, 2019) along with the highest taxation on transport system which is segregated to carbon content and fuel tax (OECD, 2018) to encourage people to use more of the public transit and non-motorized transport.

Regarding the parking, every kerb in the core city area in Thimphu is used for on-street parking which is charged on an hourly basis by a parking fee collectors but there remains inconsistency in fee range due to lack of proper parking policy (ADB, 2013). When asked about improvising parking policy in the interview, the planning officer from MoIC mentioned that;

"*..draft transport policy looks at, using parking management as a transport demand management tool and to discourage the use of private vehicle thereby encouraging the use of public transport and non-motorized modes*" (Dorji, Sithar. Deputy Chief Planning officer. MoIC. 17 July. 2019).

The executive secretary from Thimphu Thromde duly stated that;

"*..congestion charging is built into parking fee and in areas where there are serious congestions the parking fees are higher so that people are forced to do limited parking or to discourage driving in the congested areas*" (Namgyel, Karma. e-mail. 1 August. 2019)

To maintain a smooth flow of traffic in the city centre area, Thimphu municipality is constructing multi-level parking facilities and have plans to pedestrianize the street in the core area as proposed in TSP 2004. Although the roadside obstructing traffic flow exists in all neighbourhood in Thimphu only the parking in the urban core area is charged unlike in the Netherlands, where parking a car is charged in most of the urban neighbourhood. The well-defined rules and regulation on parking as indicated in road traffic signs and regulation (1990) in the Netherlands improvises traffic flow and also indicates the expense of owning a personal car.

While some progress is being made in formulating environmental protection and sustainable transportation progress, since the policies feature promising and futuristic plans and programs, the challenge lies in implementation. The lack of communication between plan formulation and implementation is vastly challenged by the lack of funding, minimum human resource capacity and inter-agency coordination as inscribed from the interviews. Bhutan seems to continually embrace the rational centralized top-down democratization method (The Durk Journal, 2018) and through the interviews, it was found that none of the organization has carried out any surveys on people's perception on the services provided and/or policy interventions.

4.4 Descriptive statistics of survey data

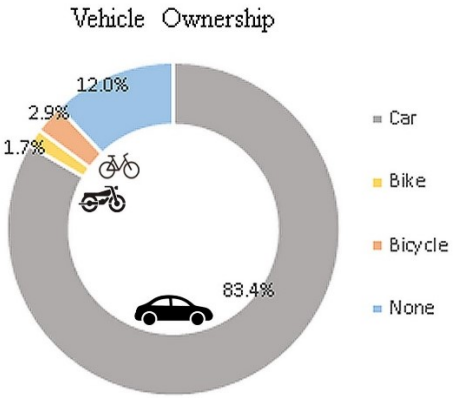
The questionnaire was distributed to 36 sectors in Thimphu including government, private, corporations and NGO's and a total of 335 people responded to the survey in a timeline of 3 weeks. Survey questionnaire distribution to an actual number of person is not known since sectoral email addresses were used and it is unknown the number of persons that can access the group e-mail. The following section outlines demographic characteristics to present an overview of the respondent's profile and locational context. For a descriptive purpose, a simple statistical frequency distribution, cross-tabulation and correlation coefficient matrix is applied for analysis. Furthermore, a description of societal expectation and mode choice of respondent's family and friends has been sketched out.

4.4.1. Respondents profile

From the total of 335 survey participants, male respondents were twice as higher as compared to the female respondents. The minimum age of the respondents was 23 and the maximum was 58 years old. The mean and median of the age are 35 and 36 years, however, the maximum number of respondents was dominated within the age group of 28 to 40 years and 5% of the respondents were above the age of 51 years. 76% of the respondents were married. The population housing and census of Bhutan (2017) assert that the household size of Thimphu district to be 4.2 persons per household, which are comparable to the survey collected from the sample size of the study where the maximum respondents have a household size of 4 members. Household comprising 3 – 5 family members dominates with 65% (213) and family members of 9, 10 and 15 together comprise of 4% of the respondents.

The self-reported data exhibits that 282 respondents out of 335 own private car comprising 83% of the total respondents, only 2.9% owns a bicycle, 1.7% (6 persons) owns motorbike and

12% of the respondents does not own a car or a bike as exhibited in chart 4.1. The respondents who own a bicycle also owns a car or a bike, therefore, the use of bicycle and motorbike to commute to work is almost negligible. The fuel type of almost all vehicle is either diesel or petrol out of which one person owns a hybrid car and none of the respondents owned an electric car.



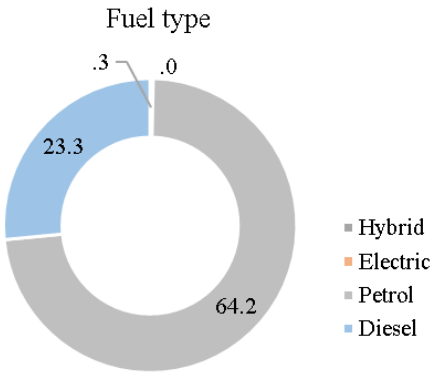


Chart 4. 1: Types of vehicle owned by the respondents.

Chart 4. 2: Fuel type of the vehicle.

Government employees dominate the respondent's rate (80%) as compared to other sectors and the majority of the respondents have completed undergraduate studies. When cross-tabbed, it was found that the highest number of government employee respondents has bachelor degree certificate and the autonomous body has a higher share of the masters-level employee as compared to different sectors and education level (Table 4.1). The monthly income and expenditure on travel to commute to work are mention in Ngultrum.[4] The average monthly income for more than 80% of the respondent ranged between Nu. 15,000 to Nu. 35,000 per month (approximately 220 to 515 USD) and the average travel expenditure is Nu. 3000 (45 USD).

		Highest level of education completed						
		High school	Certificate / Diploma	Degree	Masters	PhD	Others	Total
Work organization / sector	Self-employed	1	0	6	0	0	0	7
	NGO / CSO	0	0	1	1	0	0	2
	Private	1	0	2	0	0	0	3
	Corporation	3	1	11	2	0	0	17
	Autonomous body	2	1	15	8	0	0	26
	Government	4	26	141	97	2	7	277
	Others	0	0	2	1	0	0	3
Total		11	28	178	109	2	7	335

Table 4. 1: Work organization * level of education completed by the respondents

[4] Ngultrum (Nu.) (BTN) is the currency of Bhutan, pegged to the Indian rupee at parity. The currency exchange rate as per the Bank of Bhutan is 1 USD= Nu. 68.78, and 1 Euro= Nu. 77.25 as of July 20th 2019.

4.4.2 Mode choice

The trip characteristics, a journey to work is uniform and is assumed stable with a minimum travel frequency of two times a day and five days a week thus a habitual pattern would be established in the process. Self-reported frequency of mode choice to commute to work was reported for six mode options (walk, cycle, bus, taxi, motorbike, car). Similarly, alternative mode choice and least frequent mode choice were observed as an indicator of cognitive habitual construct and for repetitive travel pattern.

80.3% (269) of the respondents most frequently use a car to commute to work. Out of the total sample, 11.5% of the population walks, 4.6% commute via taxi and 2.5% uses public transport to commute to work every day. The alternative mode choice preference is predominantly the use of shared taxi (45%), 29% of the respondents preferred to walk and 20% choose to use the bus as an alternative option. Walking and cycling are the least preferred mode choice to commute to work as illustrated in chart 4.3.

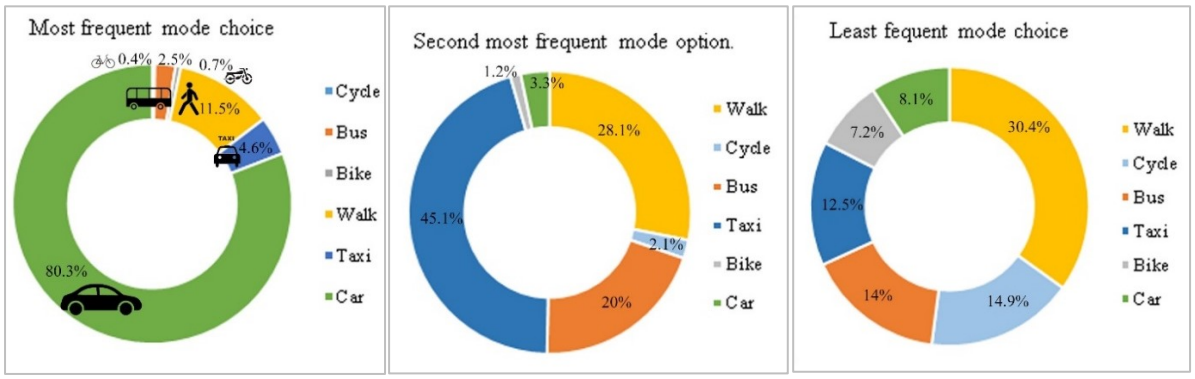


Chart 4. 3: Frequency of mode choice

The frequency of mode choice; most frequent, the alternative mode choice and the least frequent are cross-tabbed with the respondent's profile of age gender and marital status. There is no notable difference in the type of mode chose by the male or female, however, unmarried respondents tend to have higher diversity in the type of mode they choose. The most frequent mode choice is diverse with the age range of below 40 years, walking is more popular with the respondents of over 40 to 50 years and car use is predominant within the age range of 30-40 years old.

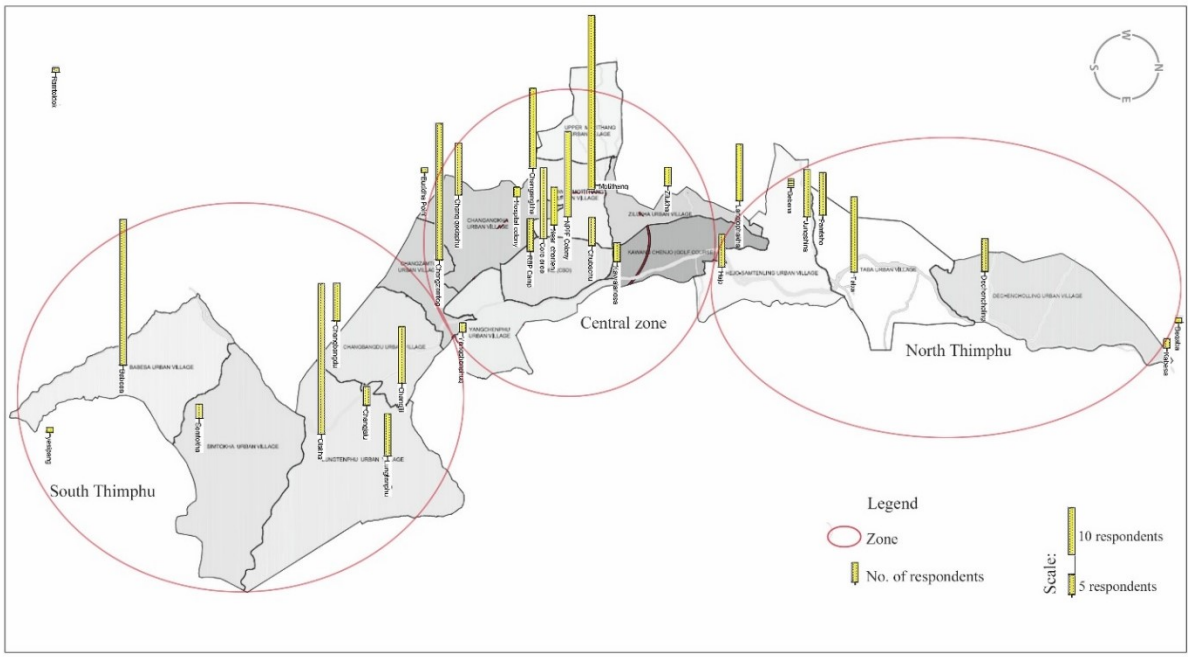
The respondents within the income range of Nu. 10,000 – Nu. 20,000 has the most diverse mode choice; the car is predominant within the income range of Nu. 30,000 – Nu. 40,000 and the percentage of respondents who most frequently walk are those in a higher income range of Nu. 50,000 – Nu. 60,000. Person's correlation indicated a statistically significant relation between vehicle ownership and monthly income but not significantly significant to frequent mode choice and income. However, the monthly travel expenditure is significantly correlated with the frequency of mode choice at (r = .313) and (p < .001).

The mode choice when computed with the gender separately, the percentage of car users and PT users are higher in the male category and, walking and use of paratransit is higher in female respondents. Marital status and the number of members in a household has no significant difference in the car as a choice of mode, 70-90% of the respondent's mode choice is car regardless of married or not or regardless of 1 member or 10 members in a household. Nonetheless, the education of the respondents has a clear pattern of car use; higher the

education level, more is the percentage of car use and it is reverse for NMT users, however the Chi-square result (χ^2 (25) = 42.062, p = .08) is non-significant, yet the correlation is positive and significant.

4.4.3. Situational determinants

The location is grouped to three zones; south, central and north as illustrated in map 4.4 within the municipal boundary of the TSP. As per the self-reported residential location, 44% (148) respondents reside in south Thimphu and 35% (116) respondents reside in and around core or central zone. Comparatively lesser respondents 21% (71) reside in north Thimphu. A graphical representation of the respondents residing in different location among the 15 LAP's is indicated in map 4.4. The residents residing in the core area has the highest car ownership and only 7% of them walk to commute to work although most of the government agencies (Ministries/headquarters), as well as other private and corporate sectors, are located in and around the core area. The southern residents have the most diverse choice of mode with highest walking commuters, taxi and PT users. The northern residents predominantly use a personal car to commute to work.



Map 4. 4: Respondent's residential locational map from self-reported survey data.

The distance of the respondent's workplace from their residence was inquired in kilometres. 80% of the respondents reside at a distance of less than 7 kilometres and the rest 20% at a distance of 7 kilometres or more from their workplace. Table 4.2 exhibit the mode choice preference when compared with the distance. Form the 20% of the total respondents who do not use a car, most of the walking commuters reside at a distance of 3 kilometres or less, taxi users reside at a distance of 7 kilometers or less and most of the public transport users (bus) reside at a distance of 12 kilometers or less. A pattern of predominant car use is observed when the distance of residence exceeds more than 12 kilometres.

		Average distance of residence to work-place in km's								Total	
		<= 3	4 - 6	7 - 9	10 - 12	13 - 15	16 - 18	25 - 27	28+		%
Most frequent mode to commute to work	Cycle	0	1	0	0	0	0	0	0	1	0.3%
	Bus	3	2	0	3	0	0	0	0	8	2.4%
	Bike	0	1	1	0	0	0	0	0	2	0.6%
	Walk	29	6	1	2	0	0	0	0	38	11.4%
	Taxi	7	5	1	1	0	0	0	0	14	4.2%
	Car	123	90	37	11	5	2	1	1	270	81.1%
Total		162	105	40	17	5	2	1	1	333	100%

Table 4. 2: Frequent mode choice*Distance of residence form workplace

The walking distance of the nearest bus stop is measured to assess if the proximity of public transport service majorly influence the choice of PT use as well as shared taxi users since bus stop and taxi stops are adjacent in most areas. More than 60% of the respondents have to walk 10 minutes or less to reach the nearest stop, 25% walks 20 minutes or less and 6% has the nearest stop at a walking distance of more than 30 minutes. The walking duration of the nearest stop is comparatively larger when measured from residence than from the workplace.

The independent variables that are observed on a continuous scale of socio-demographic, socio-economic and situational determinants were explored for normality to check if the data were uniformly distributed with Shapiro-Wilk test. The Sig. value of the Shapiro-Wilk test for both dependent (frequent mode choice) and independent variables are less than 0.05 σ, which leads to rejecting the null hypothesis. Thus, we infer that the data does not follow a normal distribution. The output of a normal Q-Q plot deviates from the diagonal line and the normality curve are mostly skewed and kurtotic for both dependent and independent variables.

Correlation analysis on the frequency of travel modes to the demographic and situational aspects from the self-reported data was computed based on spearman's correlation to measures the degree of association to which the paired variables are systematically related or tend to move together based on covariance. The spearman's correlation coefficient does not assume the data to be normally distributed neither specifies causality. Correlation analysis exhibits whether the statistical significance of variance is directly or inversely related to each other (Alreck and Settle, 2004).

The frequency of mode choice is positively correlated to vehicle ownership, level of education and distance between workplace and residence with Sig. *p*-value (> .05). The vehicle ownership is significant and positively correlated with most of the socio-demographic factors except for the location and distance the relation is not significant ($p > .05$). The bivariate correlation matrix, exhibit a non-significant correlation of mode choice to income and travel expenditure, gender and age (Table 4.3). The cross-tabulation of income and mode choice exhibit that lower-income range predominantly uses a car and higher-income ranged respondents tend to walk more despite owning a car. The high income ranged respondents predominantly resides in the core area or at a distance of 10 km's or more.

Spearman's rho Correlations

		1	2	3	4	5	6	7	8	9	10	11	12	13
1	Most frequent mode to commute to work	1.000	.544**	.032	.102	.006	.052	.236**	-.035	.090	.313**	-.011	.196**	-.078
2	Vehicle ownership		1.000	.154**	.214**	.216**	.108*	.181**	.004	.206**	.339**	.007	.049	-.071
3	Gender			1.000	.194**	.124*	-.018	.059	-.029	.165**	.083	.019	.050	.159**
4	Marital status				1.000	.398**	.053	.073	.037	.096	.099	.013	-.060	.194**
5	Age category					1.000	.028	.253**	.070	.454**	.012	.072	-.116*	.029
6	Household members						1.000	.018	.036	-.021	.084	.009	-.101	.015
7	Highest level of education							1.000	.158**	.465**	.155**	.082	.030	-.098
8	Work organization								1.000	.119*	.008	.048	.008	-.017
9	Monthly basic pay (in									1.000	.154**	.024	-.024	-.118*
10	Travel expenditure										1.000	-.015	.214**	-.074
11	Location of residence in zone											1.000	-.188**	.003
12	Distance from residence to work-place in km's.												1.000	.070
13	Regional background													1.000

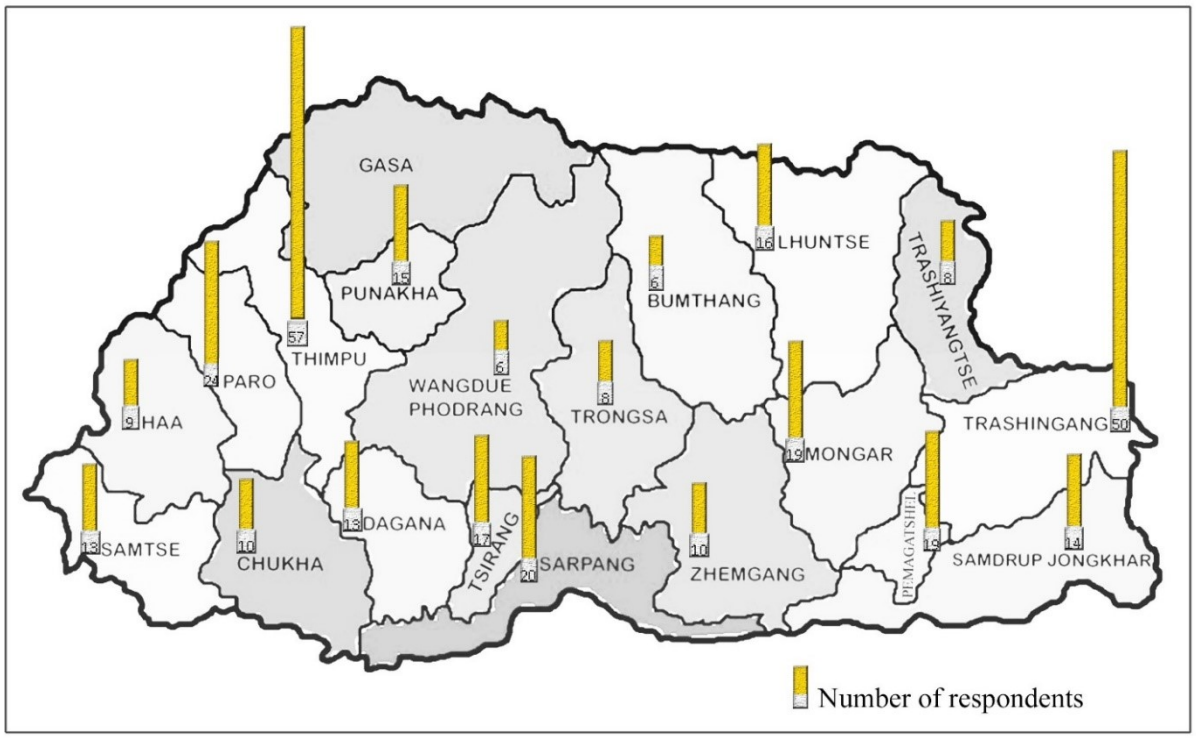
**. Correlation is significant at the 0.01 level (2-tailed).

*. Correlation is significant at the 0.05 level (2-tailed).

Table 4. 3: Spearman's correlation of mode choice and socio-demographic variables

4.4.4. Socio-culture influence factors

To assess the cultural influence on behaviour self-reported information on respondent's original hometown was collected based on the twenty dzongkhags (districts) of Bhutan because Thimphu being the capital city, it has the population migrated from across all the dzongkhags. Regionally the dzongkhags are spatially divided to the east, west, central and southern region and the dzongkhags falling in each region has a similar culture, tradition and language in general. The majority of respondents residing in Thimphu are from western and eastern region comprising of 70% respondents combined as can be observed in the map 4.5, that higher share of respondents are from Thimphu and Trashigang.



Map 4. 5: Respondent's hometown background

The respondents from the eastern region have the most diverse mode choice and highest among the respondents who owned both car and bike even bicycle at the same time. While respondents from the western region predominantly own a personal car, however, the difference is not statistically significant when tested with the Chi-square test and spearman's correlation at the p-value > 0.05. Similarly, the interdependence of mode choice to the regional background (village/ cultural background) is insignificant.

The social expectation to drive a personal car or other modes of transport were independently observed based on dichotomous stance (e.g., 0/1; yes/no) if the respondent's friends, family/relatives would expect from them to use a car, bus or NTM (walk and cycle). The 'yes' response was predominant with driving a personal car and the least was cycling to commute to work. Respondents were asked to state frequent mode choice of their family, friends and relatives, and 90% stated that their social group uses car to commute.

Chi-square test to verify interdependence of the variables with statistical significance of social expectation to different mode choice from self-reported data resulted in a significant interaction for social expectation to use personal car (χ^2 (10) = 22.131, p < .05) and for the expectation to walk (χ^2 (5) = 15.993, p < .05). Where 'χ^2' is the chi-square and degree of freedom in the parenthesis. The Chi-square result and Phi value (.219, p < .05) led us to accept the alternative hypothesis that there is a significant association between social expectation and mode choice.

4.4.5. Psychological factors

The psychological factor of attitude towards different transport modes, intention to reduce car and pro-environmental travel behaviour are computed based on the component matrix of factor analysis[5] and further applied for composite reliability coefficient. Factor analysis provided the latent relationship between the variables for aggregation and composite reliability measured the internal consistency of the attribute when combined as the total of true score variance and unlike Cronbach's alpha, it does not hypothesize unidimensionality of the attribute. The attitude toward car use is computed with four indicators (Table 4.4) measured on seven points Likert scale (strongly disagree - strongly agree) ensued composite reliability (variance score = 0.742) ensuring an effective internal structure of the computed variable. Similarly, attitude for public transport mode and NMT is computed from the indicators observed in self-reported survey data. The 'intentions' variable is computed with self-reported indicators of an intention to reduce car use and instead use more NMT (cycle and walk) mode and PT from next year.

	λ	λ²	ε
Convenience	.719	0.51664926	0.48335074
Efficient	.673	0.45346860	0.54653140
Affordibility	.553	0.30606827	0.69393173
Car use, a cause of climate change	.635	0.40342917	0.59657083
	2.581	1.680	2.320

N	4
Average variances extracted	0.420
Composite reliability	0.742

Table 4. 4: Composite reliability for computed variable of Attitude towards car use.

Perceived behaviour control refers to an ability or a convenience to perform a behaviour. The inconvenience of PBC can be either objective or subjective and personal constraints. The objective PBC is the physical constraints such as infrastructure and availability of PT services.

[5] Factor analysis is applied to explore the loading of indicators to confirm errorless correlation amongst the underlying observed variable.

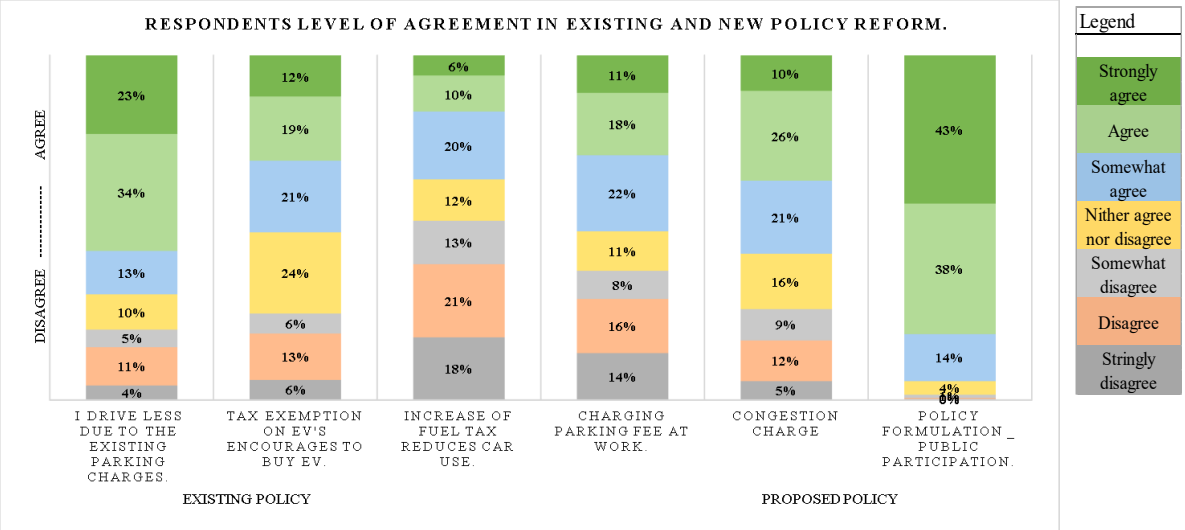
Personal constraints of PBC are the situational determinants and socio-economic factors of the independent variable. The subjective PBC is depicted by the social norm, expectation and, cultural values, which are computed in the binary logistic regression of the social norm in the inferential section.

The pro-environmental travel behaviour is a construct or a computed variable of indicators related to the perception on environmental concern, the effect of the transport sector on environment and the attitude towards changing the way of personal life to reduce carbon emission and car use. The composite reliability variance score of pro-environmental travel behaviour variable is 0.784, which means that the variable indicates more than 50% of a common variance within the computed item. The pro-environmental travel behaviour has a significant correlation coefficient with car reduction intention.

The negative correlation (sig. $p < .05$) of education level and intention infers that the higher educated individual tends to have less intention of reducing car use. Respondents who often walk have a higher intention to reduce car use and positive attitude towards different mode use rather than only the use of personal car. All the policy change measures have significant p-value ($p < .001$) correlation with the intention. The pro-environmental travel behaviour and attitude have a significant correlation with the vehicle ownership pattern, inferring that persons who do not own any vehicle have higher pro-environmental behaviour and car owners have a higher attitude towards the use of car hence lower pro-environmental behaviour. The correlation matrix as well indicates that female tend to have higher pro-environmental travel behaviour as compared to men, however, the difference is not strapping when tested for Chi-square significance ($p > .05$).

4.4.6. Policy determinants

As inferred from the literature review, policy plays a major role in building perception and attitude, instigating intention towards certain regulation based on its push or pull characteristics. Policy reforms or new policy measures and its effectiveness can be measured through the extent of acceptability that the public express via opinion and attitude towards the measure (Bamberg, Fujii, et al., 2011). The influence of policy measures towards mode choice behaviour was measured based on the self-reported agreement on a statement on 7 points Likert scale. Firstly, we solicited the attitude and intention shaped by the existing policy, then we assessed the acceptance of the support towards new policy reforms for car reduction and finally, we framed a carbon trading scheme by creating a scenario of providing personal carbon budget to trade-off with NMT mode.



Graph 4. 1: Existing policy and push policy acceptance level

Graph 4.1 exhibits, the agreement of change in intention to drive less due to the existing parking charges in Thimphu core area. On the contrary, the new reforms to charge parking fee at the workplace, congestion charging in the core area during peak hours and increasing fuel tax to reduce car use depicts lesser agreement. As remarked in the literature review, Anabel, Lane, et al,. (2006) asserts that the push policy measures tend to have higher resistance from the general public as compared to the pull policy measures. A similar trend is observed in the study, a pull measures of incentives, subsidy and hard measures of improvising infrastructure depicts immense support regardless of the outcomes (policy support graphically represented attached in annexure 4). For example, a statement on widening the road to decreases traffic congestion and to provide a separate lane for public transport depicted higher acceptance/support although the residents are aware that the city (especially the core area) has limited space for extension/widening of the road. Additionally, over 6% of the respondents opinionated in the open-ended remarks that widening the road is almost impossible (Graph 4.3).

The policy determinants were rotated for Direct Oblimin in factor analysis,[6] checked for Cronbach's alpha and computed to categories of economic change policy, physical change policy and, information and education measures as affirmed from the literature that the policy aspect shapes the behaviour preferences in individual's mode choice. The policy determinants, when computed for correlation with the mode choice, established a significant ($p < .05$) relation and the push measure of economic change policy with a negative coefficient.

The concept of carbon trading has not been reflected in transport and environment policy document of RGoB and it affirms that it has not been established in Bhutan despite being the only carbon-negative country. A follow-up question when asked in an interview with the deputy chief environment officer regarding the plans for introducing carbon trading (CT) system within the country and/or with other countries, it was mentioned that;

"*..I don't think there is a need for wishes and desire to set up a carbon trading system within the country, largely because there is no current legislation affecting individual companies and*

[6] Factor analysis is applied to explore loading of indicators to confirm errorless correlation amongst the underlying observed variable.

institutions to achieve legally binding carbon reduction. For trading with other countries, I sensed a strong desire from NEC and DHPS to start trading carbon offsets generated by hydropower plants in Bhutan" (Dorji, Tshewang. e-mail. 7 August. 2019).

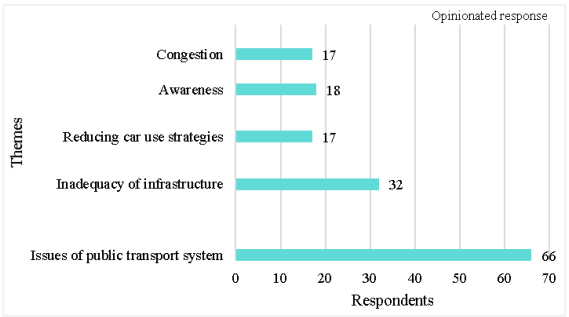
To comprehend if the electric cars and preference for NMT mode could be popularized with the concept of carbon trading scheme, a brief descriptive scenario was created where carbon budget was provided to every individual and if one travel less or travels with low carbon emission he/she could trade their carbon budget. Annexure 4, graph exhibits that more than 80% of the respondents would 'probably' to 'definitely' change their preference of electric car and would use NMT mode over cars given the carbon trading scenario measured on 5 points Likert scale. The two indicators of CT scheme is computed to CT economy change policy which exhibited a Cronbach's alpha of (0.789) for internal reliability coefficient.

4.4.7. Opinionated response

Respondents were asked (optional) to raise their opinion relevant to the study/survey and relative to current transport and environmental issues and suggestions at the end of the questionnaire. The relevant opinion and suggestions were filtered and resulted in 113 respondents. The response was classified and coded to 20 sub-theme (n = 106, opinion = 166) and further categorized into five main themes of; 1) issues of PT system, 2) poor infrastructure for NMT, 3) strategies of reducing car use, 4) need for awareness and 5) the congestion issues as exhibited in graph 4.2. A sample of opinionate responses and the thematic compilation is attached in annexure 6.

Theme	Sub-theme
Issues of public transport system	1) Increase bus frequency; 2) Increase public transport route; 3) Need proper bus stops; 4) Improper timing, safety and cleaniness 5) E-service; 6) Fossil fuel to gas or electric buses
Inadequacy of infrastructure	1) Lack of proper infrastructure for pedestrian and cycle 2) Drainage issues; 3) Road widening is not feasible 4) Need more Sky walks and underpass for pedestrian
Reducing car use strategies	1) Toll; 2) Buses for employee staffs and schools 3) Quota for EV and 2 wheeler; 4) Need metro service
Awareness	1) Health benefit form cycling 2) Bus schedule and timing; 3) Use of electricc car
Congestion	1) Improved traffic management system 2) Initiation of traffic signals; 3) Parking spaces

Figure 4. 1: Opinionated remarks theme and sub-theme.



Graph 4. 2: Opinionated remarks response rate.

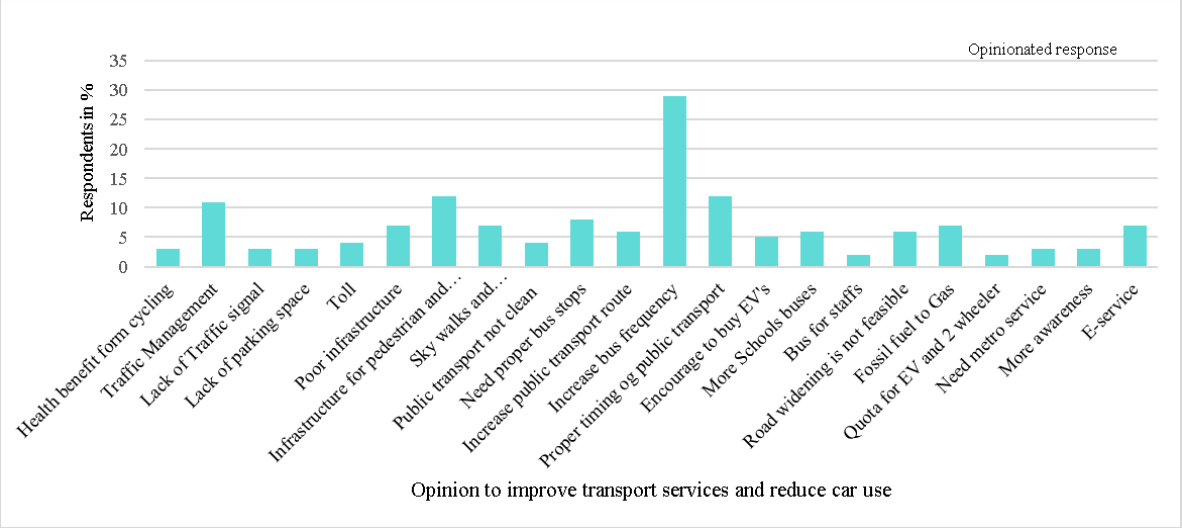
Almost 30% of the respondents emphasized a need for increasing the frequency of bus schedule and incorporating more number of buses on the road with proper timing and schedule. The opinion highlighted the need to introduce a smart card system and increase bus route as the traveller has to change another transport mode such as a taxi to reach the destination. The interview with the expertise from Bhutan post mentioned that;

"We have created a new route system and proposed for more buses to the Royal Government of Bhutan. Starting next year, we will have an adequate number of buses to solve the reliability issue which will increase the number of riders"

"we upload routes in the system on the bus and it automatically gets displayed on the route boards. We have CCTV on the buses. We are installing smart card system very soon. We will

be able to track the buses in future and find out the speed limit & fuel consumption from the office" (Penjor. e-mail. 16 July. 2019).

Regarding traffic congestion, 15% of the respondent reported the lack of proper traffic management system such as; no traffic signal as a main cause of congestion. The suggestions led to either installing traffic signals or constructing skywalks or underpass for the pedestrian in Thimphu core area and the express highway. Approximately 20% of the respondents stressed on the poor condition of NMT infrastructure (pedestrian footpath and cycling lane). In the interview of the expertise from MoIC, the Dy. Chief planning officer stated that the plans for improving NMT infrastructure are on the priority list for the current and next fiscal year. Other relevant opinion encompassed the need for public awareness, the introduction of e-service for public transport, introducing toll, buses for employee and vehicle quota system for low carbon emission modes (Graph 4.3).



Graph 4. 3: Sub-theme opinionated

4.5. Inferential analysis

The inferential analysis is aimed at establishing a systematic relation of the independent variable (IV) on the dependent variable (DV), IV on mediating variable (MV) and then to DV to ascertain a causal path and it's effect size. Although we have explored some of the inferential analysis (composite and factor analysis, chi-square test) in the earlier section, here we focus on regression to test the significant effect that forms a causal path or linearity of the relationship. First, we explore the regression of the dichotomous dependent variable of social norm and factors influencing social expectation to different mode choice. Following, we analyse the direct relation of IV and mediating variable on DV in separate cases. Finally, the psychological factors as an intervening variable mediating the effect of IV on DV (mode choice) and the effects are tested to answer the research question and sub-questions.

4.5.1 Binary logistic regression for social perception

Binary logistics regression method is applied to assess the (dis)approved dichotomized response variables to predict the effect of social expectation on the mode choice through self-reported social perception observed based on dichotomous stance (e.g., 0/1; yes/no) if the respondent's friends, family/relatives would expect for them to use car, bus or NTM. Binary logistics regression is similar to multiple regression for dichotomized variables as the R^2 can be interpreted with *Cox & Snell* R^2, and *Nagelkerke* R^2 but it does not require the assumption to meet normal distribution of the data. Besides, it can add all types of independent variables and conveys the goodness of fit significance (Wuensch, 2014).

Logistic regression was performed to ascertain the effects of attitude towards car use, socio-demographic and situational constraint factors on social pressure to drive a personal car. The logistic regression model was statically significant with $p < 0.01$, Chi-square of the model = 50 and *Nagelkerke R Square* = 26% of the variance in social perception to drive a personal car and correctly classified 82% of the model. The odds (χ) of feeling a social pressure to drive personal car decreases 0.957 times with a year increase in age but increases 1.178 times with a kilometre increase in residence distance from the workplace and further increases 3.2 times when their friends and/or relatives themselves often use a car ($p < 0.05$). Respondents, who have a higher positive attitude towards the use of a car, think that their friends and relatives want them to drive a personal car by 1.243 times as compared to those who have a lower attitude towards car use ($p < 0.01$). Female respondents are perceived to feel the social pressure to drive personal car 0.537 time greater than man at $p = 0.5$.

Binary logistic regression on social perception to use public transport as the dependent variable was performed to ascertain the effects of socio-demographic, situational constraint factors and attitude towards the use of public transport. The logistic regression model was statically significant with $p < 0.01$, Chi-square of the model = 76. The model explained 32.8% (Nagelkerke R^2) of the variance in social perception to use public transport and correctly classified 70.8% of the model. The desire of the respondent's family and friends increases 1.153 times with a unit increase in the distance of residence from the workplace. Female respondents are perceived to feel the social desire to use public transport 0.4 time greater than man at $p = 0.05$. The odds of feeling social pressure to use public transport increases with the 7.4 times when the family and friends use the bus and increased 4.3 times when the respondent's family and friends often walk at p-value ($p < 0.05$).

A verification test on gender to the social norm of family and friend's expectation to drive a personal car and use public transport to commute to work was cross-tabulated and it was observed that the female participant's response to 'yes' was largely higher than male respondents and compliments the result reported with logistic regression.

The odds of social perception or desire for the respondent to walk often significantly decreases 0.904 times an increase in a kilometre distance between the residence to work-place. The feeling of social expectation increases 1.158 times with a unit increase in respondents positive attitude towards NMT mode. Respondents who own both car and bike (cycle/motorbike) perceive that their friends and family would want them to bike 1.026 ($p < 0.05$) times greater than those respondents who does not own bike.

The binary logistic regression computed for personal capabilities and situational constraints on social expectation (norm) and to mode choice as analysed is illustrated in figure 4.2 with effect size consequently.

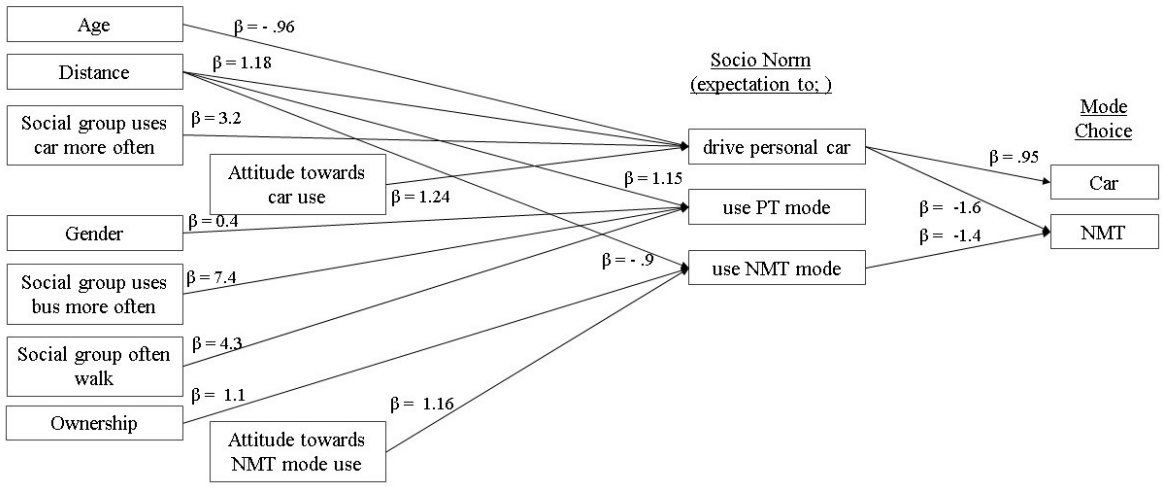


Figure 4. 2: Binary logistic odd ratio for social norm (β = effect size)

A part of first sub-question of the research is answered here as demonstrated in figure 4.2, the effect size of personal capabilities (age, gender, ownership) and situational constraints (distance) on the social norm and to mode choice. Further, the logistic regression was assessed to compute the influence of psychological factor on the social norm and it was observed that attitude factors (attitude towards car use and NMT use) and frequency of social group's mode choice have a significant effect on the social norm. The social expectation to drive personal car influences the choice of car and negatively influence NMT mode choice.

4.5.2. Multiple linear regression

Socio-demographic, socio-economic and situational constraint factors.

A multiple regression analysis was performed to predict the frequency of car, PT and NMT users based on the indicators of socio-demography, socio-economy and situational constraint factors (Table 4.5). The model met the assumption of regression such as the absence of multi co-linearity and no residual value greater than three or outliers beyond three standard deviations and Cooks distance < 1. A significant regression equation was found F (11, 310) = 15.9, $p <$ .001 with 36% (R^2) of variance explained for frequent mode choice (walk, cycle, bus, taxi, motorbike, car). As per the regression model, the predictor variables for frequent mode choice are the respondent's age, monthly travel expenditure, walking duration of the bus stop from residence and car ownership (non-ownership). However, the effects are negative since frequent mode choice is predominantly car use (80% of the respondents). Consequently, a stepwise regression for the NMT users and PT users was calculated with the same IV where the analysis result explained 45% of the variance with the model equation of F (3, 317) = 86.05, $p <$ .001. The stepwise model verified three predictors of PT and NMT users with positive effect (β); age (β= .14, p = .001), residence distance (β= –.09, p = .02), and non-ownership of a car (β= .67, p < .001). The mode choice of PT and NMT users increased with an increase in age and decreases as the residence distance increases.

Coefficients[a]						
		Unstandardized Coefficients		Standardized Coefficients		
Model		B	Std. Error	Beta	t	Sig.
1	(Constant)	7.485	.544		13.770	.000
	Gender	-.114	.093	-.059	-1.231	.219
	Marital status	.005	.113	.002	.046	.963
	Age	-.019	.007	-.168	-2.714	.007
	Household members	-.015	.021	-.032	-.695	.488
	Monthly travel expenditure	.005	.002	.139	2.678	.008
	Monthly Income	.000	.000	.025	.425	.671
	Distance from residence to workplace in km's.	.013	.013	.044	.932	.352
	Walking duration from residence to bus stop (minutes).	-.013	.004	-.180	-3.294	.001
	Walking duration from work place to bus stop (minutes)	.006	.004	.089	1.625	.105
	Vehicle ownership	-.284	.123	-.306	-2.308	.022
	Doesn't own car	-2.381	.384	-.822	-6.197	.000

a. Dependent Variable: Most frequent mode to commute to work

Table 4. 5: Regression result of socio-demographic, economic, situational factors to mode choice.

Thus, the answer to the first research question in addition to the social normative factors, the socio-demographic factors of age, travel expenditure, walking distance of the bus stop and if one (not)owns a car influence respondents mode choice particularly the choice of car and/or NMT.

Policy determinants influencing mode choice and psychological factors.

An answer to the second sub-question, policy factor influencing psychological behaviour and mode choice is assessed in this section. A multiple regression analysis performed for the policy determinants influencing mode choice explains a low variance ($R^2 < 1$) and the model is insignificant at p-value > 0.05 to explain any effect of policy on the mode choice. None the less, the policy determinants are highly influential on the psychological factors.

A hierarchical multiple linear regression was conducted to confirm the variables that predict the intention of reducing car use. The independent variables here are the policy determinants, attitude towards different mode use, personal norm and pro-environmental travel behaviour.

The stepwise method regression model meets the regression assumptions and explains 88% of the variance in intention from the attitude and policy determinants. The model significantly predicted the outcome $F(5, 316) = 470.044$, $p < .001$. The model had no multi co-linearity and no cases of having a residual value greater than three or outliers beyond three standard deviations with Cooks distance < 1, however, Durbin-Watson value of 2.002 implies medium-strength correlation of the model. Out of 10 variables, the model entered five predictive variables;

1. attitude towards the use of NTM,
2. attitude towards the use of PT mode,
3. policy measures on information and education,
4. economic change policy, and

5. infrastructure change policy.

Table 4.6 exhibits the effect of variables on intention. Participant's intention to reduce car use increased .649 units for a unit increase in attitude towards the use of NMT, but the intention decreased .167 units with a unit increase of push policy change in fee and charges (introducing congestion charge and parking fee at the workplace). The intention to reduce car use increased .237 units with a unit increase in information and educational policy change of a pull policy measure. The intention would as well increase .225 units with a unit increase in enhancing the infrastructure for NMT and PT mode. The attitude towards using public transport mode has the minimum causal effect on the intention to reduce car use however all the five variables were significant predictors of the intention.

Coefficients[a]						
		Unstandardized Coefficients		Standardized Coefficients			Correlations
Model		B	Std. Error	Beta	t	Sig.	Part
5	(Constant)	-.097	.128		-.756	.450	
	Attitude towards the use of NMT mode.	.649	.032	.663	19.990	.000	.387
	Information and education policy measures_E-services for PT mode.	.237	.018	.340	13.205	.000	.256
	Economu change policy : Fee and charges.	-.167	.013	-.349	-12.510	.000	-.242
	Infrastructure change.	.225	.029	.260	7.851	.000	.152
	Attitude towards Public transport use.	.092	.031	.086	3.002	.003	.058

a. Dependent Variable: Intention to use less car

Table 4. 6: Predictors of intention to use less car

Inferential influence of psychological factor on the choice of mode

A direct influence of psychological factor (intention, moral norm, attitude towards car use, PT, NMT mode and pro-environmental travel behaviour) on the choice of mode is rather explained by minor variance of 10% (R^2) when computed for a stepwise regression method. The model significantly predicted the outcome F (3, 316) = 9.22, $p < .001$. Since the most frequent mode choice is predominantly car use, the regression coefficient interprets that the mode choice is influenced by the positive attitude towards car use and intention to reduce car negatively influence the mode choice. We further assess the influence of psychological factor on NMT mode choice and taxi users, however, the model variance is distinctively low ($R^2 = .04$) and therefore smaller effect. The model predicted an outcome F (2, 316) = 6.33, $p = .001$.

	Unstandardized Coefficients		Standardized Coefficients		
	B	**Std. Error**	**Beta**	**t**	**Sig.**
Attitude towards PT use.	-.066	.029	-.135	-2.243	.026
Attitude towards car use.	.178	.056	.173	3.158	.002
Intention to reduce car use	-.073	.036	-.114	-1.991	.047

a. Dependent Variable: Most frequent mode to commute to work

Proenvironmental travel Behaviour	.041	.014	.167	2.978	.003
Intention to reduce car use	.046	.012	.208	3.787	.000

a. Dependent Variable: NMT mode users and taxi users

Table 4. 7: Influence of psychological factor on the choice of mode

Inferential influence of IV on the psychological construct

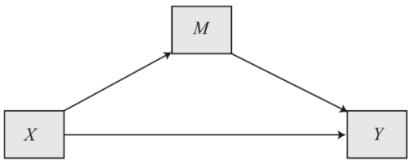
Hierarchical stepwise multiple linear regression was conducted to confirm the variables that influence the psychological construct in the formation of attitude towards different mode choice, intention, moral norm and pro-environmental behaviour. The independent variable (socio-demography, socio-economy, situational constraints and policy determinants) which has a significant influence on the psychological construct was verified with the stepwise regression method and the effect size (Beta), model variance (R^2) and significance are depicted in table 4.8. Vehicle ownership and economic change policy have a consistent influence on the construct of psychological attributes. Age and gender influence the intention and pro-environmental travel behaviour but does not contribute to the formation of attitude. Longer the distance of bus stop higher is the attitude towards car use, similarly, the physical change policy measures which link to infrastructure measure positively influences the attitude construct. These variables which have a significant predicting coefficient to the dependent variable (mode choice) and the mediating variable will be assessed for indirect effect in the following section.

Mediating variable as Dependent variable			Unstandardized Coefficients		Standardized Coefficients			
			B	Std. Error	Beta	t	Sig.	R^2
	Intention to reduce car (use more NTM in future)	Car ownership	-.235	.070	-.170	-3.366	.001	.230
		Age	.023	.011	.137	2.021	.044	
		Gender	-.322	.145	-.113	-2.225	.027	
		Information and education measures	.153	.075	.106	2.047	.042	
		Economic policy measures	.308	.075	.228	4.117	.000	
		Infrastructure Change						
	Attitude to car use	Economic chage policy (Fee and charges)	.244	.025	.485	9.943	.000	.250
		Walking duration from work place to bus stop (minutes)	.008	.003	.141	2.901	.004	
		Car owners						
	Attitude towards PT use	Vehicle ownership	-.099	.030	-.130	-3.283	.001	0.52
		Physical chage policy (infrastructure)	.192	.037	.239	5.165	.000	
		Economic change policy (Carbon trading)	.105	.032	.140	3.292	.001	
		Infrormation and education measures	.085	.033	.107	2.571	.011	
	Attitude towards NMT use	Carbon trading scheme	.179	.031	.216	5.838	.000	0.64
		Physical chage policy (infrastructure)	.468	.041	.522	11.498	.000	
		Economic change policy ((Fee and charges)	.113	.023	.226	4.994	.000	
	Pro-environmental travel behaviour	Gender	-.203	.090	-.111	-2.264	.024	.260
		None car owners	.328	.136	.119	2.423	.016	
		Physical chage policy (infrastructure)	.219	.050	.235	4.389	.000	
		Information education measures (public advocacy)	.136	.047	.146	2.895	.004	
		Economic change policy (Carbon trading)	.244	.045	.282	5.385	.000	

Table 4. 8: Linear regression for the influence of IV on MV (Hayes, 2017)

4.5.3. Mediating model test

Mediation analysis establishes the effect of *X* (independent variable) on *Y* (dependent variable) in a model with intervening variable *M* (mediating variable) causally located in between *X* and *Y* where *M* influences *X* in predicting *Y* as depicted in figure 4.3. A significant mediating effect describes psychological process that occurs to create the relationship within the dynamic properties of an individual (personal characteristics, emotions, belief). Here we examine the process modelling mechanism to test the hypothesis that *X* carries the influence of *M* and effects *Y* and we would assert how and when the relation holds for stronger or weaker effect. If the indirect effect of X on Y through M is contingent then linking X to Y can be said to be conditional (Hayes, 2017).



Source: (Hayes, 2017).

Figure 4. 3: Mediation model with single mediator variable *M* causally located between *X* and *Y*.

Psychological factors perform as a mediating variable in our case and are calculated for its mediating effect on the independent variable in predicting the dependent variable 'mode choice'. We use PROCESS regression in SPSS statistics function designed by Hayes. The PROCESS program is a regression-based path analysis for estimating the direct and indirect effect of *X* on *Y* (Hayes, 2017). Figure 4.4 depicts the causal relation and the effect that would be assessed with the PROCESS Bootstrap analysis.

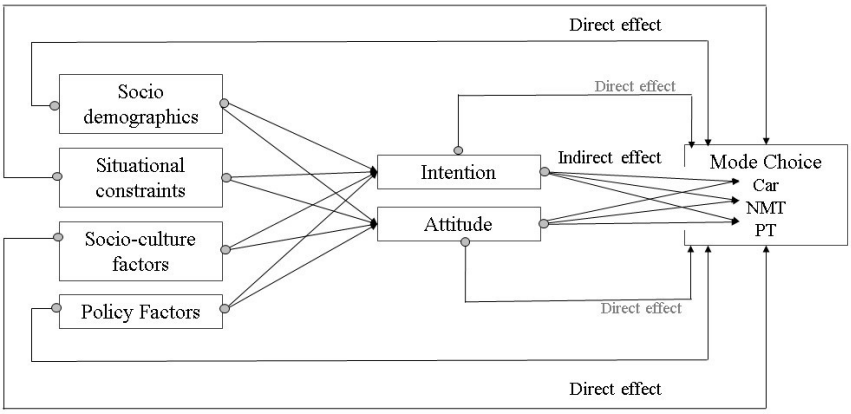


Figure 4. 4: Direct and indirect causal path

The causal step of predicting *Y* from *X* and *M*;

- *X* variable predicts *Y* ($p < .05$).
- *X* variable predicts *M* ($p < .05$).
- *X* and M together predicts *Y*
    - *M* variable predicts *Y*
    - *X* variable no longer predicts *Y* or is lessened predicting *Y*

The first three steps have already been assessed in the linear regression model, so we only analyze the effect size and significance of the mediating variable or the indirect effect. A PROCESS regression is run through to comprehend the effect of mediation in predicting car as a mode choice (*Y*) by the ownership pattern (*X*) along with the attitude (*M*). In the linear regression, we recognized the significant influence of *X* on *Y* (ownership on mode choice) as well as on the attitude construct (*X* on *M*). Equally, *M* has a significant influence on *Y*. The direct and indirect effect of *X* on *Y* together as exhibited in table 4.9, the difference between the Bootstrap confidence interval not crossing zero infers that there is a mediator effect of attitude on car ownership and choosing a car as a frequent mode choice.

```
****************** DIRECT AND INDIRECT EFFECTS OF X ON Y *****************

Direct effect of X on Y
     Effect         se          Z          p       LLCI       ULCI
     4.2900      .5230     8.2019      .0000     3.2648     5.3151

Indirect effect(s) of X on Y:
            Effect     BootSE   BootLLCI   BootULCI
Attitude      .1245      .0901      .0035      .3497
```

Table 4. 9: Indirect effect of *X* on *Y*, PROCESS regression, Bootstrap analysis

The significant predictor variables for mode choice and mediating variable (psychological factor) from the linear regression is computed for the indirect effect with mediation. A summary of the bootstrap analysis is exhibited in annexure 5. We infer that the socio-demographic factors (age, distance, walking duration to the nearest bus stop and travel expenditure) do not have the effect of mediating variable on predicting mode choice. However, owning a car or not influences the attitude construct but not the intention hence the effect of mediation is non-significant.

The policy factors that influence the attitude towards different modes better predict mode choice when intervened by psychological factors. The causal relation of attitude forming an intention and then predicting mode choice is strapping and it affirms the TPB as depicted in the literature review. The social norm (expectation) to walk or drive personal car has a positive effect on mode choice when intervened with psychological factor. The pro-environmental travel behaviour as a mediator better predicts the NMT mode choice with the attitude towards NMT. An attitude towards different mode choice (car, PT, walk, taxi) is explained by the frequent mode one uses and since the car users were highest amongst the others, the attitude towards car use has the most effect on mode choice. It is also affirmed that persons who choose NMT mode tend to surpass pro-environmental travel behaviour than whose frequent mode choice is a car.

Chapter 5: Conclusions and recommendations

With the motivation to study the travel behaviour to reduce the car use, CO_2 emission and traffic congestion in the car-dominated capital city of Bhutan along with an aim for sustaining the carbon-negative status, this thesis revolved around the different mode users but predominantly the car users of Thimphu. The focus was on understanding the determinates that construct the habit of car use and the role of policy that affect the car-oriented behaviour of the work commuters. Road transport, although, being the only means of surface transportation in Bhutan, traffic congestion was not a concern until a few years and now it is rising at an alarming rate. Similarly, the concern of carbon emission is projected to move in the same trend, it is not a concern now but in the case of a business as usual, the country will not be able to sustain its carbon-neutral status 30 years down the line. As implied from the open-ended remarks and interviews, there is an equal concern from both riders side well as the transport policy sectors regarding the rise in congestion and other issues in the transport sector. Despite the rising issues, the study on it is very less to none especially on the behaviour; no institutions or government sectors or academia's has carried out any travel behaviour study or household travel survey on Thimphu residents. Therefore, it was a necessity to carry out both survey and interview as the study embraces the psychological construct of travel behaviour, policy review and policy affecting individual cognition. This two broad theme comprised not only the soft component of psychological construct but also the built environment, personal capabilities and situation constraint that affects the behaviour of work commuters residing in Thimphu.

The study is expected to add value to the existing literature in the field of examining travel behaviour with policy cognitive factors. It is also anticipated that the study can be generalized to the working population of other cities in Bhutan due to the concordant umbrella policy and similar built environment situation. Although the data has been dominated by the car users the analysis has considered other modal option of NMT and PT modal system, thus the policy recommendation directs toward car reduction and improving NMT and PT mode system, consequently tackling the traffic congestion and carbon emission issues.

An activity-based travel data would provide more incidents of a daily trip, capturing sub-trip within a larger trip such as dropping off kids to school and shopping after work hours or on weekends, however, this study is centred on trip-based data, a journey to and from work. The study is also limited in terms of the land use and density pattern of the city, which overlooks the choice of residence and location. Due to the limited duration of the study and survey period, the study focused only on work commuters in Thimphu. Moreover, the online survey respondents were predominantly civil servants as the e-mail address of private sectors was largely inaccessible. The PT users in Thimphu are predominantly school going students and therefore it is least represented in the study, however, the open-ended remarks had exhaustive remarks on the PT issue and why the respondents (working population) do not prefer PT. To complement these issues and policy review, interviews were conducted with an intensive inquiry on the PT system.

5.1. Discussion of the findings and results.

While the study focused on a quantitative data collection to analyze the attributes that construct individual mode choice behaviour, which was predominantly the car users so the inferential analysis as well revolved around the car users and NMT mode users (walkers) as it was the second-highest among the respondents. Nonetheless, the triangulation method of open-ended response and the interview of expertise were predominantly on the issues of the PT services and enhancement of the NMT system. Consequently, here in the discussion and recommendation, we amalgamate the analysis gathered through different methods for a rational conclusion.

The socio-demographic analysis inferred no statistical difference in gender and age in car ownership and car use, however, the mode choice of NMT (walking) is more preferred by the elder population in the sample. Individual income motivates car purchase and ownership pattern successively have a greater effect on mode choice. In addition, there is a significant difference in expenditure when one drives a car as it has a statistical causal relation to the mode choice. On the contrary, the sample did not have any respondents owning an electric vehicle, even though Bhutan has cheaper hydropower electric supply and tax exemption on the purchase of EV. In the open-ended response, several suggested on introducing a vehicle quota system for EV's and two-wheelers to popularize the low emission vehicles and to neutralize the pressure on congestion and emission.

Regarding the situational constraints, the analysis reveals that the distance criteria are imperative for mode choice and more crucial for those who would want to walk. The choice of walking decreased by 19% with an increase in extra kilometre. Additionally, the distance criteria have a significant influence on social normative factors. Myriad study on NMT and employer travel plan from the literature review asserts that the average distance for regular walking and/or cycling to work is within 3 to 7 km. Besides, the British Medical Association also asserted that the distance of 5 km is most feasible for cycling (Glaister et al., 1998 cited in Dickinson, Kingham, et al., 2003), but in Thimphu regardless of more than 75% of the respondents residing within 5 kilometres or less does not cycles to work. For a small city size (26 sq. km), Thimphu has a high potential of transforming to a vibrant NMT oriented city by enhancing the infrastructure and by providing an incentive to cycle to work. The sample had less than 1% of population cycling and biking (motorcycle) combined as a mode choice, on the contrary, there are almost 3% of population owing bicycle but these cycle owners also owns a car. The city does not have NMT friendly infrastructure and cycling in Bhutan is only trending for mountain biking, besides, several other factors would influence not opting for cycling or motorbiking in Thimphu, which arises a separate entity for an in-depth study.

The answer to the third sub-question is amalgamated from the observation of existing infrastructure as per the TSP, infrastructure-related opinion from the open-ended response and the regression analysis. The concept of TOD as applied in major cities of the U.S. asserted to form an efficient tool in traffic management, congestion reduction and has the advantage of location efficiency. It also emphasizes on the walkability similar to the intelligent urbanism concept of the TSP. Developing transit centres in the less dense zone would decongest the core area, however, the institutions would require to situate around the TOD zones. As observed from the open-ended remarks, the lack of infrastructure for the NMT system impedes the public from walking and cycling. In addition, the lack of traffic signals in the city is comprehended as one of the causes of congestion thereby highlighted the requirement of the pedestrian skywalk

and/or underpass unless the city endures the non-traffic light system. More empirical studies are required to make Thimphu a smart city to adapt to the rapid growth and changing demand.

The distance of bus stop from the residence has a significant influence on mode choice and similarly, a diverse range of problems and solutions on PT were suggested out of which the frequency of bus being very less was a primary issue. Donald, Cooper, et al., (2014) asserts that intention has stronger effect for using PT although the public transport users amongst the respondents were very less, we infer that the intention to use PT is higher amongst the respondents as per the suggestions in open-ended response. However, as per the interview, these issues are not overlooked at and that the PT sectors mentioned several plans that are to be implemented in the coming years, such as; increasing the frequency of buses; initiation of new PT routes and introduction of electric bus rapid transit system through the global climate fund project; E-cards for PT are currently distributed to some students and there are plans to explore more feasible options of using e-cards. The PT users at present are predominantly students, thus a study on students perception on PT system would be relevant for future research particularly for the cities in Bhutan. The employer and/or work organization could explore for bus service that would cater its employees.

The social expectation as suggested from the literature manifests different forms in influencing different mode choices. While the cultural background has a significant correlation with the income and marital status variable, its influence on mode choice or in the ownership pattern was insignificant. When the respondent's social group owns a car or frequently drives a car, he/she feels that they are expected to drive as well and is same in the case of walk or cycle. The age and gender as a causal factor of social expectation interpret that as one grows older they feel more pressure to drive from the society and female respondents feels more social pressure to use PT than male respondents. Social norm mediated by attitude better predicts mode choice than the direct effect as asserted from the mediation analysis. An inference from the interview and opinionated remarks expressed that there exists a social stigma to cycle as a transportation mode and people are not aware of the health benefits of NMT. Thus, social inclusive awareness programs and campaigns at changing the habit of car use and promoting PT and NMT benefits is deemed necessitate for strengthening positive societal norms and behaviour change.

The support for the policy was assessed based on push and pull policy measures. The existing policy assessed its influence on behaviour change and new reforms were suggested to measure the support towards it if it was to be implemented. As learned from the literature, there is a resistance for the push policy measures such as imposing new fee and charges and/or tax reforms. The existing parking charges in the core area certainly encouraged people to drive less in the core area as reflected from the self-reported data, however, when proposed to charge parking fee at the workplace and introducing congestion charging the support towards such reforms tentatively decreased. On the other hand, when a scenario for carbon budget and carbon trading framed with push and pull policy reform together, the acceptance was relatively higher inferring the effectiveness of framing policy measures.

The perception acquired from the self-reported policy acceptance has a substantial influence on the psychological construct, in forming an attitude towards different mode and intention of reducing car use. The attitude, intention and pro-environmental travel behaviour significantly predict mode choice as an independent variable as well as when acted as mediation. The moral norm, however, was not significant in predicting the extent of car use or policy acceptance as

suggested in the literature. Psychological factors as a mediator, better predict mode choice when intervened for the policy determinants and with the attitude variable. The socio-demographic, socio-economic and situational constraint factors predicting potential is superior without the intervening psychological factor. Nonetheless, it has a substantial influence on the psychological construct but not as strapping as social norm and policy perceptions.

5.2. Research recommendations: Transition to sustainable transport in Bhutan

The concept of transition is being explored at least in Europe, a shift of sustainability notion towards a 'sociotechnical' system, which is comprehensively reconfigured by the new consensus sparked by the global crises of carbon emission and climate change. Transition thinking seeks for inclusiveness of a wider range of actors, beyond the conventional actors/decision-makers of public authorities and transport sectors/agencies (Givoni and Banister, 2013). The inter-agency coordination, as was highlighted a major challenge in the interview with the officials from transport sectors but the coordination would need to extend beyond the agencies and also with the market, manufacturer and suppliers, designers, insurance companies, media, research institutions, NGO's, and the consumers. Policy formulation would require moving from a top-down, technocratic and driven by technical expertise involving only a few stakeholders towards facilitating and enacting transition, sociotechnical transition, thinking and supporting a genuine transition to sustainable contemporary mobility practice.

A transition in behaviour change is the key answer in achieving various sustainable development goals for which understanding the attributes that drive individual travel behaviour is essential to assimilate within the existing regimes for niche development. Transition management to facilitate and enact transition in practice from the past transition in transport to strategic niche management in mobility are yet fairly limited. Transition research to stimulate creative thinking in policy intervention would provide potential compelling insights for a systematic shift towards low carbon mobility.

Equally, there has not been found exhaustive experimental research in exploring travel behaviour given the complex situation that needs to be created and contextualized. Furthermore, travel estimates with cost-benefit analysis would better encourage the decision-makers and economy analysists for planning and allocating fiscal budget would instigate immediate implementations.

5.3. Policy guidelines

For a predisposing individual level of receptiveness and support for the policy measures, the policy need to be framed with positive connotation and push policy measures needs to be consolidated with the pull measures as suggested in the literature review. The following summarized recommendation has emerged from the discussion and research findings of the previous chapter.

Recommendations:

A comprehensive policy is required for:

- Non-motorized transport system.
- Public transport system.
- Parking policy/regulation.

- National household travel survey needs to be initiated.

Physical change policy;

- Cycling lane and bicycle parking facilities.
- Separate bus lane.
- Traffic signal in the core area.
- Skywalks and underpasses for pedestrian in the express highway.
- Increase bus frequency and bus routes.
- Long-term goal to decongest core area with the concept of TOD.

Economy change policy;

- Energy taxation directives.
- Carbon trading scheme.
- Quota for electric vehicles and two wheelers.
- Free parking for electric vehicles.
- Incentives for cycling to work.

Information and education measures;

- Social advocacy on climate change, health benefits and behaviour shift.
- Awareness on climate change, health benefits and behaviour shift.
- Promotion of non-motorized transport modes.
- Sensitization program in schools.
- Enhancement of E-service system for public transport.
- Bio-fuel directives.

5.4. Conclusion

In search of the answer to the main research question, the study has acknowledged a wide range of travel behavioural of Thimphu's work commuters at a theoretical level and empirically demonstrated a shred of comparable evidence along with some contrast outcome. The complexity of behaviour is inter-linked with many aspects and since the study is based upon several self-reported perceptions, it is a challenge to dispense a single concrete assertation. The self-reported frequency of mode choice is observed based on the habitual pattern established in the process. Distance is a critical factor that does influence mode choice largely for the NMT users however there are car users even at a distance of 1.5 km or less. Despite the high vehicle import tax, 83% of the respondents own a personal car, and the ownership pattern not only influences mode choice but also determines individual pro-environmental behavioural construct. Intention and attitude predict the mode choice while pro-environmental behaviour and intention to reduce car use predicts the use of NMT mode. Further, intention and attitude are considerably influenced by the policy measures as well as ownership pattern and age.

The policy determinants are critical in anticipating the psychological cognition, although the policy attributes do not influence the mode choice directly but only when mediated by the psychological cognition. For instance, a parking policy manoeuvres an individual intention to drive less or not to park in the core area to avoid fee thus reducing the congestion and car use. Similarly, the normative factors predict the mode choice better when intervened by the psychological cognition. PT as mode choice is not popular amongst the working population of

Thimphu as the respondents who do not own a car chose to use para-transit instead. As reported, the low popularity of PT among employee is majorly due to the inadequacy of the buses, improper timing and lack of e-services causing inconvenience of the schedule and these interventions are deemed possible to intervene promptly.

Bhutan, the unexplored, underdeveloped Himalayan nation has an ample of opportunity not only to assimilate motives from the intellectuals but also to illuminate the rest concerning climate change and global greenhouse gas emission. More importantly, it is the Bhutanese society that needs to realize the global impact of carbon footprints and to sustain its carbon-neutral status since there were no remarks concerning their emission in open-ended response. Nonetheless, given the small size of the population, it is possible to reach everyone with the sociotechnical innovations and social advocacy on a lifestyle change and/or promoting a change in travel behaviour for reducing car use, carbon emission and environmental impact as a whole. It is the hope of the author that the travel behaviour analysis of this study provided a sherd of understanding that influences the mode choice of the residents in Thimphu and to sustain for the carbon-neutral status, both the government and public would require to shift the direction at the same pace.

Bibliography/References

ADB, 2013. Bhutan transport 2040 Integrated strategic vision, Asian Development Bank (ADB). *Strategic Document. [Online].,* Available at: https://www.adb.org/sites/default/files/publication/30268/bhutan-transport-2040.pdf .

ADB, 2017. Proposal for institutional change and operational improvements related to bus service in Thimphu, Bhutan. *Strategic Document. [Online].,* Available at: https://www.undp.org/content/dam/bhutan/ITS%20Report.pdf .

Ajzen, I., 1991. The theory of planned behavior. *Organizational Behavior and Human Decision Processes,* 50 (2), pp. 179-211.

Ajzen, I. and Fishbein, M. 2005. The influence of attitudes on behavior. *The Handbook of Attitudes,* 173 (221), pp. 31.

Alreck, P. L. and Settle, R. B., 2004. The survey research handbook. Third Edition. McGraw-Hill.

Anable, J., Lane, B. and Kelay, T., 2006. An evidence base review of public attitudes to climate change and transport behaviour. The Department.

Anderson, M. K., ed., 2010. Characteristics of trips and travellers in private and public transportation in the Danish travel survey data, [Selected Proceedings from the Annual Transport Conference at Aalborg University]. Aalborg Universitet. Trafikforskningsgruppen. pp. 16.

Bamberg, S., Fujii, S., Friman, M. and Gärling, T. 2011. Behaviour theory and soft transport policy measures. *Transport Policy,* 18 (1), pp. 228-235.

Banister, D., Anderton, K., Bonilla, D., Givoni, M., et al., 2011. Transportation and the environment, Annual review of environmnet and resources. *Environment,* Available at: https://www.annualreviews.org/doi/pdf/10.1146/annurev-environ-032310-112100 .

Center for Bhutan Studies, 2017. List of Articiles Published in Journal of Bhutan Studies. Vol 1 No1 to Vol 36 (1999-2017). [online] Available at: http://www.bhutanstudies.org.bt/publicationFiles/JBS/JBS%20Vol%2036/05%20JBS%20Articles%20from%201999-2017.pdf .

Chorus, C. G., Arentze, T. A. and Timmermans, H. J. 2008. A random regret-minimization model of travel choice. *Transportation Research Part B: Methodological,* 42 (1), pp. 1-18.

Cialdini, R. and Trost, M. 2004. Social norms, conformity, and compliance. *The Handbook of Social Psychology,* pp. 151.

Department of Renewable Energy, 2015a. Bhutan Energy Data Directory. *Ministry of Economic Affairs. Royal Government of Bhutan,* Available at:

https://www.moea.gov.bt/wp-content/uploads/2018/07/Bhutan-Energy-Data-Directory-2015.pdf .

Department of Renewable Energy, 2015b. Energy Efficiency in Transport Sector. *Ministry of Economic Affairs, Royal Government of Bhutan,* Available at: https://www.moea.gov.bt/wp-content/uploads/2018/07/Final-Transport-EE-report.pdf .

Department of Revenue & Customs, 2010. Revised Rules & Regulations on Fiscal Incentives 2010, Ministry of Finance, Royal Government of Bhutan. *Policy,* Available at: https://www.mof.gov.bt/wp-content/uploads/2014/07/Rules_FI2010.pdf .

Dickinson, J. E., Kingham, S., Copsey, S. and Hougie, D. J. P. 2003. Employer travel plans, cycling and gender: will travel plan measures improve the outlook for cycling to work in the UK? *Transportation Research Part D: Transport and Environment,* 8 (1), pp. 53-67.

Dijst, M., Farag, S. and Schwanen, T. 2008. A comparative study of attitude theory and other theoretical models for understanding travel behaviour. *Environment and Planning A,* 40 (4), pp. 831-847. Available at: https://www.scopus.com/inward/record.uri?eid=2-s2.0-43349105376&doi=10.1068%2fa39151&partnerID=40&md5=a5ee8a847899917cc523eebf210fb4d8 [Accessed 6 April 2019].

Dittmar, H. and Ohland, G., 2012. The new transit town: best practices in transit-oriented development. Island Press.

Donald, I. J., Cooper, S. R. and Conchie, S. M. 2014. An extended theory of planned behaviour model of the psychological factors affecting commuters' transport mode use. *Journal of Environmental Psychology,* 40 pp. 39-48.

Eriksson, L., 2008. *Pro-Environmental Travel Behavior: The Importance of Attitudinal Factors, Habits, and Transport Policy Measures,* .

Fraser, N. and Bhattacharya, A., 2001. Geography of a Himalayan kingdom: Bhutan. Concept Publishing Company.

Geels, F. W., 2012. A socio-technical analysis of low-carbon transitions: introducing the multi-level perspective into transport studies. *Journal of Transport Geography,* 24 pp. 471-482.

Gelman, A. and Cortina, J., 2009. A quantitative tour of the social sciences. Cambridge University Press.

Givoni, M. and Banister, D. 2013. Moving towards low carbon mobility. *Social and Political Science,* Available at: https://books.google.nl/books?hl=en&lr=&id=MgWcOd3ZrPAC&oi=fnd&pg=PR1&dq=moving+towards+low+carbon+mobility&ots=P5MGwbzUbF&sig=LwzrO6l-RoUVjtV8eabEYG2gKCU#v=onepage&q=moving%20towards%20low%20carbon%20mobility&f=false .

GPP, 2019. *Global petrol prices.* [Online]. Available at: https://www.globalpetrolprices.com/gasoline_prices/ [Accessed 2019].

Guell, C., Panter, J., Jones, N. and Ogilvie, D. 2012. Towards a differentiated understanding of active travel behaviour: using social theory to explore everyday commuting. *Social Science & Medicine,* 75 (1), pp. 233-239.

Hayes, A. F., 2017. Introduction to mediation, moderation, and conditional process analysis: A regression-based approach. Guilford Publications.

IEA, 2016. CO2 emission from fuel combustion - highlights, Paris. *International Energy Agency,* Available at: https://emis.vito.be/sites/emis.vito.be/files/articles/3331/2016/CO2EmissionsfromFuelCombustion_Highlights_2016.pdf [Accessed 12/03/2019].

IPCC, 2011. IPCC special report on renewable energy sources and climate change mitigation.

Jaffe, E., 2013. *Why people choose cars, even when mass transit would serve them better.* Feb. 1. Available at: https://www.citylab.com/transportation/2013/02/why-people-chose-cars-even-when-metro-would-be-faster/4566/ [Accessed 2019].

Jing, P., Zhao, M., He, M. and Chen, L. 2018. Travel mode and travel route choice behavior based on random regret minimization: A systematic review. *Sustainability,* 10 (4), pp. 1185.

KFH Group, 2013. Transit capacity and quality of service manual.

Khamrang, L., 2018. Changing Socio-Spatial Structures and Growing Urban Issues in the Quest of Making Thimphu a Dream City. *Rig Tshoel,* pp. 99.

Klöckner, C. A. and Blöbaum, A. 2010. A comprehensive action determination model: Toward a broader understanding of ecological behaviour using the example of travel mode choice. *Journal of Environmental Psychology,* 30 (4), pp. 574-586.

Klöckner, C. A. and Blöbaum, A. 2010. A comprehensive action determination model: Toward a broader understanding of ecological behaviour using the example of travel mode choice. *Journal of Environmental Psychology,* 30 (4), pp. 574-586. Available at: https://www.scopus.com/inward/record.uri?eid=2-s2.0-78149284350&doi=10.1016%2fj.jenvp.2010.03.001&partnerID=40&md5=e43d2bd4329f012a7a72a5316d2b3bdd [Accessed 2 June 2019].

Kuensel, 2010. Road conjestion in Thimphu*. National newspaper*. Available at: http://bhuyangs.blogspot.com/2010/12/road-congestion-in-thimphu-city.html [Accessed 2019].

Kuensel, 2015. The World Bank is funding the upgrade of 77 more bus stops in the city, *National newspaper.* Kuensel. Available at: http://www.kuenselonline.com/first-modern-bus-stop-opened/ [Accessed 20/7/2019].

Kuensel, 2019. Taxis register for electric vehicles . National Newspaper, Kuensel. Available at: http://www.kuenselonline.com/26-taxis-register-for-electric-vehicles/ [Accessed 2/6/2019].

Lachapelle, E., Montpetit, É and Gauvin, J. 2014. Public perceptions of expert credibility on policy issues: The role of expert framing and political worldviews. *Policy Studies Journal,* 42 (4), pp. 674-697.

Lanken, B., Aarts, H., Van Knippenberg, A. and van Knippenberg, C. 1994. Attitude Versus General Habit: Antecedents of Travel Mode Choice 1. *Journal of Applied Social Psychology,* 24 (4), pp. 285-300.

Lefèvre, B., 2009. Urban Transport Energy Consumption: Determinants and Strategies for its Reduction.. An analysis of the literature. *SAPI EN.S.Surveys and Perspectives Integrating Environment and Society,* (2.3), .

Malinowski, B., 1936. Culture as a Determinant of Behavior. *The Scientific Monthly,* 43 (5), pp. 440-449.

Mattauch, L., Ridgway, M. and Creutzig, F. 2016. Happy or liberal? Making sense of behavior in transport policy design. *Transportation Research Part D: Transport and Environment,* 45 pp. 64-83.

Ministry of Economic Affairs, 2018. Detailed Feasibility Study on Industrial Linkages and Cluster. *Royal Government of Bhutan,* Available at: https://www.moea.gov.bt/wp-content/uploads/2017/10/Final-Report-Complete.pdf .

Ministry of Information and Communications, 2015. Intelligent Transport Systems (ITS) Feasibility Study and Preparation of a Comprehensive ITS action plan for Thimphu City. *Royal Government of Bhutan,* Available at: https://www.undp.org/content/dam/bhutan/ITS%20Report.pdf .

Ministry of Information and Communications, 2017a. Annual Info-Comm and Transport Statistical Bulletin, RGoB. *Policy and Planning,* 8th edition Available at: https://www.moic.gov.bt/wp-content/uploads/2017/08/Final-Info-Comm-and-Transport-Statistical-Bulletin-1.pdf .

Ministry of Information and Communications, 2017b. National Transport Policy 2017 (final draft). RGoB. *Policy Protocol Report,* Available at: https://www.moic.gov.bt/wp-content/uploads/2017/08/Draft-Final-PPR.pdf .

Ministry of Transport, Public Works and Water Management, 1990. Road Traffic Signs and Regulations in the Netherlands. Available at: https://www.rijschooldenk.nl/uk_road-traffic-signs-and-regulations-in-the-netherlands-rijschoolDenK.pdf .

Ministry of Works and Human Settlement ed., 2004. Thimphu Structure Plan. Revision-1. Thimphu: Ministry of Works and Human Settlement.

Ministry of Works and Human Settlement Royal Government of Bhutan, 2008. Thimphu city development strategy. RGoB. *Strategic Document,* Available at: https://web.archive.org/web/20110706162839/http://www.mowhs.gov.bt/downloads/Thimphu_City_Development_Strategy_2008.pdf .

Nakamura, K. and Hayashi, Y. 2013. Strategies and instruments for low-carbon urban transport: An international review on trends and effects. *Transport Policy,* 29 pp. 264-274.

National Environment Commission, 2011. Second National Communication to the UNFCCC. RGoB. *National Report,* Available at: https://unfccc.int/resource/docs/natc/bhunc2.pdf .

National Environment Commission, 2015. Intended Nationally Determined Contribution, NEC, Royal Government of Bhutan. Available at: http://www.nec.gov.bt/nec1/wp-content/uploads/2015/09/Bhutan-INDC-20150930.pdf .

National Environment Commission, 2016. Bhutan State of the Environment Report, RGoB. Available at: http://www.nec.gov.bt/nec1/wp-content/uploads/2016/07/Bhutan-State-of-Environment-Report-2016.pdf [Accessed 16/12/2018].

National Statistics Bureau, 2017. Population & housing census of Bhutan. Available at: http://www.nsb.gov.bt/publication/files/PHCB2017_national.pdf [Accessed 15/12/2018].

National Statistics Bureau, 2019. Population projections Bhutan. Available at: www.nsb.gov.bt .

Nilsson, M. and Küller, R. 2000. Travel behaviour and environmental concern. *Transportation Research Part D: Transport and Environment,* 5 (3), pp. 211-234.

OECD, 2018. Taxing Energy Use 2018, The Netherlands. [Online]. Available at: https://www.oecd.org/tax/tax-policy/taxing-energy-use-2018-netherlands.pdf .

Parthan, K. and Srinivasan, K. K. 2013. Investigation of alternate behavioural frameworks for mode choice decisions of workers in Chennai city. *Procedia-Social and Behavioral Sciences,* 104 pp. 573-582.

Phuntsho, K., 2013. The history of Bhutan. Random House India.

Quarmby, D. A., 1967. Choice of travel mode for the journey to work: some findings. *Journal of Transport Economics and Policy,* pp. 273-314.

Road Safety and Transport Authority, 2018. Annual Report for Financial Year 2017-18, RGoB. *Sectoral Annual Report,* Available at: https://drive.google.com/file/d/1PBhs5CB1JMS97OA4Pn_UZjdcwTVSubvt/view .

Scheiner, J. and Holz-Rau, C. 2007. Travel mode choice: affected by objective or subjective determinants? *Transportation,* 34 (4), pp. 487-511.

Stephens, N. M., Markus, H. R. and Phillips, L. T. 2014. Social class culture cycles: How three gateway contexts shape selves and fuel inequality. *Annual Review of Psychology,* 65 pp. 611-634.

The Durk Journal, 2018. Democratisation of Bhutan. 4 Available at: https://f4dialogue.dk/wp-content/uploads/2018/05/DRUK-Journal-Democracy-in-Bhutan-Spring-2018.pdf [Accessed 15/05/2019. [Online].].

Thimphu Dzongkhag Administration, 2018. Dzongkhag at glance. Thimphu Dzongkhag. *Statistical Publications,* Available at: http://www.thimphu.gov.bt/downloads?Type=28&Sector=All .

Thimphu Thromde, 2015. Thimphu Structure Plan, TSP and LAPs since 2002 – An Update. Available at: http://www.thimphucity.bt .

Thimphu Thromde, 2019. Thimphu Thromde, Royal Government of Bhutan. Available at: http://www.thimphucity.bt .

UN, 2017. Economic analysis and policy division, In the media- Building productive capacity in Bhutan for LDC graduation. Available at: https://www.un.org/development/desa/dpad/publication/in-the-media-building-productive-capacity-in-bhutan-for-ldc-graduation/ [Accessed 1/4/2019].

UNCRD, 2017. Case Study on Bhutan LRT System ~ Outcome of the Pre-feasibility Study, United Nations Center for Regional Development. Available at: http://www.uncrd.or.jp/content/documents/4943Background%20paper%20for%20EST%20Plenary%20Session%205.pdf .

UNDP, 2016. *Bhutan: Low emission development strategy for the transport sector*. [Online]. Available at: http://www.nec.gov.bt/nec1/wp-content/uploads/2017/04/BHT_TRANS_LEDS_v6.pdf .

UNEP, 2007. Global Environment Outlook GEO4 environment for development. *United Nations Environment Programme,* Available at: https://na.unep.net/atlas/datlas/sites/default/files/GEO-4_Report_Full_en.pdf .

United Nation Development Program, 2016. *UNDP low emission development strategy for transport sector for Bhutan*. *Strategic Document. [Online].,* Available at: http://www.nec.gov.bt/nec1/wp-content/uploads/2017/04/BHT_TRANS_LEDS_v6.pdf .

Van Driem, G., 1994. Language policy in Bhutan. *Bhutan: Aspects of Culture and Development.Gartmore: Kiscadale Publications,* .

Van Thiel, S., 2014. Research methods in public administration and public management: an introduction. Routledge.

Walcott, S. M., 2009. Thimphu. *Cities,* 26 (3), pp. 158-170.

Williams, D. G., Spotswood, F., Parkhurst, G. and Chatterton, T. 2019. Practice ecology of sustainable travel: The importance of institutional policy-making processes beyond the traveller. *Transportation Research Part F: Traffic Psychology and Behaviour,* 62 pp. 740-756.

World Bank, 2018. Bhutan. Available at: https://data.worldbank.org/country/bhutan [Accessed March 20, 2019].

Wuensch, K. L., 2014. Binary Logistic Regression with SPSS. [Online]. Available at: http://core.ecu.edu/psyc/wuenschk/MV/Multreg/Logistic-SPSS.PDF .

Yangka, D., Rauland, V. and Newman, P. 2018. Carbon neutral policy in action: the case of Bhutan. *Climate Policy,* pp. 1-16.

Annex 1. Research Instruments

Online survey questionnaire.

Dear participants,

Thank you for agreeing to take part in this survey in measuring travel behaviour of Thimphu's work commuters.

This survey is conducted for master thesis research in Urban Management and the information obtained will be used for academic purpose only. Your identity will be kept confidential and the survey is completely anonymous.

Analysis from this survey is mainly to recognize the travel behaviour of Thimphu's work commuters so as to seek solutions for the rising car use and thereby building up to traffic congestion in Thimphu, increasing emission of CO2 from transport sectors, environmental degradation, assess transport policy issues and thus to make the city more sustainable.

Filling out this survey should take around 10 minutes. Please note that this survey consists of both multiple choice and open-ended questions so please answer all the questions.

Your opinions count.

Please click the link below if you are currently employed and if you consent to participate in the study.

1. What is your gender?
   ○ Male ○ Female

2. What is your age?

   [ ]

3. Where do you work?

○ Government ○Autonomous body ○ Corporation

○ Private ○ NGO / CSO ○ Self-employed

○ Others [ ]

4. What is the highest level of education you have completed?

○ PhD ○ Masters ○ Degree ○ Certificate / Diploma ○ High school

○ Others

5. Are you married?

○Yes ○ No

6. Where do you reside in Thimphu?

7. What is the average distance (in km's) from your residence to office?

8. From the options below please tick one or more, the type of vehicle you own.

○ Car ○ Bike ○ Bicycle
○ None

9. Which type of Fuel does your car or bike run on?

○ Diesel ○ Petrol ○ Hybrid ○ Electric ○ N/A

Based on your daily travel to work, please answer the following;

10. Which is the most frequent travel mode you use to commute to work.

○ Car ○ Bike ○ Taxi ○ Bus ○ Cycle ○ Walk

11. Which is the alternative frequent travel mode you use to commute to work.

○ Car ○ Bike ○ Taxi ○ Bus ○ Cycle ○ Walk

12. Which is the least frequent travel mode you use to commute to work.

○ Car ○ Bike ○ Taxi ○ Bus ○ Cycle ○ Walk

Following statements are based on the use of public transport (City Bus) in Thimphu. Please tick YOUR agreement to each statement, even if you do not currently use city bus.

13. Using city bus is convenient.

○ ○ ○ ○ ○ ○ ○

Strongly agree	Agree	Somewhat agree	Neither agree nor disagree	Somewhat disagree	Disagree	Strongly disagree

14. Using city bus is affordable and good value.

○	○	○	○	○	○	○
Strongly agree	Agree	Somewhat agree	Neither agree nor disagree	Somewhat disagree	Disagree	Strongly disagree

15. Using city bus would tackle problems of traffic congestion

○	○	○	○	○	○	○
Strongly agree	Agree	Somewhat agree	Neither agree nor disagree	Somewhat disagree	Disagree	Strongly disagree

16. To commute to work most of my friends and relatives:
    - ○ Cycle to work
    - ○ Walk
    - ○ Drive personal car
    - ○ Use city bus
    - ○ Use taxi

Following statements are based on the use of private car. Please tick your agreement to each statement, even if you do not drive or owe a car at the moment.

	Strongly agree	Agree	Somewhat agree	Neither agree nor disagree	Somewhat disagree	Disagree	Strongly disagree
17. Using car is convenient.	○	○	○	○	○	○	○
18. Driving car is satisfying and enjoyable.	○	○	○	○	○	○	○
19. Driving personal car is affordable.	○	○	○	○	○	○	○
20. Reducing car use is not an individual's responsibility.	○	○	○	○	○	○	○

Choose one or more from the following:

21. My friends and family expect me to:

Walk to commute to work;
○ Yes ○ No

Cycle to work;
○ Yes ○ No

Drive to work;
○ Yes ○ No

Use public transport;

○ Yes ○ No

Please tick YOUR agreement to each statement, even if they do not directly affect you.

22. I drive less in Thimphu core area due to the existing parking charges.

○ Strongly agree – 6 – 5 – 4 – 3 – 2 – Strongly disagree

23. I would want to buy an electric vehicle in future because of it's tax exemption.

○ Strongly agree – 6 – 5 – 4 – 3 – 2 – Strongly disagree

24. Increasing fuel tax can reduce the use of car.

○ Strongly agree – 6 – 5 – 4 – 3 – 2 – Strongly disagree

Following statements are some of the initiatives that the government may take to promote environmentally friendly transport initiatives. Please tick YOUR agreement to each statement, even if they do not directly affect you.

25. Widening the roads could reduce congestion.

○ Strongly agree – 6 – 5 – 4 – 3 – 2 – Strongly disagree

26. General taxation could be increased to pay for public transport.

○ Strongly agree – 6 – 5 – 4 – 3 – 2 – Strongly disagree

27. Developing cycle lanes would encourage people to cycle to work.

○ Strongly agree – 6 – 5 – 4 – 3 – 2 – Strongly disagree

28. I would cycle if there are financial incentives to cycle to work.

○ Strongly agree – 6 – 5 – 4 – 3 – 2 – Strongly disagree

29. I would use city bus often if there is a priority lane for the buses.

○ Strongly agree – 6 – 5 – 4 – 3 – 2 – Strongly disagree

30. I would use public transport often if there is an E-services (such as ticketing, time schedule) for city bus.

○ Strongly agree – 6 – 5 – 4 – 3 – 2 – Strongly disagree

Please tick YOUR agreement to each statement, even if they do not directly affect you.

31. Charging parking fee at work would reduce using car to commute to work.

○ Strongly agree – 6 – 5 – 4 – 3 – 2 – Strongly disagree

32. A congestion charge during peak hours would help reduce traffic and car use.

○ Strongly agree – 6 – 5 – 4 – 3 – 2 – Strongly disagree

33. Policy formulation requires more advocacy and inclusion of public participation.

○ Strongly agree – 6 – 5 – 4 – 3 – 2 – Strongly disagree

One possible option for government is to give each individual a 'personal carbon budget'. This would mean that everyone would be able to use a specific amount of carbon each year. If an individual wished to travel more, they would need to purchase more 'credits' from other individuals who had not used their budget.

34. Based on the description, would this encourage YOU in principle to reduce the use of gasoline car?

○	○	○	○	○
Definitely not	Very probably	Probably	Probably not	Definitely

35. Based on the description, would this encourage you to walk or cycle more?

○	○	○	○	○
Definitely not	Very probably	Probably	Probably not	Definitely

Please tell us how much YOU agree with each of the following statements.

36. Transport is one of the major causes of climate change problems.

○ Strongly agree – 6 – 5 – 4 – 3 – 2 – Strongly disagree

37. We will all need to make changes in our lifestyle to reduce environmental problems.

○ Strongly agree – 6 – 5 – 4 – 3 – 2 – Strongly disagree

38. In a year from now I intend to use less car and more public transports, walk and cycle.

○ Strongly agree – 6 – 5 – 4 – 3 – 2 – Strongly disagree

The last section of the survey is based on your residence, household and Income.

39. Can you please mention the Dzongkhag (district) of your Village.

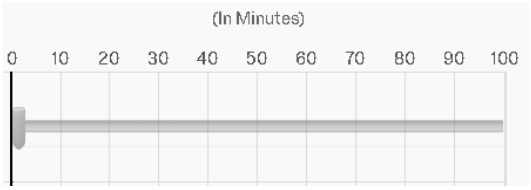
40. Can you please tell us how many members are there in your household, currently living together?

41. Ca you please state your monthly basic pay (in Ngultrum)?

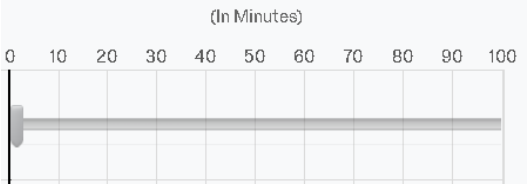
42. In a month, on average, how much do you spend in transportation for commuting to work (on fuel, taxi or bus) (in Ngultrum)

Please slide the bar below to indicate the walking duration in minutes.

43. How long does it take for you to reach to the nearest bus stop from your residence to bus stop?



44. How long does it take for you to reach to the nearest bus stop from your work place to bus stop?



45. The comment box below is optional; you can choose not to respond or provide any comment or suggestion on current transport and environment situation of our city and that is relevant for the survey or for this study.

This is the end of the survey.

I would like to thank you for your time.

If you wished to be informed about the results, please leave your email address in the comment box below.

Annex 2. General question guide for the interview

The interview question were amended to suit for specific sectors.

1. Can you please describe your professional background and role in the agency?
2. What role do you and your organization play in formulating and implementing transport policies?
3. Are there any criteria to ascertain that the measures provided are most required for the society and how do the organization ascertain its implementation?
4. Why do think almost no one in Thimphu commute to work by bicycle? Are there any plans to prioritize and encourage bicycling?
5. Do you think the congestion charging should be introduced in Thimphu? And why?
6. Why most people commute to work by car instead of public transport (PT)? What are the future plans to enhance PT system to make more working people use bus?
7. Does your organization carry out any survey pertaining to people's perception on policies your organization formulated?
8. What kind of social, economic and environmental evaluation mechanism are in place?
9. What kinds of implementation were carried out so far form the transport strategy (related to reducing car use/ or enhancing NMT) that your organization formulated?
10. What are the challenges faced during the implementation?
11. Do you think people are aware of the policies and mechanism in place for creating awareness and feedback system?
12. What new policy measures such as rules, regulations and strategies or guidelines are in pipeline for car reduction or for the overall transport sector?

Annex 3. Interview; key informants and their details.

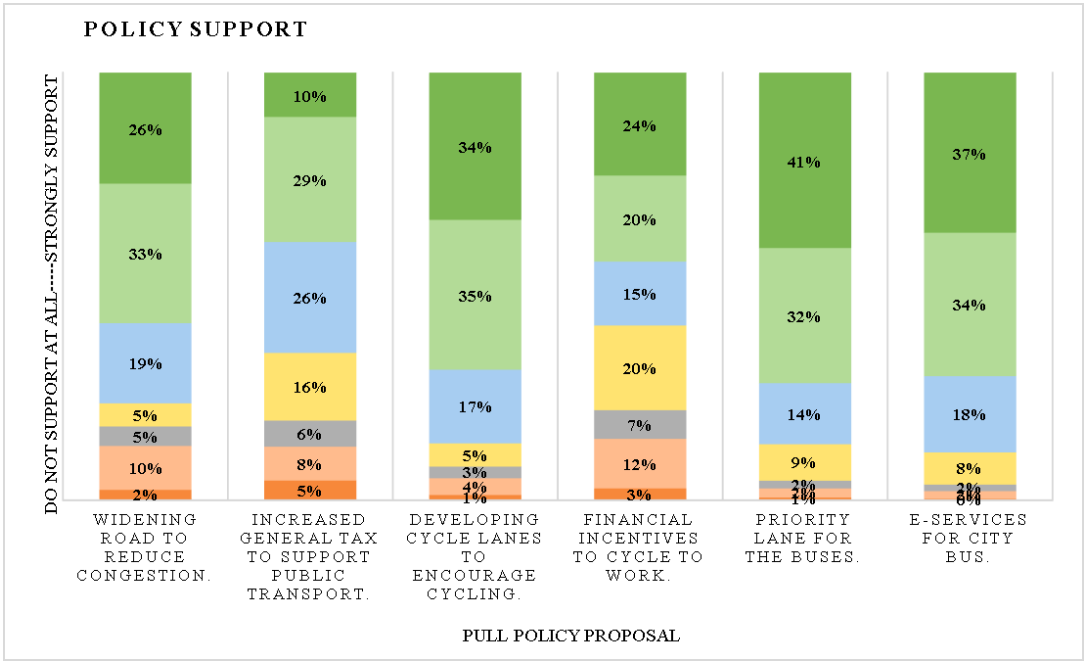
Key Informats	Organization	Policy roles	Name	Date	
1. Executive Secretary	Thimphu Municipality	Infrastructure	Karma Namgyel	1-Aug	e-mail
2. Engineer	Thimphu Municipality	Implementating	Puspa Raj Sharma	2-Aug	e-mail
3. Planning officer	Thimphu Municipality	agency	Karma Dorji	2-Aug	e-mail
4. Deputy Chief Planning officer	Ministry of Information and Communication	Formulating transport policies	Sithar Dorji	15-Jul	e-mail
5. Transportation engineer	Road Safety and Transport Authority	Traffic rules and regulations	Ugyen Norbu	19-Jul	e-mail
6. Head of Operations and Maintenance	Bhutan Post	Public transport services	Passang Tshering	16-Jul	e-mail
7. Deputy Chief, Environment Officers	National Environment Commission	Low carbon policies	Tshewang Dorji	7-Aug	e-mail

Table 4. 10: E-mail interview of expertise in transport sectors, Royal Government of Bhutan

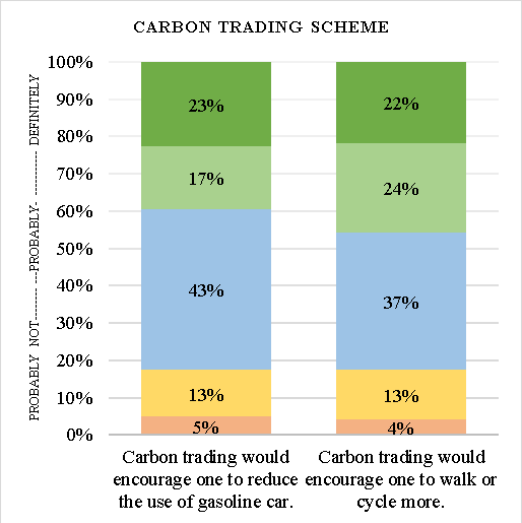
	Inquiry	Combined thematic responses
1	Role of the organizations	Ensure safe, reliable, affordable and equitable transport service; Reduce vehicular emission and congestion. Implementation of the plans; Environmenta assessment.
2	Challenges	Inter agency coordination; Human resource; Financial resource; Implementation challenges_infrastructure.
3	Why almost no one in Thimphu commute to work by bicycle?	Improper infrastructure; Safety issues; Not aware of healt benefits; Social stigma.
4	Collaborate with other transport agencies	Committee of relevant agencies
5	Measures in place to reduce car use	Green Tax on import of vehicle and on fuel; Increase the number of city bus.
6	Perception on congestion charging.	Parking fee replaces congestion charging; Road pricing may help.
7	Parking policy	Parking management tool
8	Survey pertaining to people's perception	Not a common trend; Public feedback box; No surveys, only public consultations.
9	Any awareness programs	Training to professional driver; National television; Agency's websites
10	Social, economic and environmental evaluating mechanism	GNH policy screening procedure Environmental Impact Assessment; Vehicle emission test
11	New policy measures/plans	Institutional integration; New Route System; NMT - priority; 300 non fossil fuel taxi initative; Lanes for PT; Quota for EV's; Bus rapid transit (electric); Electrification of transport sector

Table 4. 11: Thematised responses

Annex 4. Policy support



Pull policy reform acceptance.



Support for carbon trading scheme.

Annex 5. Bootstrap analysis

Mediation path		Bootstrap analysis
X	Ownership	Direct effect of X on Y Effect se Z p 4.2900 .5230 8.2019 .0000 Indirect effect(s) of X on Y: Effect BootSE BootLLCI BootU Attitude .1245 .0901 .0035 .3
M	Attitude towards car use	
Y	Mode choice Car	
X	Ownership	Direct effect of X on Y Effect se Z p 2.3554 .3915 6.0171 .0000 Indirect effect(s) of X on Y: Effect BootSE BootLLCI BootU Attitude .1125 .0987 -.0204 .3
M	Attitude towards NMT use	
Y	Mode choice NTM	
X	Attitude towards NTM	Direct effect of X on Y Effect se Z p -.0800 .2744 -.2914 .7707 Indirect effect(s) of X on Y: Effect BootSE BootLLCI BootU Intentio .7758 .2069 .4502 1.2
M	Intention_ car reduction	
Y	NTM users	
X	Car ownership	Direct effect of X on Y Effect se Z p .0258 .0202 1.2740 .2027 Indirect effect(s) of X on Y: Effect BootSE BootLLCI BootU Intentio .0071 .0071 -.0065 .0
M	Intention_ car reduction	
Y	NTM users	
X	Walking duration to the bus stop.	Direct effect of X on Y Effect se Z p -.0025 .0106 -.2345 .8146 Indirect effect(s) of X on Y: Effect BootSE BootLLCI BootU Attitude .0008 .0016 -.0029 .0
M	Attitude towards car use	
Y	Car use	

Bootstrap analysis

Annex 6. Opinionated response

Sl. No.	Respondent number	Opinion	Theme
1	4	Since Bhutan is the only carbon negative, usage of bicycle will help it increase more carbon negative and people might prefer bicycle over car. And cycling is not only benefiting the environment but also helping with the life of people.	Health benefit form cycling
2	6	We need more frequency of bus service to be able to commute. Since the frequency is less, and there is no city bus service in our area to travel to office, its inconvient not to use car or taxi. We need a e-payment system like in korea to become paperless.	Increase bus frequency
3	9	If you notice most of the cars that are driven in an around Thinphu have only max two or three people. People are driving one car per person that's one problem.	Car pooling
4	19	Not having regular bus movements/ irrelevant timings/ less buses etc are the main reasons for using individual car.	Increase bus frequency
5	22	I would suggest government to look for solution to solve traffic congestion in Thimphu especially in morning, afternoon and evening	Traffic congestion
6	24	In my view following are the major reasons for traffic congestion in Thimphu 1. Pedestrian Walkway across the road (Zebra cross). 2. Lack of passage to cross the road (Over pass or under pass). 3. Narrow roads. 4. poorly maintained roads. 5. Very very poor public transport facilities. 6. No flyovers. 7. Lack of parking space.	Traffic signal Lack of parking space Poor infrastructure
7	31	effective, efficient, convenient and clean transportation system like in countries like some good countries like singapore etc will discourage people buying more cars and use the transportation. the city buses in thimphu at the time is economical but sure it is not convenient since drives take in so many people in, more than the capacity, it does not move in time and it is not maintained	PT not clean PT not efficient
8	35	Public Transport do not ply nearby my work place	Increase PT route
9	38	Proper drainage system should also be looked at while talking about the traffic congestion. Zebra bumps on highways are making the traffic worst. Perhaps underpass and sky walks would greatly ease the traffic congestion.	Sky walks and underpass for
10	39	Traffic congestion has become the trending issue in the capital even during the odd hours. I feel this is mainly because of the poor traffic management system or lack of proper channel to curb this rising problem. what i have had noticed is, the traffic is smoother when those traffic police does not monitor and another one is mainly due to the zebra crossings in numerous points. The solution to this could be to build either the underpass or the flyover for the commuters to pass. This would greatly help the RSTA in managing the traffic well thereby saving the substantial amount of time.	Traffic management. Sky walks and underpass for pedestrian
11	42	Thimphu is over crowded with increasing number of vehicles every year. Today many households own more than 1 car. Taxis are very expensive. The introduction of city buses have immensely benefited a lot of public especially the school children and youths. There is a lot that can be done t o encourage use of public transport facilities, to walk more, to cycle more, etc. I hope studies/research such as yours will be useful in providing information to the government and decision makers to bring some positive changes in the society.	Need to prioritize NMT
12	44	Increasing parking fees, taxes, car prices or everything will NEVER EVER HELP given the nature (kham) of our people including me. Current problem related to transportation will ONLY BE HELPED if we have convenient (frequent) and comfortable transportation. Current buses are packed and smelly.	Increase bus frequency. PT; lacks comfort
13	48	if there is a separate lane for cycle and good/safe footpath for pedistrians..i hope there will be more people who prefers to walk..especially like us who has a kid to drop in schools..it is not safe to let them walk at present.	Safety: Infrastructure for pedestrian and
14	57	I work in MoIC and we have been working to de-congest Thimphu for a long time. The outcome is obviously not to the expectation. You could have added other parameters to make the survey better, especially on the e-vehicles. We are currently implementing one EV project currently. Good luck and it would be nice to see the result of this survey.	e-vehicles
15	58	To reduce traffic congestion, we need to have a smart route management. Make a beautiful pedestrian bridge on every critical junctions. Do not put speed breaker, but put closed railing on the road, so that people don't take the road, but the bridge. ANd also, should make a bypass to avoid central road, to avoid congestion.	NTM Infrastructure Sky walks
16	62	1. Traffic congestion is real problem that faces at present moment so, I would suggest different institute like school can deploy their own buses and let all the student travel in respective bus; 2. Different offices nearby can discuss and propose one or two city bus as separate designated for picking and doping of staff; 3. At a developing stage Government can't stop importing of vehicles but government has ways to initiate to reduce environment impact and air pollution due to fuel car, so I would suggest government to provide Quota (70-80%) for electric car purchase. 4. Build Fly over bridge for the travel since people crossing and moving in between the road lead to more congestion; 5. High time to Royal Government of Bhutan to encourage on electric car import by providing qouta, plenty of charging station, and so on.	Need to prioritize NMT Sky walks, staff bus EV Quota
17	71	to reduce city congestion, city core area can be brought under entry toll tax to force people to use public transport.	Toll
18	72	To encourage usage of city bus or deter individual to use personal car to work or to promote green environment, govt must: 1. Increase frequency of bus timings, must cover popular destinations like hospitals, shopping centres, vegetable markets etc apart from extending bus service till 10pm or 12 midnight. 2. Buy cars from individuals and give incentives for buying electric cars (one main factor discouraging purchase of electric cars is its high cost, low mileage per charge, extremely low charging points, low life of battery and its high replacement cost), 3. How about upgrading the petrol and diesel car to gas? 4. Increasing tax on cars and fuel will not help as car is a necessity and not a luxury anymore. 5. Why not govt. propose on having residential colonies for each ministry and introduce staff bus, school bus etc? 6. Widening roads to reduce traffic congestion is not possible as buildings are already constructed and paying compensation for acquisition would be costly... the only viable solution is to have subways or elevated highways.	PT frequency Increase PT route Proper timing of PT Increase Tax EV, No road widening
19	75	The major problems (not found in your survey question)barring the use of city bus are: Its less frequent and requires longer waiting time at the station City bus timing are uncertain There is no proper seats in the city buses.	Fossil fuel to Gas PT timing PT frequency
20	80	1. Efficiency of public transport needs to be improved in terms reliability, frequency and reach. 2. There need to be proper bus stops where people can wait in sun or in rain. 3. Use technology such as mobile app and digital information boards in the bus stops for bus route, ticked booking and locating city buses. 4. Since Thimphu is a hilly city using electric bike/cycle sharing services could work if made affordable and convenient for people supported by dedicated lane or making certain core areas car free.	PT frequency Proper bus stops Infrastructure

Sample of the open-ended response and their thematic categories.

Annex 4: IHS copyright form

IHS copyright form

In order to allow the IHS Research Committee to select and publish the best UMD theses, participants need to sign and hand in this copy right form to the course bureau together with their final thesis.

Criteria for publishing:

1. A summary of 400 words should be included in the thesis.
2. The number of pages for the thesis is about 50.
3. The thesis should be edited

Please be aware of the length restrictions of the thesis. The Research Committee may choose not to publish very long and badly written theses.

By signing this form you are indicating that you are the sole author(s) of the work and that you have the right to transfer copyright to IHS, except for items cited or quoted in your work that are clearly indicated.

I grant IHS, or its successors, all copyrights to the work listed above, so that IHS may publish the work in *The IHS thesis series*, on the IHS web site, in an electronic publication or in any other medium.

IHS is granted the right to approve reprinting.

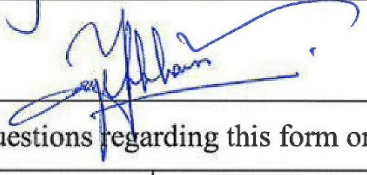
The author(s) retain the rights to create derivative works and to distribute the work cited above within the institution that employs the author.

Please note that IHS copyrighted material from *The IHS thesis series* may be reproduced, up to ten copies for educational (excluding course packs purchased by students), non-commercial purposes, providing full acknowledgements and a copyright notice appear on all reproductions.

Thank you for your contribution to IHS.

Date : SEPTEMBER 4 - 2019

Your Name(s) : Yangchen Lhamu

Your Signature(s) : 

Please direct this form and all questions regarding this form or IHS copyright policy to:

The Chairman, IHS Research Committee Burg. Oudlaan 50, T-Building 14th floor, 3062 PA Rotterdam, The Netherlands	j.edelenbos@ihs.nl Tel. +31 10 4089851

IHS
Making cities work

Institute for Housing and
Urban Development Studies of
Erasmus University Rotterdam