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Master's thesis

Time Pressure and Flexibility in Daily Agendas

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Thesis presented in fulfillment of the requirements for the degree of Master of Transportation Sciences

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PREFACE

"Far and away the best prize that life has to offer is the chance to work hard at work worth doing" Said by Theodore Roosevelt

This thesis is a pivotal requirement for Masters in Transportation Science at University of Hasselt. I chose this topic because of its novelty in field of activity based modeling. The idea of measuring time pressure in daily agenda would be helpful in activity based modeling to predict transport mode in future. I am planning to investigate further in associated facets. This report consists of the research methodology, literature review, Survey design and implementation, survey analysis and conclusions on the research topic. I have been working on the topic from the selection of my topic on 9, November 2015.

Primarily, I would like to thank GOD Almighty for granting me strength to complete this piece of work. I would like to thank my promoter Prof dr. ir Tom Bellemans, Co-promoter, Prof dr. Davy Janssens.

I would like to pay special gratitude to my supervisor Dr ir. Luk Knapen for being the reason of support and motivation in every stage of this project. Without his kind supervision it was not possible to accomplish the targets of this research. He provided me sufficient time and assistance and his valuable feedback and comments proved constructive in this research process.

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TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

SUMMARY

This research is interested in measuring time pressure for different periods of the day regarding activities in agenda. To measure time pressure, actual duration of the activities and total budgeted time are important factors. Measuring time pressure and its relevancy in daily agenda is less investigated field. Therefore, in literature research was difficult to find a precise concept. The theoretical concept behind two models Aurora and ADAPTS are compared and a model is developed to locate the position of time pressure in activity agenda. It is found that during the rescheduling decision process time pressure is an inevitable component and its intensity is dependent on the time budget of the day. Literature review on the topic has defined a conceptual framework for time pressure. That gives the complete insight in the determinants of time pressure and its significance in daily agenda. Socio-demographic and value of time are the determining factors for time pressure, already investigated to some extent in literature. Activity schedule complexity and perceived pressure control are the proposed determinants in this research. Needs are fulfilled by individual activities and these activities have means, determinants and constraints to perform. These tools, constraints and determinants altogether form the agenda. Activities on agenda are characterized by their list of attributes. Duration of activities is relevant to determine the time pressure.

Based on literature findings the expected outcomes are: the TP should confirm the same influences of socio-demographic indicators, while exploring respondent's daily activity agenda. Perceived time pressure (PTP) on the other hand is a new term to investigate in this research. Studies demonstrated that perceived difficulty or perceived time pressure generally influence the behaviour. It was hypothesized that perceived time pressure will influence more than actual time pressure and that it is predictable from actual time pressure. PTP has prominent influence on mode choice for the activities in agenda. If previous statement becomes true then it is possible to predict mode choice from actual time pressure. Additional assumption in this study is about the complexity of the agenda, (which is determined by the number of activities in one-day schedule) has influence on PTP. i.e. More number of activities in the agenda yield more time pressure

To link the literature with reality, a survey was designed and implemented to investigate influence of socio-demographic variables (determinants), actual time pressure and mode choice on the perceived time pressure in daily agenda. Result of the survey analysis demonstrated that People usually perceive less time pressure than the actual time pressure for each activity in the agenda. However, for whole agenda reported PTP number exceeds actual TP. Among socio-demographic variables only *gender* and category of *net household income* (2001-3000€) have influence on perceived time pressure (PTP) (determinants). Actual time pressure has no significant effect on PTP. However, time pressure due to difference of activity duration has significant effect but its parametric effect to change PTP is very small and there is equally likely chance to decrease in PTP with actual TP. People living in rural areas feel less PTP and they use car more. Additionally, use of public transport and car result in decreased perceived time pressure (PTP). Public transport and car both are significant preferred transport modes under high time pressure and complex agenda. Based on the analysis following definition of time pressure is formulated as research outcome:

"*PTP is the feeling of individual of not being able to reach wanted level of utility at certain time. This time deadline is specified by either third party or individual himself. Intensity of the time pressure cannot be measured from difference in planned and actual duration of the activity in agenda.*

Because PTP is influenced by the psychological factors which are different for different individuals. Set of psychological variables consisted of locality, time pressure due to activity duration (if it is more than planned), income level, mode choice, preferred transport mode under TP and gender difference. Individuals however, satisfice to cope with PTP"

The research roadmap for this study was defined to predict PTP from actual time pressure which is not possible as actual time pressure is different from the reported time pressure. Therefore, people perceive differently than the actual calculation of time pressure. However, time pressure due to difference of activity duration has influence (Method 2) on PTP which has weak parametric effect. This is positive indication for the future research if dataset is improved. The research roadmap also required the prediction of mode choice from the actual time pressure in case actual time pressure predicts PTP. This research concluded the alternative solution as frequent transport mode has significant influence on PTP, although parametric estimates are not much practicable. Subsequent liability is on poor data quality in this research. Furthermore, the research topic is investigated for the first time in the field of transportation and it is likely to find better results in future studies. It is recommended to conduct another confirmatory research with better set of observations.

Moreover, this study found following additional outcomes. There is strong positive relationship found between time pressure during the travel to the activity location and time pressure within activity. That indicates, if a person feels time pressure during the travel to the activity location then it is likely to feel time pressured within activity. The theory of bounded rationality (Satisficing) is also confirmed in this study as an additional outcome. Majority of people tend to cope their time through satisficing.

1 INTRODUCTION

1.1 Background

Activities are scheduled by individuals according to their daily needs for instance, when an individual has to go to work. Discussion on flexibility in daily agenda is persuaded with an example case. Schedule planning of a random person is specified as a person has to start his day by reaching his office by 9:00 AM and he usually comes back at 5'o Clock in the evening. He uses public transport to reach his work place. Therefore, he attempts to maintain his schedule regular and punctual. He is a married man and has two children under age of 12. His wife works part time as sales woman. She has different job hours during the month and usually she is at home in the morning. Hence, she has responsibility to take children to school and when she is at work, he brings their children. They usually do the errands on weekends. Above mentioned activities constitute daily agenda of a household routine life. A question arises, what happens to the agenda of that person and household members when they have to go for a social visit or one of their children has a party at friend's house. Every individual has a plan for upcoming day according to the limited time available. Individuals plan their activities in sequence considering the available time. Hereafter, the question arises, are they able to adapt the schedule as planned in daily routine. There can be exceptions in the routines and some of the activities may be delayed due to certain reasons and they exert time pressure in available time deadline. Moreover, sometimes available time is not enough to travel or reach to the subsequent activity causing delay.

Daily activity patterns of an individual have a direct impact on travel behavior (mode and choice). This impact configures traffic congestion and policies. People schedule their routine activities according to their needs; hence, travel is an induced demand of these activities (Arentze & Timmermans, 2009). Some activities are fixed over certain period of time for example: school and work. Fixed activities are termed as primary or mandatory activities in literature. Other activities are flexible in nature as social or recreational activities. Mandatory activities determine the time availability for flexible activities (Arentze & Timmermans, 2011). Every activity has a certain threshold of time to perform it and after that it effects the implementation of next activity. An individual determines sequence of activities taking into account available resources i.e. cost, time and others(Arentze, Ettema, & Timmermans, 2010). Time and money are not the only constraints effecting the activity decisions. It is pertinent to take into account the interaction of distinctive activities where some activities are performed collectively. Joh, Arentze & Timmermans, (2002) proposed Aurora model that suggests, individuals initially plan their schedule of activities for the day. This plan includes location, duration, travel mode and order of the activities. Rescheduling in plan occurs because of either time availability or not, for adding or removing some activities from the schedule during the execution of activities (Joh, Arentze, & Timmermans, 2002). For instance, an unexpected delay or early execution of an activity provides flexibility in agenda. Time needed for scheduling activities is cause of time pressure, proposed by Gärling et al. (Joh et al., 2002). The flexibility in scheduling activities has effect on choice of mode and number of trips. There is need to know about the time constraints that effect the decision to change plan.

1.2 Problem statement

Activity based research is now common in transportation science. Consequently, dynamic activity models are solution for transportation policies and transport demand management. In order to develop these activities based model individual's travel pattern is important to identify. Individuals travel pattern is based on daily activity travel (Joh, Arentze, & Timmermans, 2001). This research is interested to know the effect of flexibility in activity pattern. It is quite possible in the process of execution of an activity, time availability is affected for subsequent activity in a schedule. Effect in time availability causes time pressure which derives the question how an individual expects to adjust unwanted effect of time pressure between available time periods? Therefore, uncertainty in decision for choosing travel modes at that moment employed by time pressure is needed to be measured. Activity based approach was defined by Hägerstrand (1970) and his colleagues. According to this approach, individuals make their choices which are influenced by many constraints. These constraints are classified as *capacity*, *coupling* and *authority constraints* in literature. "*Capacity constraints"* relate to natural needs like eating sleeping drinking. Individuals have fix schedule for these constraints in daily agenda. Secondly, "*coupling constraints"* relate to the fact that some activities are performed mutually with household members or friends. For this reason, synchronization for timing and location decisions are important. Lastly, "*authority constraints"* relates to the limitation on availability of public transport or closing hours of markets or places where activity has to be executed (García-Jiménez, Ruíz, Mars, & García-Garcés, 2014). Activities planning take into account these constraints. Question arises that how many numbers of constraints are accepted in individual's daily agenda? This study is mainly about defining time constraints in context of daily agenda and explores the method to measure it. Relationship between time pressure and activity travel decision is included in scope of this study. Fixed activities are usually inflexible in time and they consume larger part of time resource of the day. Other household activities (shopping, taking care of another member etc.) are adjusted in remaining time resource. Activities on the daily agenda are ordered in sequence by individuals according to the availability of time. Moreover, individuals select the travel mode depending on time availability. Hence, it is hypothesized that if time pressure is known, travel mode can be predicted.

1.3 Objectives

1. *To define time pressure scientifically in terms of daily activity agenda*

Research contribution: Important research outcome of this study is to find scientific explanation for time pressure and its impact on daily travel pattern. It is important to have clear elucidation of the concept before measuring it in any context. Focus of the study is to define time pressure in field of travel behaviour and its causative factors. Relevance of time pressure in adapting daily agenda is also in the scope of this study.

2. *To review literature, evaluation of research methods on flexibility and time pressure in daily agenda*

Research contribution: Reviewing and evaluating existed methods is an important task of this study. There is yet limited work available in this field. There is an opportunity to find positive and negative aspects of methods in the existing literature. Most suitable method is used to measure the

time pressure. From the extensive literature review, it became possible to evaluate the existing method to measure time pressure and its affects. The effort is made to find drawbacks and improve measuring tools used in the method. Time pressure is also related to cognitive characteristics of human behaviour and indirectly to uncertainty in decisions making. To apprehend time pressure, there is need to integrate behavioural realism into measuring method.

3. *To develop a method to measure time pressure and to find relative importance in activity based modelling.*

Research contribution: Developing a method to measure time pressure is significant research outcome of this study. A detailed review and appraisal of literature helped in finding suitable method to measure time pressure. It was required to investigate measuring tools that can be helpful in survey design. A survey will be designed and implemented to collect the data for testing method. If this study leads to a successful development of a method then it is possible to include time pressure in daily agenda and its effects to improve the existing working of activity based model.

1.4 Research questions

The current research study will be inclined to riposte the following questions:

- To which level people can easily adapt their daily agenda?
- What are the constraints in agenda?
- How many constraints are acceptable in the people's daily agenda?
- How time pressure is related to constraints?
- How time pressure is measured?
- How time pressure is related to decision of travel mode in daily agenda?

1.5 Rationale of the study

Modelling transportation system consists of three distinct components (network, land use and travel demand) which are analysed separately. For example, four step modelling but now there is a shift toward agent based modelling which is disaggregated framework. Agent based concept means agent has set of behaviour which are used to communicate with other agents in society and environment (Sokolov, Auld, & Hope, 2012). Activity based modelling experience was largely based on only one day activity observation, which resulted in underestimation of different activity pattern on different days (Arentze, Ettema, & Timmermans, 2011). On the other hand, these models were not able to take consideration of interaction of activities suggested by Hamed and Mannering, 1993 (Arentze et al., 2011). Arentze, Ettema, & Timmermans have related interaction of activities in term of frequency of activities and time allocation to the activities. Inclusion of choice decisions affecting scheduled activity has improved the performance of demand models (Bowman & Ben-Akiva, 2001). Individual activity pattern is not static and dynamic activity schedule is based on rescheduling decisions. These rescheduling events happen due to the time pressure and unexpected events (Joh et al., 2001). Term, time pressure is only used in literature of activity based modelling as one of the parameter which influences the decision making. In the recent study by Chen, Chorus, Molin, & Wee,

tried to measure the time pressure but they focused on measuring the time spend on making a decision and it is simulated experiment which was designed to test the model (Chen, Chorus, Molin, & Wee, 2015). This study is novel in nature as time constraints are identified in the daily agenda and assumption is made to predict the travel mode choice from the measurement of these constraints. Time allocation to the activities in agenda holds the scope for time constraints.

1.6 Research plan

A brief overview in form of conceptual model of research plan is explicated in the Figure 1-1. Few important steps are briefly explained in following sections.

1.6.1 Literature review

Review of the literature typically includes the particular and background information available on the subject to be studied. It helps in logical development of the research direction under investigation and assist in drawing the boundary between what has already been done and what this study will count the difference (Ridley, 2012). Research questions of this study are relatively new in the field of predicting travel behaviour and there is little possibility to find any mature developments. However, it was expected to find the relevant techniques from the literature which support measuring effects of time pressure on activity pattern. Time pressure in context of daily agenda is less investigated in the field. Therefore, issue based approach is used to help find out relevant concepts which supported developing conceptual framework for time pressure. Concept and methodological based approaches are also used regarding time pressure in literature. Detailed literature is discussed in Chapter 2. Organization of the literature review is planned in a way that definition of time pressure is searched from other field of sciences and some relevant concept such as i.e. satisficing, time fragmentation and coping with time pressure are described. Effect of time pressure on daily agenda is less investigated till the date, therefore, limited studies were found on the subject. Based on some studies a conceptual framework is defined in Chapter 2. Consideration is also given to the role of social cognitive factors in enabling time pressure like perceived time pressure (PTP). Outcomes of the literature writing are specified as:

- Appraisal of measuring tools and methods to apprehend time pressure
- To evaluate methods to measure time pressure
- To determine contributory social cognitive factor in defining time pressure

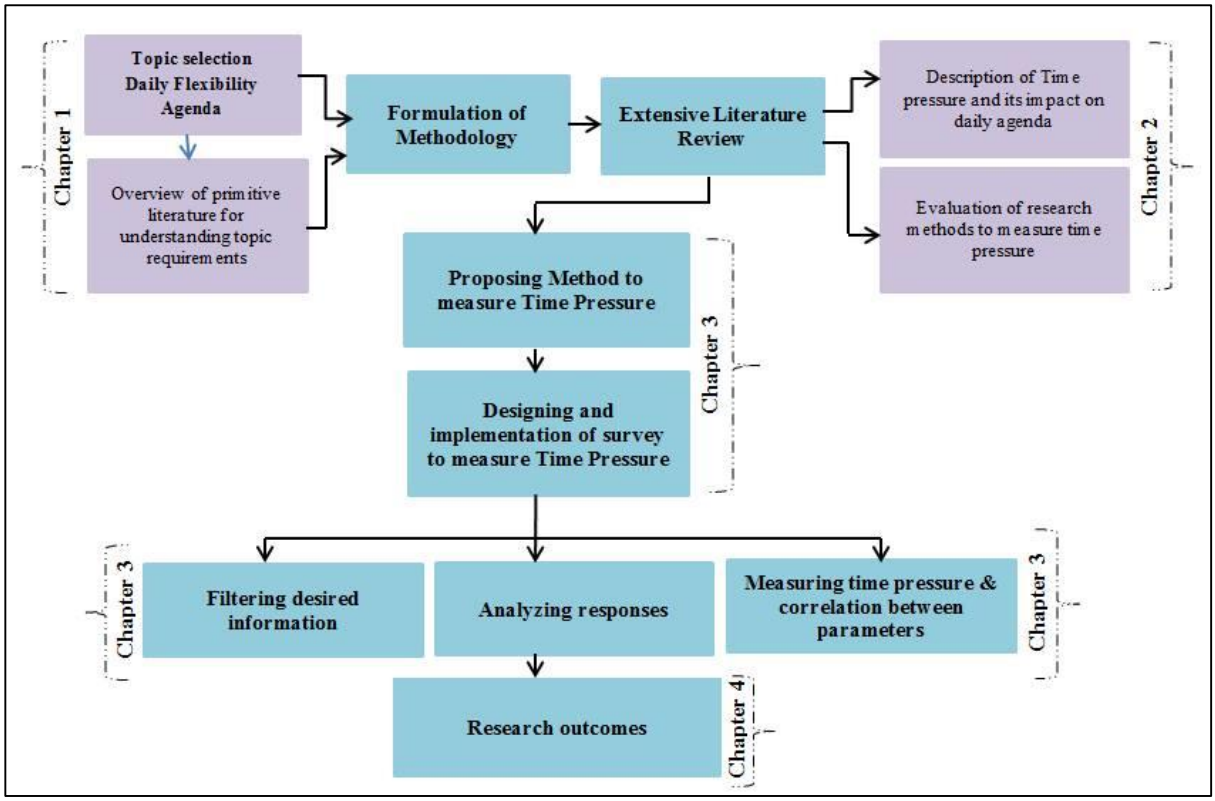


Figure 1-1: Overview of research plan
Source: Author's own, 2016.

1.6.2 Methodology

After developing the method to measure time pressure and identifying the tools to measure it, a survey was designed. Online survey was distributed among respondents. Respondents were selected based on convenience sampling but certain criteria is considered. To measure time pressure socio demographic factors are important. Therefore, maximum variability was achieved in socio-demographic factors (age, gender, income, marital status, people with children under age of 15 etc.). It was decided to get the maximum number of responses 250 to 300 from Belgium especially Hasselt region.

1.6.3 Development of method to measure time pressure

Method for calculating time pressure is described in detail in chapter 3. The method is mainly based on the research of Chen et al., 2015, in which they investigated the effect of time pressure and complexity of tasks on activity travel choices (Chen et al., 2015). Time pressure used for the analysis in the study is derived from availability of time for travel to reach certain activity location and actual time spent on travel. Respondents will be inquired about the activities from their previous day schedule.

1.6.4 Data collection/ implementation of survey

As mentioned in Section 1.6.2 that 250 to 300 respondents are required to get sufficient size of sample. Online survey tool, Qualtrics is used to collect the responses. The main strength relies on the

variability in socio-demographic factors. After conducting the survey categories will be demarcated for these factors which are demonstrated in Chapter 3.

1.6.5 Statistical analysis

Interpreting the survey responses and filtering useful information is a time consuming task. Data skimming and management are logical steps toward making information useful to employ in supportive software tool. After arranging the filtered information, statistical analysis will be used to find correlation or relationship between the parameters. Brief overview for the logit model is described in following section.

1.6.6 Multiple logistics regression

Multiple logistic Regression is used when nominal variable is used as dependant variable and independent variable are equal to two or more. Effect of these measurement variables on dependent variable is studied. This relationship is explained as the effect of independent variables ($X_1, X_2 \ldots . X_k$), which they can have on the probability of obtaining certain value of the dependent variable (Y) (McDonald, 2014). Multiple logistic regression equation that estimates the value for dependent variable (Y) is represented as:

$$\ln\left(\frac{Y}{1-Y}\right) = \beta_\circ + \beta_1 X_1 + \beta_2 X_2 + \cdots . \beta_k X_k$$

$\beta_1, \beta_2, .. \beta_k$, are the slopes in equation 1.1. values associated with βs are weights which are acquired by minimization of squared deviation's summation (McDonald, 2014), as presented below:

$$\sum_{i=1}^{N} (Y_i - \bar{Y}_i)^2$$

Regression parameter associated with intercept $\beta_\circ$ is considered as reference for categorical predictor variable (Harrell, 2013). For multiple linear Regression maximum likelihood method is used for best fitting equation. Nominal independent variable are also used in multiple logistic Regression (McDonald, 2014). Each addition of variable in the equation results in increase of unadjusted R^2 value if predictor variables are not correlated. If they are correlated then combined result are complex in interpreting (Stockburger, 2014).

Multiple logistics regression equation will be used for current study to develop the relationship between travel mode and time pressure. Travel mode in this study is used as dependent variable (Y). Besides, it is hypothesized that if time pressure is known, travel mode is predictable. Details for how this Regression equation will be used on the research variable will be demonstrated in Chapter 3.

1.6.7 Drawing conclusion

Clear description of findings from the research process is termed as conclusion. Likewise, conclusion section is the summery of the research outcomes. Details of the research outcomes will be provided in Chapter 3. Research outcome of this study are described briefly:

- Rigorous description of time pressure
- Methods, tools and instruments to measure time pressure
- Results of the survey that can quantify the time pressure
- Description of relationship between the socio-cognitive or socio-demographic factors effecting time pressure

1.6.8 Time frame

Research is a time bounded activity and limited time is available to complete this task. Planning the research activities in advance has time saving potentials and results in better organization of work. Time frame of this study with important activities is presented in Figure 1-2.

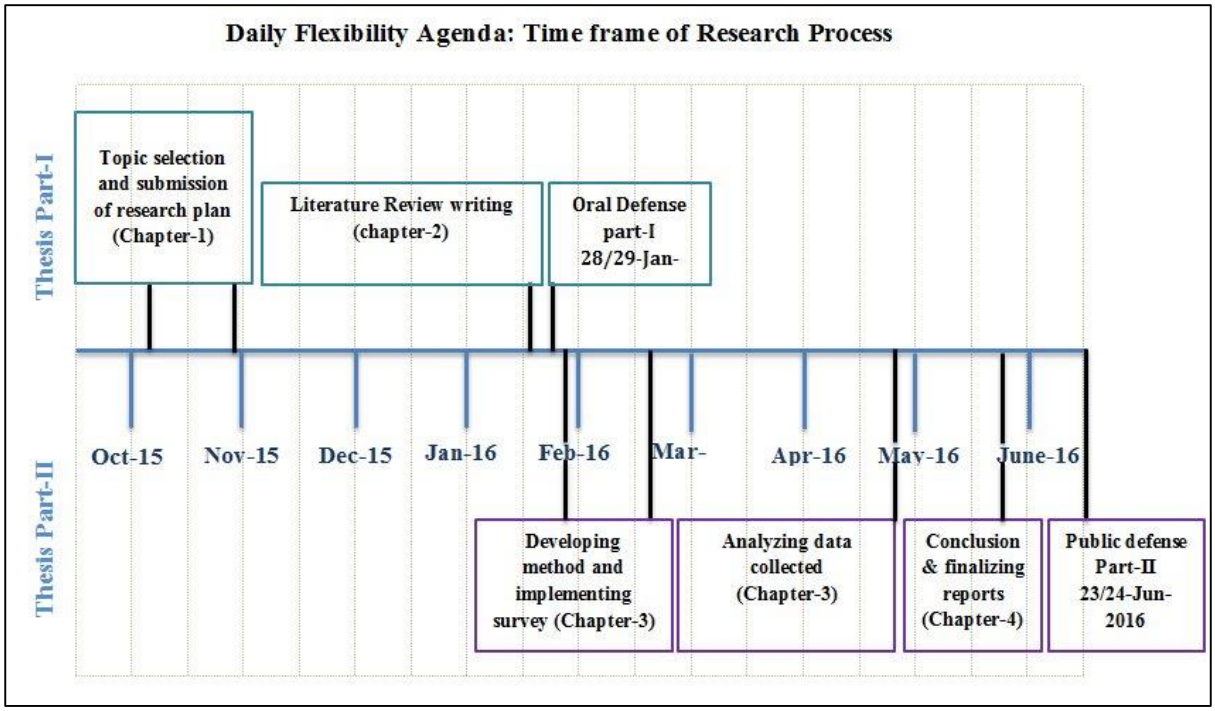


Figure 1-2: Time frame for research
Source: Author's own construct, 2016.

1.7 Limitations

Limitations refer to constraints faced in the research process. Limitations of this study are classified into capacity, instrumental and authority constrains. These constraints are explained in following headings.

1.7.1 Capacity constraints

Capacity constraints are related to instrumental limitation. Survey tool (Qualtrics) will be used in this survey is less efficient. More number of responses would have been expected if special interactive dynamic activity simulator was designed. Activity time simulator cannot be designed due to the requirement to write dedicated software and for which sufficient time is not available. Additionally, survey will be implemented in Hasselt region and habitants of Hasselt speak Dutch language. Communication barrier can be a potential challenge for author as survey will translate into Dutch language for the affluence of respondents.

1.7.2 Authority constraints

Convenience sampling approach is used in the research process. Therefore, there are possibilities of acquiring some misleading bias results. Novelty of this research topic resulted in less number of reference list. Additionally, respondents are not bound to participate in this study and people responded on their own choice. It may also depend on the subject of their interest too.

2 THEORETICAL EXPLANATIONS FOR TIME PRESSURE

Travel demand management (TDM) measures intend to lessen the environmental, infrastructural and economic pressures allied with daily mobility. This reduction is only possible through minimizing the behavioral consequences of these measures (Eriksson, Nordlund, & Garvill, 2010). Besides, roads are congested these days with low occupancy vehicles resulting in environmental, infrastructural and livability deterioration. Among other sustainable solutions carpooling is an option too. If the number of low occupancy vehicles is reduced on the road, it can efficiently contribute to above mentioned deterioration mitigation. The current situation shows that people are simply not willing to give up their car use. Furthermore, efforts made for reduction in car use and promoting high occupancy transportation modes have considered many behavioral factors to anticipate change. Along with other participating reasons, the influence of time pressure on choices made to select travel modes is less investigated. This chapter will provide comprehensive understanding of time pressure, its effect on decision to be made, coping with time pressure and supplementary detail regarding its effects on scheduling and rescheduling of activities on daily basis. This research is fundamentally interested in investigating the impact of time pressure in daily agenda planning. This is novel concept and is less investigated in daily agenda. Due to the fact related literature was difficult to find, the effort is made to find relevant material and relevant concept from transportation and other sciences (financial, medical, social sciences etc.).

2.1 Time pressure: Literature review

In this section time pressure is described from different field of studies to know how they anticipate time pressure. In the research work of DeZoort on time pressure in auditing, displays high stress level among professionals in auditing who face the time constraints. Stress level can impact attitude, intentions and behavior. In auditing literature, time pressure is explained in two primary dimensions such as *time budget pressure* and *time deadline pressure*. Both concept are not identical (DeZoort, 1998).

Time budget pressure: This kind of pressure is chronic and pervasive in nature and arises when allocated resources to perform a task are limited. Major causes for limited resources include personal limitations, profitability and cost constraints. An example to illustrate the time budget pressure in auditing is market competition that induces pressure to maximize efficiency and control costs. Time budget pressure is manageable in strategic manner (DeZoort, 1998).

Time deadline pressure: This type of pressure is acute in nature and task completion is required within specific targets. Deadline pressure can be both unexpected and foreseeable. Time deadlines are harder to manage than time budget constraints because of the unanticipated nature (DeZoort, 1998).

Relationship of time pressure in accounting work is inverted-U shaped that refers to improved judgment from no or low levels to moderate pressure. It tends to worsen when time pressure increases to high level (DeZoort, 1998). In the domain of Psychology, literature depicted under time pressure people tend to perform quickly but the accuracy of performance usually declines (Salas et all. 1996, 33: (DeZoort, 1998).

According to Linder, (1970) and Voss and Blackwell, (1975) (economic approach) studies, human activities segment the time in mandatory and leisure. Subsequently, Time pressure, is defined in terms of insufficient flexibility in time period which is constrained in resources. Time pressure is also explained as temporal discrepancy that individual experience (Hendrix and Martin, 1981; Mantel and Kellaris, 2003; Sullivan, 2008, as cited in Lallement, 2010). Insufficiency of time and limited resources can be connected to the concept of time deadlines and budgets. Sociologists consider time pressure as a matter of time management (Feldman and Hornik, 1981; Cotte and Ratneshwar, 1998; Reeves and Szafran, 1996, as cited in Lallement, 2010), that influences the process of decision making (Nickols and Fox, 1983; Berry, 1979; Okada and Hoch, 2004; Herrington and Capella, 1995, as cited inLallement, 2010). It may be measured objectively and controlled (Hornik, 1984; Hendrix, 1984; Park, Iyer and Smith, 1989; Robinson and Nicosia, 1991; Marmorstein, 1992; Kellaris and Mantel, 1994; Kolodinsky, 1990; Nelmapius et al., 2005, as cited in Lallement, 2010).

Hilbrecht Zuzanek, & Mannell, (2008), studied time use, *time pressure and gendered behaviour in early and late adolescence* and explained time pressure as a feeling not able to perform activities and continuously experiencing feeling of rush. Therefore, people with high number of workloads likely to experience high time pressure (Zuzanek 2004, as cited in Hilbrecht, Zuzanek, & Mannell, 2008). According to Eriksson et al. (2007), time pressure is related segmentation of time and difficulty in allocation of time. Time pressure is gendered behaviour as it is confirmed in many studies. The likelihood to experience extent of time pressure is more in women than men (Zuzanek, 2000; Mattingly and Sayer, 2006; Marshall, 2007, as cited in Hilbrecht, Zuzanek, & Mannell, 2008), as women spend extra time on household activities and personal care in addition to their daily activities (Hilbrecht et al., 2008). Bergada, (2007) structured the human behaviour in four temporal frameworks. He identified two dimensions of time pressure that are closely related to chronic nature of time pressure. One dimension is fragmented time that refers to urgency indicating the individuals who have ability to change from one activity to another very quickly. Additionally, time is transformed into a "moment" in which actions have not ephemeral character and duration of activities is important. In this context behaviour is difficult to predict (Bergadaà, 2007). The other dimension is "in rhythm time" that refers to unification of urgency and temporal framework chosen by entities. This type is contrast of fragmented time and discusses the stability and duration (Bergadaà, 2007). In general, time pressure is a force that motivates the individual to act on time and this concept is comparable with chronic time pressure (fragmented time). The origin of a time constraint is important to know as it helps ranking deadlines (Wright and Weitz, 1977; cited in Lallement, 2010) whether they are evitable/ inevitable (Darpy, 1999, as cited in Lallement, 2010). Amount of time pressure and consideration of possibilities allow an individual to postpone or stop certain activity. Deadlines are also characterised as external and internal in other studies (Miyazaki, 1993; Gross, 1994; Aggarwal and Vaidyanathan, 2003; Abendroth and Diehl, 2006; Brannon and Brock, 2001; Ariely and Wertenbroch, 2002, as cited in Lallement, 2010). Internal deadlines refer to time limit chosen by individual and external deadlines are societal recommended by environment (Lallement, 2010).

Furthermore, the term time pressure agreeably used in processing information for sales offers by Jeanne Lallement, 2010 as:

> *"It does not refer to urgency or acting in haste (Riveline, 1991; Aubert, 2003; Usunier, 1995), nor does it allude to being "in a hurry", an expression that suggests a lack of control over one's actions, but rather the individual assessment of occasionally not having enough time to complete a task. Whatever the origin of the deadline, it limits the individual's capacity to consider all the information available and make a decision in optimal conditions (Park, Iyer and Smith, 1989; Schellinck, 1983;*

Pieters, Warlop and Hartog, 1997; Dhar and Nowlis, 1999; Suri and Monroe, 2003)" (Lallement, 2010 p.48)

2.2 Coping with time pressure

Coping with time pressure in literature is confirmed as a process with three main responses by the individual. The process is explained in an article by Jeanne Lallement, 2010 on processing of information. This process is also confirmed by Edland and Svenson (1938) in field of psychology for alternative strategies to deal with time pressure (DeZoort, 1998). In field of auditing the coping response of auditor is explained by Asare et al. (1998). Auditors in case of investigation of material, they are likely to lessen the number of tests keeping the sum of causes same under time budget pressure and if pressure is much higher to tolerate then individual tend to avoid problem (DeZoort, 1998). According to Lallement, 2010, in case of processing information three response are expected from individual cognitive stream: speeding up or acceleration, filtering the given information and changing information processing strategy as intensity of time pressure changes (Miller, 1960, as cited in Lallement, 2010). The individual responds to time pressure by treating the available information at accelerated pace that refers to first type of response "acceleration". Many authors observed this phenomenon in different studies such as Maule, Hockey and Bdzola, 2000; Bettman, Luce and Payne, 1998; Payne, Bettman and Johnson, 1988, as cited in Lallement, 2010). The second strategy is about considering only part of the information to make choices. In this situation there are two approaches found in literature. Researchers such as Edland, (1993), Kerstholt, (1994) Payne, Bettman and Johnson, (1988) are convinced that individual tend to make conscious choices of certain attributes and named it as "selection". While others viewed conscious strategy not useful and suggested better strategy to be based on emphasis on negative facts (Wright and Weitz, 1977, as cited in Lallement, 2010). This approach is named as *filtering* or "*filteration*". The third coping response is variation in making decision. Change in making decision gets intricate with intensity and individual tend to change the strategy to scrutinize the information. Change in strategy occurs in two ways: (1) shift from satisfactory decision to non-satisfactory and (2) escaping. According to Bettman, Luce and Payne (1998), an individual makes a decision based on comparison between attributes to alternatives when time pressure is high. This refers to *intra-attribute strategy* and *intra-alternative strategy* respectively. If the time pressure intensity further increased and there is no sufficient time left to look into all information then the individual switches to more simple strategy. That means examining information based on breadth (number of important attributes only). To summarize this process, it is clear that intensity of time pressure leads to avoidance or delay this effect depends on the type of decision and willingness for that. Under very intense time pressure, quality of the decision is lowered (Lallement, 2010).

Lallement, 2010 described these three responses in case of processing information on some sales offer but these coping strategies are originally defined from psychology literature. Therefore, they represent the general human response under any kind of time pressure (DeZoort, 1998). Besides, focusing on the subject of this research there is no suitable example found which could be included to present how an individual cope with time pressure during the daily activity agenda. Additionally, it can be assumed that if a person has long list of simple activities to perform in a day then it is quite possible to feel time pressured due to increased number of activities to complete in one day. Under high time pressure he tends to consider less number of alternatives in choice of mode and high probability is continuing habitual car mode. Moreover, he perceives car as potential satisfier without considering the option of public transport even if it is more efficient mode. An example case, in

which person needs 8 hours for work, visits the bank to sign a document, pick up a paper from the city hall, bring the children to and from school and buys some food (all between 08:00h and 17:00h). In this case the person undoubtedly, will feel time pressured which can affect his travel mode choice. Joh et al., 2001 specified coping time pressure in case of rescheduling decision. If high time pressure situation is imposed on agenda then utility of the rescheduling need is higher than the activity on existed schedule and hypothetical individual in such situation tends to re-adjust the schedule (Joh et al., 2001).

2.3 Satisficing

Satisficing is a phenomenon that justify the decision making process. The idea to investigate the concept is due to its potential support in evaluating decisions or choices under time pressure. Herbert A. Simon in 1956 introduced this term and it is combination of two words *satisfy* and *suffice*. According to the ideology individuals either find optimal solutions to simplify their world or try to make it at least satisfactory for realistic world. Basically,it is a cognitive approach of an individual that involves him/her to examine available alternatives until the acceptability threshold is reached ("Satisficing," 2015).

According to the study by Misuraca, Faraci, Gangemi, Carmeci, & Miceli, (2015), the theory of bounded rationality by Simon, 1956 is explained as follows: because of the environmental limitations and difficulty in individual information processing, people tend to satisfice. That means searching for satisfactory solution rather than ideal one. Simon's theory is recognized as explanation toward universal behavior. Later, Schwartz (2000) attempted to find the role of individual's personality traits in satisficing. He proposed that individuals have their own choices. Some prefer constantly to find the best choice, which refers to comprehensive exploration of options. Others make their choices just satisfy their given certain standards, which raises to non-exhaustive search. The first kind is typical maximizers, who would search thoroughly about cars brands, visit lot of showrooms and will put effort in finding the desired color, brand and list of attribute in buying a car. On the other hand, typical *satisficers* will just consider certain important criteria and will abort further search if find accordingly. The satisficers do not necessarily settle for moderate quality. They are considered to be interested in quality and to be ambitious just like maximizers (Misuraca, Faraci, Gangemi, Carmeci, & Miceli, 2015). Satisficing is an important cognitive behavior to be used in decision making process during daily activity dynamic planning. Satisficing is under investigation stage till the date and point seem to be missed that how a satisficer act under different level of intensity or time pressure.

Fellner, Güth, & Maciejovsky, 2009 tested the theory of satisficing. In this paper, the concept of "bounded rationality" is used in term of satisficing instead of optimizing behavior, as suggested by simon (1955) originally. This study was the first to test the bounded rationality particularly in achieving goals. Study was an experiment using an investment game. According to this game, participant have to invest their savings in risky assets and riskless bonds. Assets were supposed to yield the return with equal likelihood of high and low. On the other hand, bonds only delivered a certain positive return (Fellner, Güth, & Maciejovsky, 2009). Fellner et al. (2009) suggests categories for bounded rational actors represented in Figure 2-1. It is recommended, if all (Two in case of the investment game) alternatives available to actor do not trigger his needs than they are unreasonable. However, if actor finds some required features than he will be at stage of *potential satisfying*. At this stage actor will analyze his requirement and adjust the minimum goals and if this satisfies his need he

will be at stage of *actually satisficing* otherwise he is *non-satisficer*. Next stage is analyzing at actually satisfiying, if choice analysis still result in few satisficing gaps then he is *potential satisficer* otherwise he is *actual satisficer* (Fellner et al., 2009). Categories consist of non satisficer, potential satisficer and actual satisficer as demonstrated in Figure 2-1.

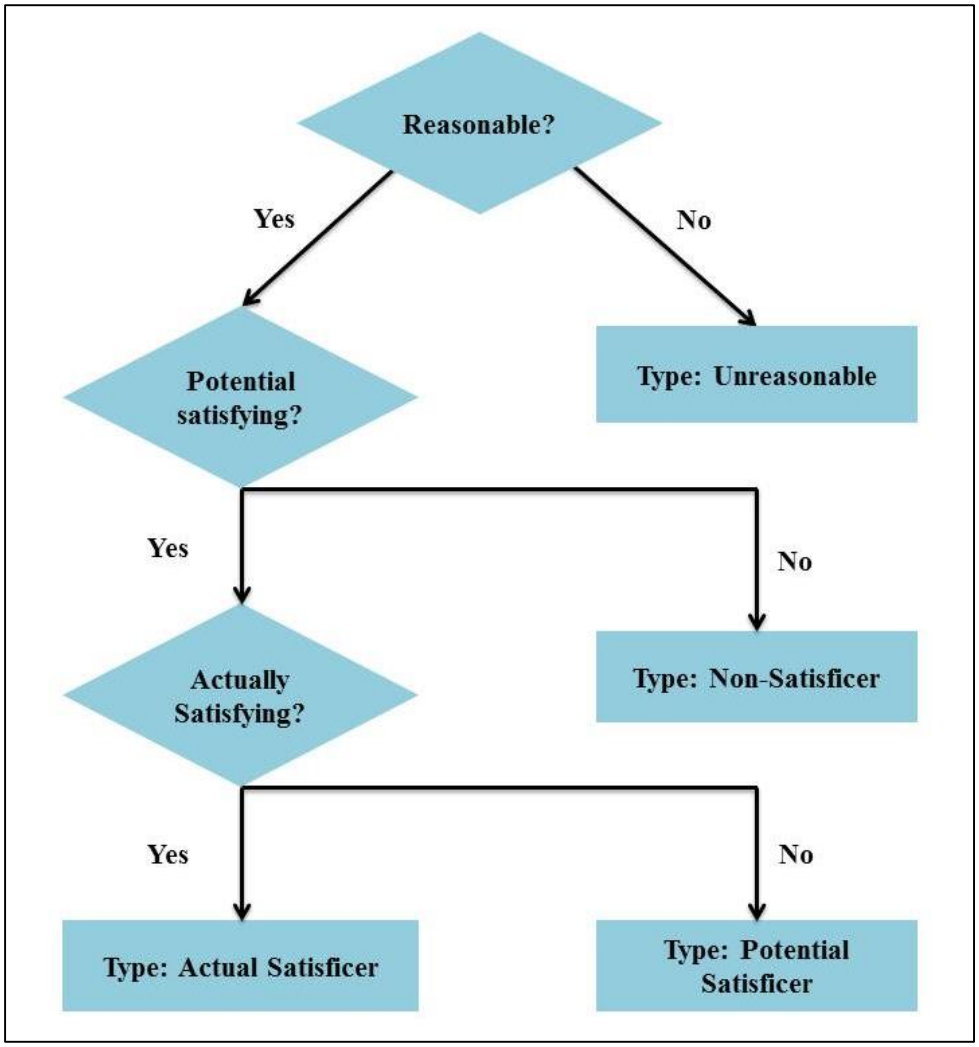


Figure 2-1: Classification of satisficer
Source: (Fellner, Güth, & Maciejovsky, 2009).

In activity based modeling Arentze & Timmermans, (2009) used the concept of bounded rational behavior. A *needs based* theory is proposed to develop a model for generating activities for the agenda of a household. In their work they used the concept of rational behavior that means minimizing the needs to keep them at lower level rather than maximizing. Maximizing utility indicates faster growth for satisfaction. However, individuals behave rationally in reality and rationality is explained in form of potential utility. According to the theory need growth is benefited when it is confined in available resources (i.e. Time, available car etc.).

2.4 The *needs* based theory

The need based theory is originated by Theo A. Arentze and Harry J.P. Timmermans, (2009) in their research work "A need-based model of multi-day, multi-person activity generation". It is related

to this research in defining the decision making process in accomplishing daily activity agenda. According to the theory, every single activity of "individual's activity repertoire" performed by individual is intended to satisfy a certain need (Arentze & Timmermans, 2009). For example, going to work satisfy the economic need and housekeeping gratifies the need for cleaning untidy house. Moreover, activities usually either upsurge or reduce the need for other activities; likewise, it has side-effects that change its utility positively or negatively. For example, eat-out with friends to the extent that it may decrease time for sports and spending much time on any physical activity may increase time for relaxing. Additionally, needs are shared by individual sharing the household. For example, satisfying the certain need like grocery shopping can satisfy the shared needs of all household members. These kinds of activities are either performed by single member or mutually by two or more members. These activities termed as household activities (Arentze & Timmermans, 2009).

Perceived utility is negatively affected if the need is induced and positively if need is satisfied. This theory can be derived from the expression presented by equation 2-1 for a utility h derived from an activity j in time t is given below:

$$U_{jh}^{t} = U_{jh}^{0} - \sum_{i} \Delta B_{ijh}^{t}$$

$$\Delta B_{ijh}^{t} = \begin{cases} b_{ijh} B_{ih}^{t} & if\, b_{ijh} \leq 0 \\ b_{ijh}(B_{ih}^{max} - B_{ih}^{t}) & if\, b_{ijh} > 0 \end{cases}$$

U_{jh}^{0} is the need independent utility. $0 \leq B_{ih}^{t} \leq B_{ih}^{max}$ denotes the need of person h on time t and on dimension i. $-1 \leq b_{ijh} \leq 1$ is identified as potential to satisfy need i for activity j and of person h. ΔB_{ijh}^{t} is the change of need. B_{ih}^{max} is however, representative of maximum size of person's need. Potentials properties are attributed as effects of activities on needs and explain the lessening or growth of the needs. Furthermore, j subscript represents all characteristics of activities like location, duration, accompanying person and time of the day. After completion of one activity and before starting other activity, a function to update needs is defined as follows (Arentze & Timmermans, 2009):

$$B_{ih}^{t+V_j} = \begin{cases} B_{ih}^{t} + \Delta B_{ijh}^{t} & if\ \Delta B_{ijh}^{t} \neq 0 \\ B_{ih}^{\oplus}(B_{ih}^{t}, V_j) & if\ \Delta B_{ijh}^{t} \neq 0 \end{cases} \quad (2\text{-}3)$$

$$B_{ih}^{\oplus}(B_{ih}^{t}, V_j) = \frac{B_{ih}^{max}}{1 + \left(\frac{B_{ih}^{max}}{B_{ih}^{t}} - 1\right)\exp(-\beta_{ih} * V_j)} \quad (2\text{-}4)$$

V_j, in the above equation represent the time consumed (duration) on the activity. β_{ih} is constant used for growth speed of need i of person h. Needs grow over period of time independently according to the growth function presented in equation 2-4. Replication of activities on regular interval is explained by this induced growth.

Attributes of the activity are dependent on potentials b. To model the continuous impact activity attribute duration on potential b, following expression is used (Arentze & Timmermans, 2009):

$$b_{ijh} = \left(\frac{1}{1+exp\left(\beta_{jh}^{\alpha}[\alpha_{jh}-V_j]\right)}\right) b_{ijh}^{0} \quad (2\text{-}5)$$

where -1≤b_{ijh}^{0}≤1 explains the maximum activity potential for attributes other than duration and β_{jh}^{α} and α_{jh} are the constant parameters. The expression in brackets is S-shaped function, which grows to one as maximum value and duration spent is relatively extended (long) in comparison with α otherwise to minimum zero. Where, β is positioned at influction point and it refers to marginal potential for duration. Besides, if positive marginal potential is supposed to exceed maximum duration than this function do not apprehend the negative effect for longer durations which leads to bore-dome or beyond the satisfaction limit(Arentze & Timmermans, 2009). Consequently, due to scarcity of time, it is rare for an activity to enter in phase of negative marginal returns.

As mentioned above that theory suggests that activities have positive or negative effects on needs. Negative effect induced other activities to satisfy the same need and positive effect satisfies the need with only one activity. However, this fact explains the concept of substitution and interaction relationship among the activities, within need based theory. For household activities the Equation 2-1 is transformed as:

$$U_{jh}^{t} = U_{jh}^{0} - \sum_{i\in I^S} \Delta B_{ijh}^{t} - \bar{\omega}_h \sum_{i\in I^G} \Delta B_{ijh}^{t} \quad (2\text{-}6)$$

Where I^S and I^G represent the subset of personal need and household need respectively. $\bar{\omega}_h$, represents the weight assigned to household needs relative to personal needs ($\bar{\omega}_h \geq 0$). This case is different from previous as the change in need (ΔB_{ijh}^{t}) occurs even if the activity is not conducted by the person due to the household shared needs. Consequently, other member may conduct the activity and it is represented in the equation as attribute of the activity. Need dependent component(U_{jh}^{0}) also becomes zero in that case. Additionally, $\bar{\omega}_h$ is indication of pre-disposition of the person h. value greater than 1 for this parameter refers to benevolence and less than 1 as extent of selfishness (Arentze & Timmermans, 2009).

2.5 Time fragmentation activities

The word fragmentation in dictionary is explained as process of splitting up into parts ("fragmentation - definition of fragmentation in English from the Oxford dictionary," 2015). Couclelis (2003, p. 11) defined fragmentation as a process which splits activity into parts of small sizes and these activities take place at different time and at different locality. Additionally, activity fragmentation is classified mainly in two types: "Temporal fragmentation" and "Spatial fragmentation". In case of temporal activity fragmentation, sub tasks are performed at different times. Likewise, in case of spatial fragmentation, different locations are used to complete the sub tasks (Hubers, Schwanen, & Dijst, 2008).

Bergadaà, (2007) identified four temporal frameworks for the individual's cultural activities. One of them is fragmented temporal framework. That refers to the individual's split up actions. Individual consider the urgency as a preferred mode and able to move to the next task quickly (Bergadaà, 2007). Furthermore, the use of this fragmentation process in need based theory is developed by Arentze &

Timmermans, 2009. Engagement in an activity for long time is productive but in extended term perspective it is doubtful. Likewise, for longer period, at certain point in time, amount of utility of activity is no longer productive or same amount of utility is produced. ΔT, correspond to need recover time and ΔB refers to satisfaction rates. "Need recover time" explains about time that need requires for reoccurrence to its original state, subsists before the activity. Graphs represent the compromise between long/short duration and high/low frequency between activities. To decide which pattern maximises the utility, average speed growth of need is considered in each interval time. It is suggested, second pattern utility is higher as speed growth is higher in that case. Concept of speed growth is defined in section 2.5 (Arentze & Timmermans, 2009).

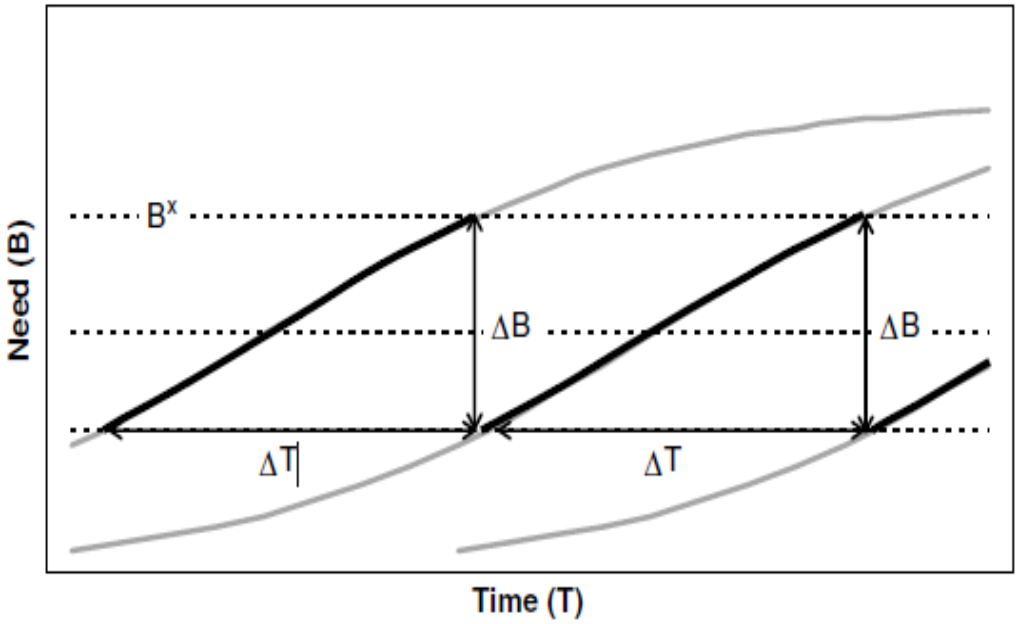


Figure 2-2 Temporal pattern of an activity for low frequency of long duration engagement
Source: (Arentze & Timmermans, 2009)

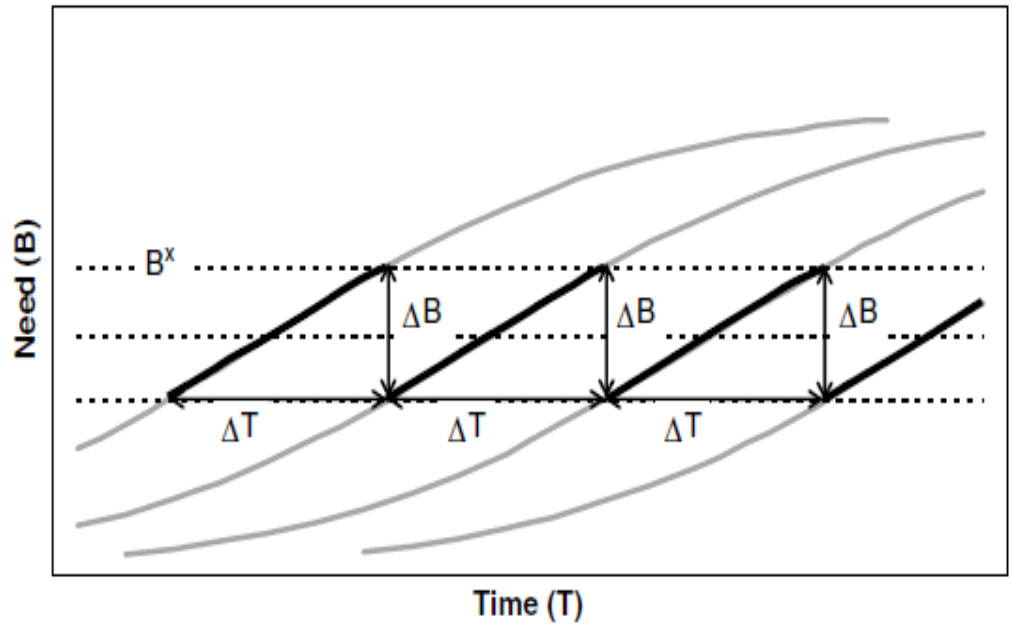


Figure 2-3: Temporal pattern of an activity for high frequency of short duration engagement
Source: (Arentze & Timmermans, 2009)

Thus it was concluded that with increase in frequency of an activity results in increase in derived utility monotonically. While, utility per unit time (UoT, in scarce time situation) spent tend to decrease at certain point. Additionally, convexity of utility of time (UoT) function demonstrates the relationship that arises to the certain point where unit activity time yields maximum need satisfaction. Than further increase in frequency means activity time (duration) is no longer productive and UoT tend to become relatively low on further investment of time (Arentze & Timmermans, 2009). Hubers, Schwanen, & Dijst, (2008) however, discussed the negative affect of activity fragmentation on transportation flows. Activity fragmentation clearly increases demand and in result road congestion can increase at certain time (Hubers et al., 2008).

2.6 Evaluation of models to measure time pressure

Among the limited studies available to measure influence of time pressure on activity travel behaviour along with task complexity by Chen, Chorus, Molin, & Wee, (2015) is summarized in this section. Task complexity besides time pressure is modeled in discrete choice model. This study is a contribution to travel behavior modeling and data from activity travel simulator, specially designed for the study, is used to incorporate the complexity of task computed with time pressure in discrete choice model used for activity travel behavior (Chen et al., 2015). In this section, experimental relevancy with time pressure is focused because the result of the study by Chen et al. (2015) concludes that there is no interaction effect found between time pressure and complex activity pattern therefore, in presence of high level of time pressure there is no significant improvement of the effect of task complexity on the travel behavior (Chen et al., 2015).

2.6.1 Model development

This section originally induced from the article by Chen, Chorus, Molin, & Wee, (2015) and explains time pressure in discrete choice modelling. Discrete choice model adopts the theory of random utility maximization proposed by McFadden 1973. Utility of the alternative i is, $U_i = V_i + \varepsilon_i$ where V_i systematic component is andε_i, is random error component. In case of k attributes, V_i has linear parametric function form as $V_i = \sum_{k=1}^{K} \beta_k \, . x_{ik}$, in this equation β_k is the weight of attribute k and x_{ik} corresponds to value of attribute k which the alternative for person i. It is known that for multinomial logit model distribution of the random component is "independently identically distributed (IID)" with "extreme value type-I" (Chen et al., 2015). Choice probability in this case is as follows:

$$P(i) = \frac{e^{\mu . V_i}}{\sum_{j \in c} e^{\mu . V_j}} \qquad (2\text{-}7)$$

μ represents to scale parameter and in inverse relation to error term variance $var(\varepsilon) = {\pi^2}/{6\mu}$. Scale parameter is set to normalization value 1 because it is not possible to identify mutually with taste variable so the variance takes value as, ${\pi^2}/{6}$. MNL model suggests that under IID assumption error term for alternative i is independent of the alternative j and variance of all the error term distribution of each alternative is same. This fact is termed as homoscedasticity. When this error term is no longer identically distributed among alternative this is called heteroscedastic logit (HL) and this

flexible model is used for choice tasks with different levels of task complexity. Effect of time pressure is modelled on travel behaviour through incorporating it in an heteroscedastic model. In the HL model, the scale parameter μ is characterized as an exponential of time pressure and constant in task choice represented by s (Chen et al., 2015) . This function follows the form:

$$\mu_s = \exp(\alpha(DS_s)) \tag{2-8}$$

Where $\alpha(\,)$, is a linear function and DS_s is associated measure of time pressure in choice situation s. The measurement associated with task complexity and the interaction effect is eliminated because the focus of this study is only time pressure. It was hypothesized that high time pressure will increase the difficulty in choosing the alternative with highest utility and it will make scale parameter μ smaller and variance of the error component larger. This also relates to the increase in randomness in choice made (Chen et al., 2015).

2.6.2 Measurement of time pressure

The authors used the concept of time pressure in terms of time expended on making a decision. This is associated with the term *time budget constraint*. It is assumed that if an individual has less decision time budget will result in experience of high time pressure. The time pressure is measured as follows$DS_s = {}^{DT_s}/_{DTB_s}$, in this expression DS_s relates to time pressure measure in choice situation, DT_s accounted for actual decision time and DTB_s represents to decision time budget in choice situation s. The difference between actual decision time and time decision budget is explained through an example. If a person has available time budget of 80 seconds and he is able to decide in 75s and another individual, make decision in 40s than the first person will more pressured then the other. Time pressure measure for first person is 0.94 and for second it is 0.50. It is derived from the hypothesis that scale decreases as the function DS_s and if its value get close to zero that means individual did not care about the best option and he used small portion from time budget available. It can also be related to the absence of engagement to the choice experiment. Furthermore, small values of DS_s mention small scale values, which gives "*inverted U-shaped curve*". This is called *engagement effect*. HL model incorporates both engagement and time pressure's monotonically decreasing relationship with scale. "Linear" and "quadratic" both terms for DS_s variables are offered in HL model. If reversed U-shape is resulted from the experiment then DS_s is considered as *engagement time pressure* instead of *time pressure* merely (Chen et al., 2015).

The systematic component of utility is formulated as, $V_i = \beta_{TT}.TT_i + \beta_{TC}.TC_i + \beta_{TI}.TI_i + \beta_{Car}.Car_i$, where TT_i is indicates the travel time of alternative i; TC_i represent the travel cost; TI_i indicate number of travel interchange. Car_i is dummy variable which takes value 1 if travel mode is car otherwise zero (Chen et al., 2015).

2.6.3 Scale Specification

Scale parameter is included in heteroscedastic model takes the form as, $\mu_s = e^{(\delta_T .DS_s + \theta_T.DS_s^2)}$, DSs denotes the engagement/ time pressure; δ_T and θ_T signify the parameter for *linear* and *quadratic* factors of the engagement time pressure or simple time pressure index respectively. A non-monotonic relation between the scale of utility and engagement/time pressure exists which is

mentioned in Section 2.6.2. δ_T is expected to increase positively and θ_T is negative and engagement/time pressure index is hypothesized to have optimum value which is between high or very low value. Developed HL model was estimated along with three other models: MNL model, mixed logit (ML) model and heteroscedastic mixed logit (HML) model. Mixed logit model do not take into account scale effect but taste heterogeneity. On the other hand, HML model takes both into account. Model was estimated on 1356 observed choices 12 choices from each participant (Chen et al., 2015).

2.6.4 Results

Results from estimation of models are mentioned in the Table 1. This research will only discuss the effect of time pressure. Parameters δ_T and θ_T found significant and are equal to 2.56 and -3.96 respectively. This proved their hypothesized non-monotonic relation with scale parameter. Figure 2.4 indicates plotted relation between *engagement time pressure* or *time pressure* and scale. In the Figure 2.4 dotted line is representative of *HL model* and the continuous line denotes *HML model*. Y-axis signifies scale value/ exp(D_s). The curve in the Figure 2.4 represents that scale value first increases until the optimized value () is reached, as DS_s increases farther this optimal value starts decreasing. It is consistent with hypothesis that for the very small value of DS_s means the no engagement with choice task of the participant. Decision made become more random in presence of high time pressure. it is suggested that travel choices can be governed by considering the travelers sensitivity to time pressure (Chen et al., 2015).

Table 2-1: Estimation of results

Parameters	**Value**	**t-stat.**	**Value**	**t-stat.**	**Value**	**t-stat.**	**Value**	**t-stat.**
Mean ($\boldsymbol{\beta_{TC}}$)	-0.0415	-2.74	-0.0738	-2.66	-0.115	-4.75	-0.159	-3.88
Spread ($\boldsymbol{\beta_{TC}}$)^a					(0.115)		(0.159)	
Mean ($\boldsymbol{\beta_{TT}}$)	-0.0125	-2.16	-0.00669	-0.63	-0.0476	-5.10	-0.0636	-3.67
Spread ($\boldsymbol{\beta_{TT}}$)					(0.476)		(0.0636)	
Mean ($\boldsymbol{\beta_{TI}}$)	-0.373	-14.41	-0.690	-3.86	-0.590	-9.72	-0.938	-5.20
Spread ($\boldsymbol{\beta_{TI}}$)					0.406	4.21	0.590	2.63
Mean ($\boldsymbol{\beta_{Car}}$)^b	0		0		0		0	
SD ($\boldsymbol{\beta_{Car}}$)					1.70	6.07	2.92	4.12
$\boldsymbol{\lambda_{DT}}$			-0.0101	-6.05			-0.00745	-3.16
$\boldsymbol{\delta_T}$			2.03	3.95			2.56	4.44
$\boldsymbol{\theta_T}$			-3.36	-4.58			-3.96	-5.01

Source: (Chen et al., 2015)

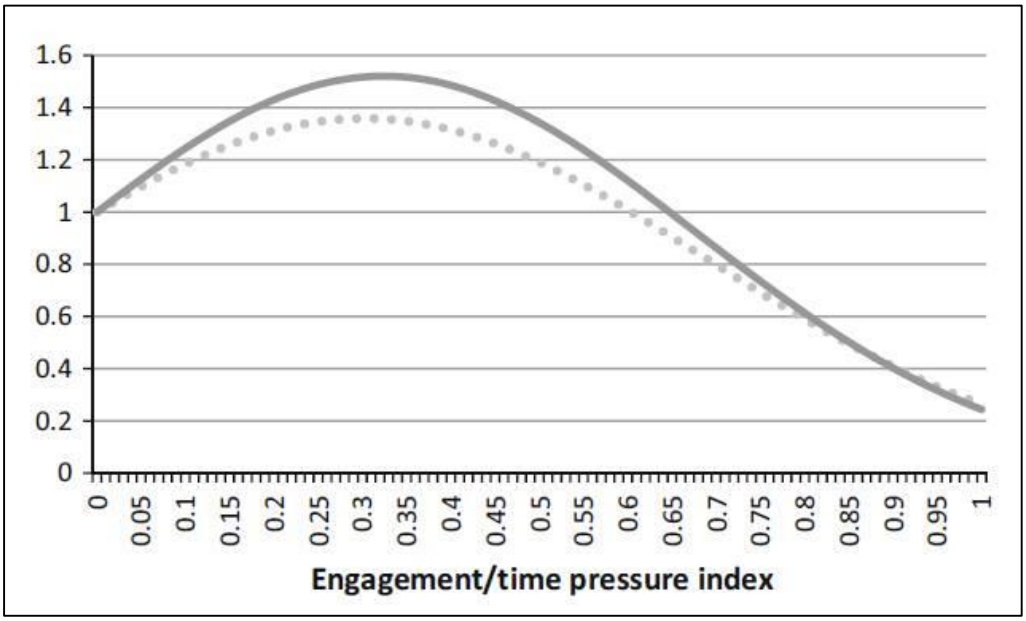


Figure 2-4: scale parameter on y-axis as a function of DSs ("HL model" represented by dotted line, "HML model" represented by solid line)
Source: (Chen, Chorus, Molin, & Wee, 2015)

2.7 Relevance of time pressure in activity modeling

Activity based modeling (ABM) framework is originally designed to capture realistic travel demand on road networks. In previous practice, models were developed considering the aggregate flow which was dependent on network capacity. The activity based (AB) models generally evaluate the travel demand management and transport supply strategies. Consequently, assessing the road pricing or congestion charging schemes, intelligent transportation systems and behavioral effective programs i.e. ride sharing or flexibility scheduling. AB models are able to predict the daily travel pattern of activities carried out by individuals (Auld & Mohammadian, 2012). Time pressure plays relevant part in daily activity scheduling and rescheduling. Dynamic investigation of travel behavior is relevant to the success of *congestion administration* and *intelligent transportation systems* (Lee & McNally, 2006, as cited in García-Jiménez, Ruíz, Mars, & García-Garcés, 2014). Therefore, short term and medium term rescheduling decisions play important part in routine activity agenda (García-Jiménez, Ruíz, Mars, & García-Garcés, 2014).

Arentze & Timmermans, (2009) proposed a model to generate activity agenda for household and it takes into account the dynamic nature of activities though considering the interaction between activities. They developed their model based on need based theory as described in Section 2.4. They introduced a decision rule for generating activity agenda which is reproduced in this section as it is the only study (to best of author's knowledge) considering the time pressure in process of generating agenda. This rule aims to maximise the utility in terms of timing and duration decisions. At first need is established, after that duration (V) is determined for maximum utility. This duration helps in calculating the utility (U) and if value of utility of time (UoT = U/V) is greater than threshold then activity is included in schedule otherwise it will be excluded or postponed. This rule is repeated for all the activities in stock. The expression used to measure utility of time takes into account the potential interactions between activities. The threshold term is used for the minimum threshold utility-of-time.

Considering the time as scarce component, minimum UoT is levied on each activity to get maximized utility within available time budget. Furthermore, time pressure depends on needs and time desirable for mandatory activities and it varies accordingly. Higher scarcity of time yields higher value of UoT of activity. If threshold indicates accurate value of time pressure, then rule is said to be optimal. Lower threshold value means exceeding time budget for the day otherwise available time still remains. However, unequal distribution of mandatory activities over week days sets threshold specific to day of the week which represent time budgets of day-varying size. As this study used the household context, therefore more than one individual can conduct the household activity. Household activities can reduce time-budget for personal activities (Arentze & Timmermans, 2009).

According to the study by García-Jiménez, Ruíz, Mars, & García-Garcés, 2014, scheduling process data is collected by using typical quantitative methods. These methods include the observing attributes, changes in activities and associated travel trips. Quantitative approach gives incomplete explanation for the reasons behind rescheduling decision. However, qualitative methodology rather better explains planned and observed behaviour. The determinants for flexibility in activity scheduling process are explored through qualitative analysis of open ended answers from a survey for rescheduling decisions over span of seven days. The survey was conducted in two wave activity panel spread over period of two years. The determination behind the panel study was to get better insight of the effects of travel change choices on scheduling process. Each survey was further divided in three phases. In first phase, pre-planned activity schedule for a week, was determined through face-to-face interview. The second phase consisted of comparison between observed and pre-planned activity schedule. Characteristics of activities (location, time and duration) were collected through a mobile phone device with application of activity-travel diary. Third phase was about investigating the causes for difference in executed and planned schedules though in-depth telephone interview (García-Jiménez, Ruíz, Mars, & García-Garcés, 2014).

Qualitative analysis includes identification of the themes and formulating hypothesis. The open-ended answers of the respondents inspect ‘why’ people change their travel pattern from planned schedules. Therefore answers to the question classified reasons into categories. These categories are quoted as follows taken from García-Jiménez, Ruíz, Mars, & García-Garcés, (2014).

a. *Social determinant: the decision is influenced due to people’s relation with other.*
b. *Household determinant: The decision is changed due to plans of other household member i.e. children, parents or spouse etc.*
c. *Non-household determinant: decision is influenced because of the friends or other social gatherings.*
d. *Weather determinant*
e. *Mandatory activity determinant: examples include work and going school or university*
f. *Discretionary activity determinant: volunteer, social, community/civic, beauty, sports, etc.*
g. *Maintenance activities determinant: banking, household and personal activities, appointments, shopping, eating, sleeping, laundry etc.*
h. *Resources determinant: the decision is influenced due to limitation or constraints in resources.*
    - *Own resources: individual can control these resources (income)*
    - *External resources: individual cannot control these resources (availability of public transport or private transport)*
i. *Activity timing/duration determinant: the decision may delay in subsequent or preceding activities.*

Under above mentioned influences either activity is supressed or attributes (location, mode, duration etc.) are changed. This study is interested in all categories of reasons ‘why’ people change

their decision. Resource and activity duration determinant are related to the time budget and time deadline constrains respectively. Moreover, from above mentioned panel study, 6 out of 60 responses have been categorised in these categories. The percentage for these reasons is 10 and it is quite reasonable number to address the effect of time pressure in activity scheduling, based on this study.

2.8 Comparison of dynamic activity scheduling and rescheduling agenda

In this study a comparison is made between two dynamic activity scheduling processes used in ADAPTS and Aurora. Leading authors for both models are Joshua Auld and Chang Hyeon Joh respectively. Concepts behind both models to accommodate dynamicity of activities are explained briefly to know the important properties of both models. A brief comparison is made and modified model is presented to track the use of time pressure in the agenda scheduling.

2.8.1 *Agent-based Dynamic Activity Planning and Travel Scheduling (ADAPTS) model*

The gist of concept is based on the article "Activity planning processes in the Agent-based Dynamic Activity Planning and Travel Scheduling (ADAPTS) model" published by Auld & Mohammadian, (2012). The concept used in ADAPTS is termed as "*planning order model"*. This model is influenced by the planning horizon concept introduced by Doherty in 2005. According to this concept, first a process is carried out with planning of activities and then planning of attributes for each activity and each component attribute further has its own planning horizon. Horizon refers to look at the possibility of that attribute to be planned. Time dependency of activity planning and scheduling process is the key of theory for this model. Moreover, planning schedule framework consists of three phases. *Activity generation* is the first phase and it is largely about the decision to add an activity on the schedule. Activity horizon is active at this moment and it involves the flexible values for some fundamental attributes of activities. Order of the attribute decisions are also decided at this stage and it is called "planning order model". Planning order modelling is the core step as it accommodates dynamicity of the activity planning process. This dynamic behaviour of activities is based on constraints, past experiences and current needs Next (second) stage is called "*Activity Planning*". At this stage the actual value of the activity attribute is determined and the order of activities is specified according to the conditional dependencies within attributes. Finally, the outcome of last phase is *actual scheduling* of activity and activity is added in the agenda and conflicts are resolved. Additionally, individual acts as an agent in ADAPTS model and follow the steps mentioned above to execute activity travel pattern. Simplifying this process into following research question that are resolved in above mentioned stages are:

- New activity added?
- Attribute values of existing activity initiated?
- Conflicts resolved?
- Planned activity is executed?

Fundamentally, ADAPTS simulates this activity scheduling process for certain time interval and then the integrated simulator generates the trip assignment on road network (Auld & Mohammadian, 2012).

2.8.2 *Agent for utility-driven rescheduling of routinized activities (Aurora) model*

Summary of the concept used in Aurora model is derived from the article "Modeling Individuals' Activity–Travel Rescheduling Heuristics: Theory and Numerical Experiments" by Joh, Arentze, & Timmermans, (2002). The authors suggested that time pressure is key function of activity rescheduling procedure. There are two modules defined for this model. First module determines the attributes of rescheduling alternatives i.e.; duration, location, sequence, travel mode, time of the day of activity and disutility of non-schedule activities. Subsequently, considering utility of all these options stretches the set of feasible rescheduling operations which are limited by bounded rationality (satisficing) in individuals. The second step is complimentary heuristic search model based on following assumptions:

- Individual tend to plan activities on initial agenda at a time and implement those activities which maximize their perceived utility
- Therefore, this process becomes iterative and stops when option which are best possible, likely to have satisfactory utility.
- A threshold is imposed for implementation of additional activities on agenda. This threshold is result of *resistance to change* and *mental effort* in adjusting the choices
- Resistance to change refers to type of change
- Number of changes implemented is determined by the amount of mental effort exerted.

The process starts with the existing schedule and utility of rescheduling process is evaluated by attributes. Utility of existing schedule assumed to have no adjustment in any activity and are stated as "current". Next step is if any rescheduling activity is needed by individual and it has higher evaluated utility than current schedule. Subsequently, rescheduling activity is implemented through the attributes that help increasing utility. The model is returns back to first stage and adjusts the schedule as to the existing schedule otherwise it will be suspended and existing schedule remains the same it was. Recurring back and adjusting schedule each time increases the mental fatigue. The duration attribute in this model has first to adjust with other attributes and then finely tuned around activity duration so that equilibrium state is achieved where marginal utility is the same between new set of activities in agenda. This process also accommodates the parameter related to resistance to change (changing the location to nearest, optimizing duration or mode etc.) that increase the threshold in utility (Joh et al., 2002).

2.8.3 *Modification of the dynamic activity scheduling process*

Overview of both processes of ADAPTS and Aurora illustrates that they share many common steps as both start with current schedule. Rescheduling is carried out to attain maximum utility for addition of an activity. Attribute evaluation is accomplished in both processes and activity is added to the schedule if the attribute choices contribute increasing utility. Otherwise, the existing schedule is implemented. Additionally, this study finds that in Aurora model more behavioral components are used. In processing of attribute evaluation Aurora suggests that the decisions are made with bounded rationality. That means considering the external constraints and limited information availability, individuals settle for a satisfactory option. On the other hand, this kind of behavioral rationality is missing in ADAPTS process. Aurora is also efficient in considering the effect of resistance to change on utility of activity, which is another missing behavioral parameter in ADAPTS. Furthermore, Aurora and ADAPTS both consider the duration of the activity is key attribute among list of options.

Based on both processes, a model is modified to identify the position of time pressure in daily agenda scheduling and rescheduling.

Figure 2-5 demonstrates the combination of two Processes (ADAPTS & Aurora) and it works same as explained in above paragraph. Time pressure is a new addition in the process and it is either the result of the addition of an activity or of unexpected delay in schedule. If an activity is included in the contemporary schedule, then time pressure is increased automatically. It is an inevitable component and its intensity depends on the available time budget. This research is particularly interested to investigate this time pressure as it gives rise to two notions: the first is objective lack of time that means time scarcity and the second is the set of associated actions (Lallement, 2010) referring to change in transport mode, speeding, change of route.

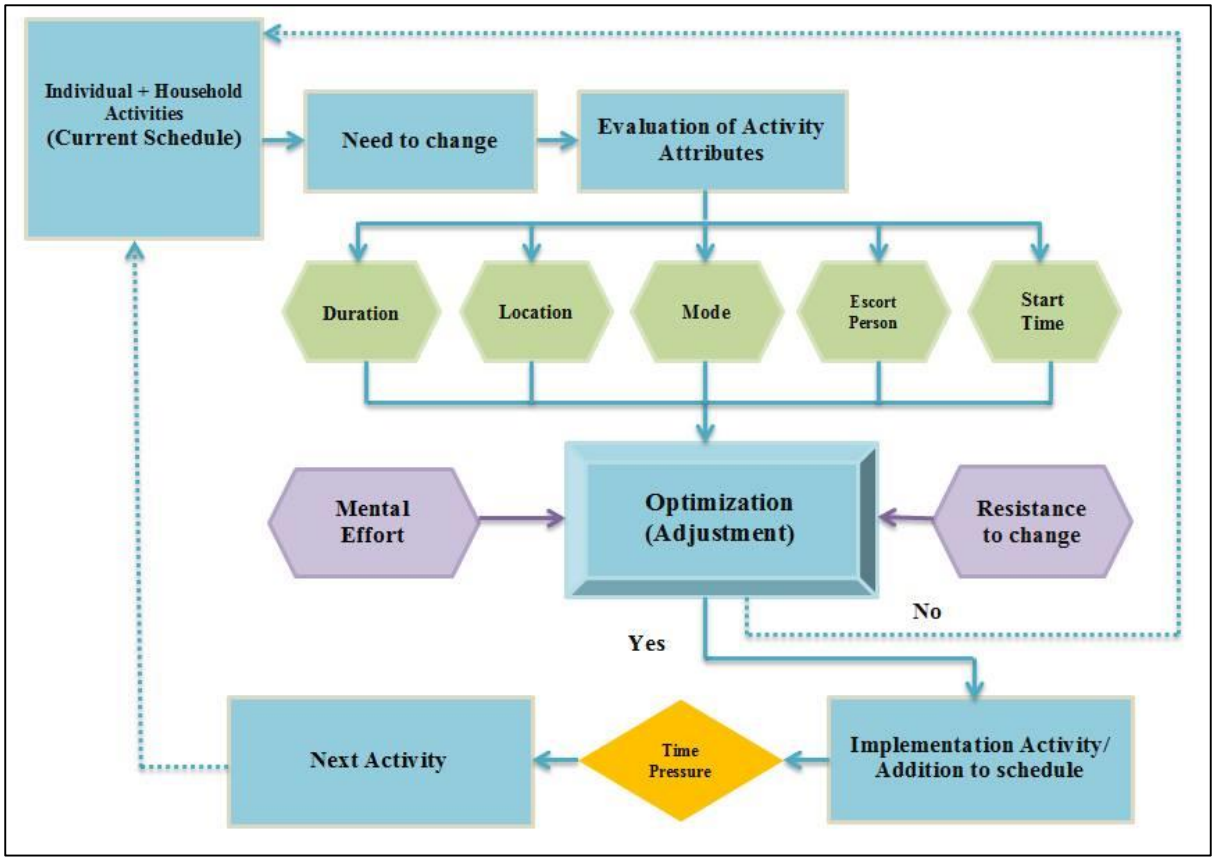


Figure 2-5: Dynamic activity rescheduling process based on ADAPTS and AURORA
Source: (Joh, Arentze, & Timmermans, 2002 & Auld & Mohammadian, 2012).

2.9 Determinants of time pressure

Factors that can determine the time pressure are studied from literature to use in the survey. Important determinants are explicated below:

2.9.1 Socio-demographics

There is no literature available to the date which explains the influence of time pressure on daily travel scheduling considering the demographical differences. However, there is literature available

studying who feel more time pressured. By studying these factors in this research can extend the scope of those finding in terms of travel decision. Furthermore, there is opportunity to confirm the assumption in surveys if they contribute the same. Gender difference is prominent in the influence of time pressure. This is consistent in many studies (Laurijssen & Glorieux, 2013; Roxburgh, 2002). People with high income are subject to work longer hours a week and yet they have greater demand for activities like dining out, volunteer work, attend movies and concerts, supports events and others outdoor activities that obviously generate travel need. They feel more time pressured than low income. Roxburgh, 2002 does not agree with the statement by Robinsen and Godbey, 1997 that well educated people feel more pressured than less educated. She concluded from her study that case varies among man and women. This statement is true for women that they are more under influence of time pressure than men if they are well educated. For men, prestige associated with higher education provides opportunity to manage time pressure. Author termed this as social resource for men and this is not a resource for women (Roxburgh, 2002)

Marital status is also another important determinant for time pressure. Married men are exposed to less time pressure then married women. The reason behind the fact is women are engaged in less flexible indoor and outdoor activities (preparing meal, taking care of children, laundry grocery shopping etc.). On the other hand men are engaged in relatively flexible activities like cutting grass, paying bills or car maintenance (Blair & Johnson, 1992; (Laurijssen & Glorieux, 2013; Roxburgh, 2002). Furthermore, full time worker, both men and women with children feel time pressure due to the responsibilities associated with child care. Among full time worker, again women are more subject to time pressure than men because of the devotion to their family (Laurijssen & Glorieux, 2013).

2.9.2 Value of time (VOT)

Individuals are "willing to pay" to save travel time which is directly influenced by socio-economic factors, *trip purpose* and *situational constraints* such as time pressure. Time pressure which an individual experience during the different time of the day is an influence of variation of VOT of same individual i.e. Time pressure varies on time of the day for an individual, such as reaching to office (Mandatory activities) or responding to emergency has high value of time. On the other hand, reaching to sports, friends carries less value of time (Leisure activities). Some leisure activities become more valuable in time if they have fixed schedule for example tickets to movie. That means individual has to reach on time to cinema. The insertion of additional time pressure before certain activity increase the value of time (Paleti, Vovsha, Givon, & Birotker, 2015).

2.9.3 Activity schedule complexity

Activity schedule complexity means availability of many alternatives to choose from and multidimensional activities i.e. combinations of activity chains and associated travel. According to Chen et al., (2015) if task complexity is high then individuals tend to choose random decisions and that leads to serious bias in forecasting effect of transport policies (Chen et al., 2015). The statement is true for the role of task complexity in activity travel choices. There is no study found to predict the role of activity schedule on time pressure. This research assumes that complexity in activity agenda increases the effect of time pressure. For example, if an individual has more number of activities than normal routine with complex trip chaining then it increases the time pressure and consequently, it may

affect decision choice for transport mode. Consider a person needs to pick up his kid from a school after work, and drop him to friend's birthday party. Afterward, he goes for a social visit along with his wife and picks up the kid on return to home. This represents the example of complex chaining and timing attribute is important. Therefore, such kind of situations employs time pressure and individual assumes car as faster mode of traveling.

2.9.4 Perceived Time Pressure (PTP)

Perceived time pressure (PTP) is a cognitive component and refers to situational constraints. For example, according to Theory of Planned Behavior (Ajzen, 1991), to make a decision about choosing transport, individual's intention is affected by three determinants. First determinant is attitude toward that mode, second is social pressure and third is perceived behaviour control (PBC). Perceived time pressure is related to perceived behaviour control (PBC). Perceived behaviour control refers to perceived difficulty to use specific mode (García-Jiménez et al., 2014). This research assumes the similar behavioural effect of PTP. Actual time pressure and perceived time are dissimilar terms. Considering the fact of overloaded and busy schedules there is general perception of less time availability among people who feel time pressured. Therefore, time pressure has impact on quality of life and decision making (Gleick, 1999, Roxburgh, 2004). Observed studies showed that perception of time pressure is higher in general population as it was before. People feel rushed often because of the less availability of time in America (Harris, 1987, Godbey and Graefe, 1993, Roxburgh, 2004). There are no studies available to investigate PTP effect on actual time pressure. This thesis hypothesized that PTP results in increasing actual time pressure and its effects on consequent actions in daily agenda.

2.10 Conclusions

Literature review search has provided determinants of time pressure including its significance within daily agenda. A conceptual model is developed to summarise what is investigated from literature research. Figure 2-6 presents the conceptual model to understand role of time pressure in daily agenda based on literature findings. This research suggests that determining factors for time pressure are socio-demographic, value of time (VoT), activity schedule complexity and perceived time pressure (PTP). Needs (goals and objectives) are confined within determinants, tools and constraints for the routine activities for individuals. This statement relates to the concept of satisficing. However, activities are imposed partially by community and partially by the individual's own heuristics. To fulfil goals and objectives, the individual has some *constraints* (time availability, duration of mandatory activities etc.) and *tools* (availability of car, organizational talent, ability to work at home, high frequency public transportation etc.) and *determinants* (PTP, VOT, number of activities). Determinants, tools and constraints altogether interact with each other and define the agenda for the day. The structure of agenda is characterized by time fragmentation, time budget constraints and deadlines. Each activity in the agenda has its own list of attributes. The most important attributes are duration of the activity, starting and ending time. This timing attributes help determining the time pressure in agenda. Time pressure is an inevitable component between the activities and it has different value or intensity for each activity for specific time of the day. Determinants influence the intensity of time pressure directly as presented by the link in Figure 2-6. Furthermore, it is effected by previous activity duration if takes longer than originally planned. In that case starting and ending time for each activity is essential in determining value of time pressure. At

the end of the day cumulative time pressure can be calculated from values of time pressure for separate activity.

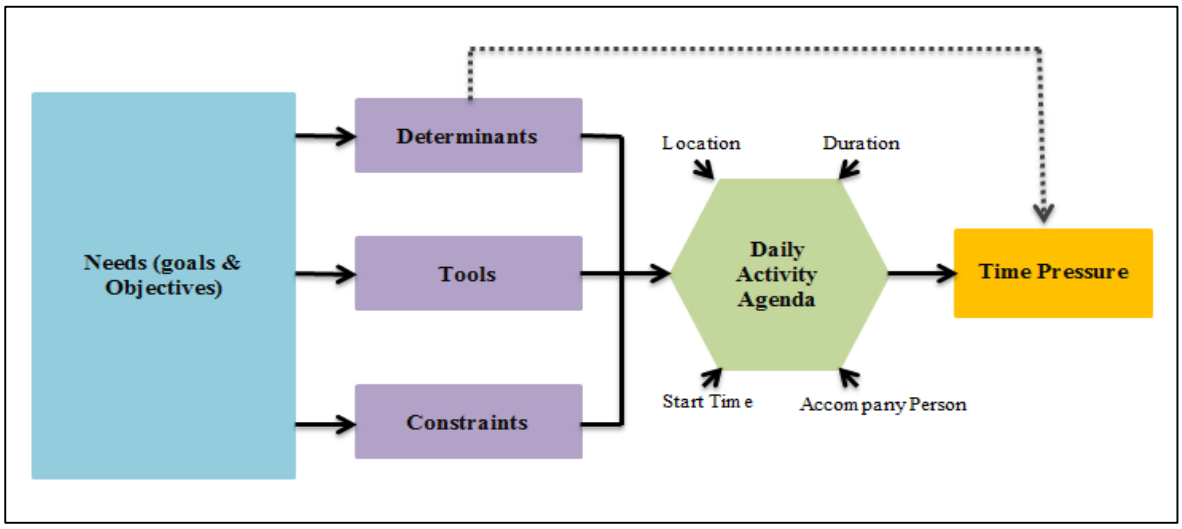


Figure 2-6: Framework for time pressure
Source: Author's own based on suggestions of supervisor, 2016.

2.11 Way forward

This chapter elucidated the concept of time pressure. Now it is possible to move forward to develop a rigorous definition for time pressure in the field of activity based modelling. The method used to measure time pressure by Chen et al., 2015 is used as foundation to modify the method in this research. Besides, few research questions arose during the literature review about time pressure that would be managed to resolve. For example, the effect of determinants like activity schedule complexity and perceived time pressure (PTP) are not investigated in literature before. Therefore, this research will be first to understand the effect of these determinants on time pressure which will further lead to study effect of time pressure on scheduling decision (objective). A survey will be implemented to analyse the research questions for this study. Suitable statistical techniques will be applied to get the efficient interpretation of data.

3 SURVEY DESIGN AND IMPLEMENTATION

3.1 Introduction

To keep track of what is found in the literature review, key concept of time pressure is repeated in this chapter. This research suggests that determining factors for time pressure are socio-demographic, value of time (VoT), activity schedule complexity and perceived time pressure (PTP). Needs (goals and objectives) are confined within determinants, tools and constraints for the routine activities for individuals. This statement relates to the concept of satisficing. However, activities are imposed partially by community and partially by individual's own heuristics. To fulfil goals and objective individual has some constraints (time availability, duration of mandatory activities etc.) and tools (availability of car, organizational talent, ability to work at home, high frequency public transportation etc.) and determinants (PTP, VOT, number of activities). Determinants, tools and constraints altogether interact with each other and define the agenda for the day.

Additionally, structure of agenda is characterized by time fragmentation, time budget constraints and deadlines. Each activity on agenda has its own list of attributes. The most important attributes are duration of the activity, starting and ending time. This timing attributes help determining the time pressure in agenda. Time pressure is an inevitable component between the activities and has different value or intensity for each activity for specific time of the day. Determinants influence the intensity of time pressure directly. The method presented by Chen et al., 2015 is used as foundation to calculate the time pressure. Besides, the effect of determinants like activity schedule complexity and perceived time pressure (PTP) are investigated in this research through online survey. Before moving toward questionnaire preparation, research questions are rephrased in following section.

3.2 Practical implication of research questions

After developing understanding from the literature study, research questions are modified to help formulate content of questionnaire. The questionnaire aims to consider following content:

- Needs of individual have influence on individual's agenda time pressure and needs are defined by the demographics. Who are they (Male/Female)? What they do (Profession/student)? How much they earn? etc. Do needs provide enough information to measure the time pressure?
- Availability of time, duration of the activity and type of activities refers to constraints and tools in the agenda of individual. Do they help developing significance pattern on time pressure during each activity in agenda?
- At first, actual time pressure will be calculated from the giving information of activity time. Later, perceived time pressure (Reported by respondents) is predicted by actual (calculated) time pressure.
- How many activity constraints are accepted during the day? Constraints can be evaluated from the reported list of activities, for instance if respondent report time pressure significantly after three or more activities. How the complexity of agenda (Number of activities) is relatable to the time pressure in agenda?
- Do people adapt their agenda as planned and if there are activities which were not planned originally, are they explanatory to time pressure in agenda?

- Finally, if mode choice can be predicted from calculated time pressure by knowing dependency relationship between time pressure and mode choice.

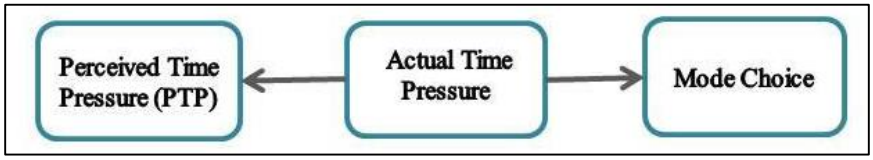


Figure 3-1: Research road map

3.3 Questionnaire Design

Questionnaires are typically used to perform the function of profiling the population in quantitative research. Therefore, they are used to record the behaviours, attitudes, experiences and general pattern of the specific set of sample population (Rowley, 2014). Survey design is elemental for this study, due to the fact that topic "time pressure in daily agenda" is investigated for the first time. Time period available for the task also needed a pragmatic approach to design questionnaire that can help collecting the suitable dataset to analyse. Questionnaire preparation is an iterative process to reach a set of working questions (Rowley, 2014). The process of preparing the questionnaire for the study is described in the following sections.

3.3.1 Structure of the questionnaire

Section 3.1, "implications of research questions" has formed the overview of the survey content. Flow chart in Figure 2-1 represents the structure of the survey which is correlated with the concept of time pressure.

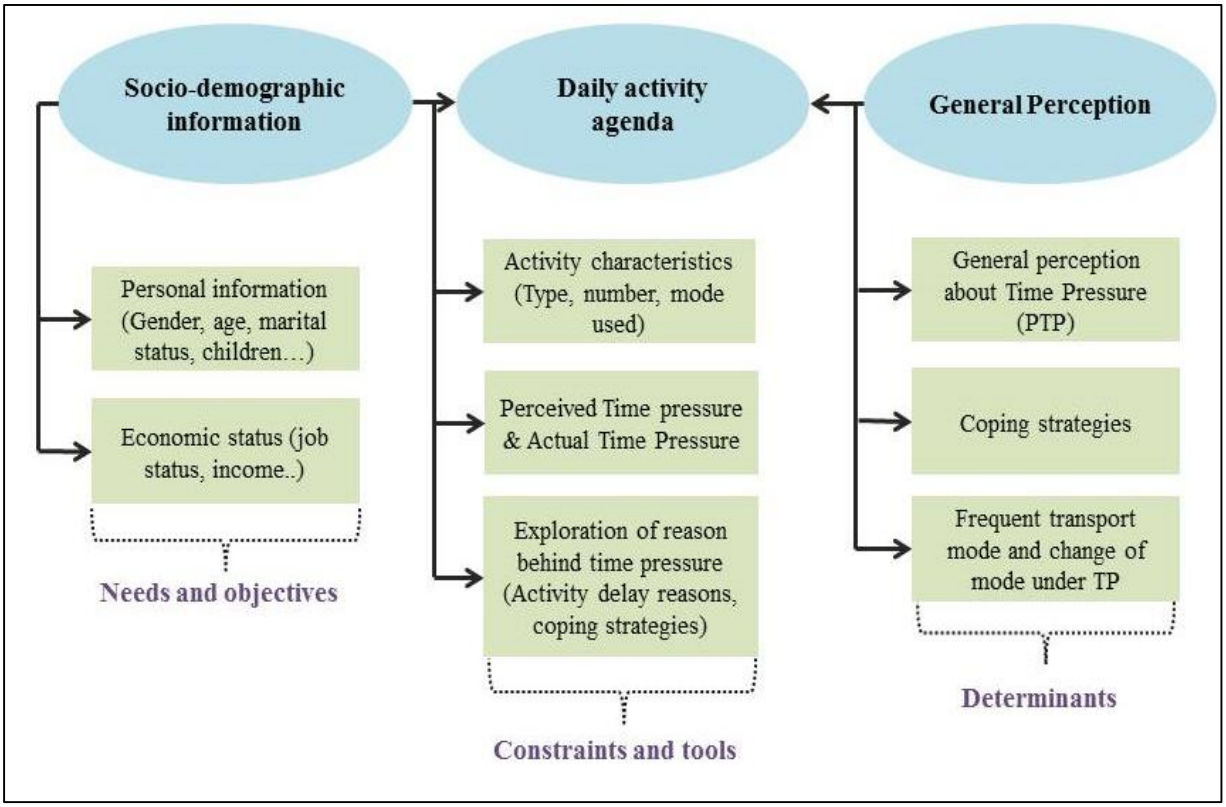


Figure 3-2 Flow chart of survey structure

3.3.2 Survey ethics

Online surveys are the source of quick response and large amount of information without involving the extensive cost of implementing the survey. Online surveys also eliminate the cost of travel to the respondent's desired meeting place. However, there are certain vulnerabilities related to online surveys such as coverage, non-response, sampling and measurement error. (Kraut et al., 2004 Johnson, 2005, and Lumsden, 2005, De Cesarei & Baldaro, 2015). Survey is designed considering the general ethics and code of conducts for getting practicable data. Important ethics taken into consideration are described in following points:

- Anonymity of questions is considered while designing. Personal questions are avoided, however, the questions, which were important to ask such as income level were included. Respondent are assured that the information will be kept anonymous.
- Questionnaire also takes self-image management into consideration representing the questions in such way that people do not answer to seek social desirability. For instance, question about perceived time pressure is not directly asked as "did you felt time pressure", rather it is asked "were you able to complete your activity in planned time/duration"
- Excessive length of the questions is avoided but the length of the survey is exceeded due to filling up of all activities in agenda (Maximum of 8).
- Open ended questions are not included in the survey as they were not required. Open ended questions require personal opinion which leads to increase time of the survey. They are also not considered good in analysis because researcher might interpret differently than respondents.
- Questions are targeted and include carefully selected options to cover the humanly possible choices.
- Accessibility of the questions is checked through testing the questionnaire first. Response and opinions are incorporated over the questions which were less accessible to respondents. Simple language is used for questions and their choices. Jargons and abbreviations are also avoided in the questionnaire.
- Questions are used in the logical order in order to involve the respondents
- Questionnaire start is the brief introduction of the survey and then continues with very simple question about their demographics.
- Offering something in return may increase the responses but this research is not funded, therefore, researcher could not offer anything in return.
- Administering the survey is important too. Therefore, respondents were made motivated through telling the purpose of the survey, use, completion time, last date for replying, survey result usage and complete contact detail in draft E-mail.
- Follow up reminder are also necessary to get more responses, besides some respondent might not be able to get time first time (De Cesarei & Baldaro, 2015; Gould, 2011).

3.3.3 Demographic profile

Among the determinants of time pressure, as described in section 2.9.1 that socio-demographic variability is basic consideration for this survey. To test this fact in survey it was decided to choose the following variables.

1. Location type (Urban, suburban and rural)
2. Age
3. Gender

4. Education level
5. Profession
6. Income level
7. Marital status

According to Rowley, 2014 questions design process is informed by experience and previous research. In this case there is no previous research and relevant research options are discussed by reviewing the most relevant literature. Socio-demographic questions were included in the first block in Qualtrics. The idea was to lead the respondent from informal start. Furthermore, their personal information like name and address for exact identification are strictly avoided, in case they don't want to share their identity. In the end of the questionnaire E-mail address is required if anyone want to know the findings of the research. Further elaboration for each socio-demographic variable is given below:

a. Location type: Location type is considered in the questionnaire to investigate the fact that people living in urban, rural or suburban areas have different pattern of effect on time pressure. For instance, living far from work place or school can introduce time pressure on certain activity in agenda or on the decision to choose transport mode.

b. **Age:** Age of the respondents is calculated by asking their birth year only. The compelling reason to ask the birth age has limited chances to cheat in describing age. Whereas, age is calculated through subtracting the current year (2016), from birth year reported.

c. **Gender**: literature shows consensus that time pressure is generally reported by females. Hence gender difference was included to study its impact pattern on time pressure.

d. **Education level:** Each country or region has their own specified levels for education. Survey target population is people around Belgium therefore, education level are adapted from the travel demand survey for Flanders (Onderzoek verplaatsingsgedrag vlaanderen) as it is. The list of option is presented below:
   - Primary School (1)
   - General Secondary school (not fully completed) (2)
   - General secondary others (Technical, professional, arts, sports....) not fully completed (3)
   - General Secondary school (completed) (4)
   - General secondary others (Technical, professional, arts, sports....) completed (5)
   - Higher non university degree (6)
   - University Degree (7)
   - None (8)

e. **Profession**: professional sector and status also seem to affect the time pressure in daily agenda. Corresponding impression is to study, if different profession contributes different amount of time pressure during daily life. Likewise, questions for professional activities are adapted from the travel demand survey for Flanders (Onderzoek verplaatsingsgedrag vlaanderen). First question is asked whether respondents are involved in professional activity. If they are not currently involved in any professional activity then all possible options are covered in the next question for example::whether they are students, looking for job or medically unfit to work etc. all possible choices for non-professional activities are described below:
   - Student (1)
   - Looking for job (2)
   - Pension (3)

- Unfit to work (Medical reason) (4)
- Working in own house (5)
- Volunteering activity out of home (7)
- Other (6)

Moreover, information about professional activity is assembled in two steps. In first step professional sector (Private or Government) and its status (Employed or self-employed) is inquired in addition of types as blue collar and office job. In second step, economic sector list is demonstrated in the questionnaire (Appendix-I) is based on the Statistical Classification of Economic Activities in the European Community, Rev. 2 (2008). It comprises of 23 economic activities. Corresponding fact is survey was largely distributed among the people in contacts with researcher and supervisor.

f. **Income level:** Income level is also a good variable to test for time pressure in daily agenda. In this research 6 classes of income levels are defined ranging from less than 1000€ to more than 5000€ as demonstrated in the Annexure-I

g. Marital status: marital status is another prominent variable which abounds in literature in relevance to time pressure as described in section 2.9.1. Marital status is demonstrated in 5 choices adapted from travel demand survey for Flanders (Onderzoek verplaatsingsgedrag vlaanderen) survey. It is described that married women feel more time pressured and even more if they have living number of children. Forgoing fact leads to add question about marital status and their number of children who live with them.

3.3.4 Daily agenda with time pressure

A separate block in Qualtrics is allocated to this section and carefully designed in order to get the appropriate dataset. To get the value of time pressure between the activities it is decided to acquire one-day schedule of a working day from the respondents. In activity based (AB) modelling, data for the scheduled activities is usually collected through using personal digital assistance (PDAs) and other supporting technological systems alongside interviewers that make sure the data entries are correct. For example, in recent years' activity scheduling behaviour is gathered on computer aided diaries like CHASE and PARROT etc. This study investigates the time pressure in a day schedule of respondents. Difficulty in situation happened as researcher does not have access to that kind of PDAs or computerized activity diaries. Therefore, it was decided to use online survey tool Qualtrics for that purpose. Notably, respondent has to report the previous working day by recalling all the activities he/she has performed that day. Before proceeding further toward contents encompassed in questionnaire, key concept of activity and trip combination is elucidated below.

Activity/trip concept

Study defines first activity in agenda is started with travel to certain location. Therefore, it is assumed that first activity will start with travel to one location and the amount of time spent there to perform certain tasks. Next activity starts with travel to another location and spending time there to do certain task or set of activities. For example, a person starts his day with going to work, traveling to work place and spends time in office work till lunch time. Likewise, at lunch time if he decides to go outside then it is considered another activity afterward going back to work place and doing work until he leaves for home is next activity. Notably, at one location people can perform many tasks or sequence of activities is the important consideration of this concept. For example, at home he can

watch television, sleep and prepare food etc. The visual representation of mentioned concept is shown in Figure 2.1.

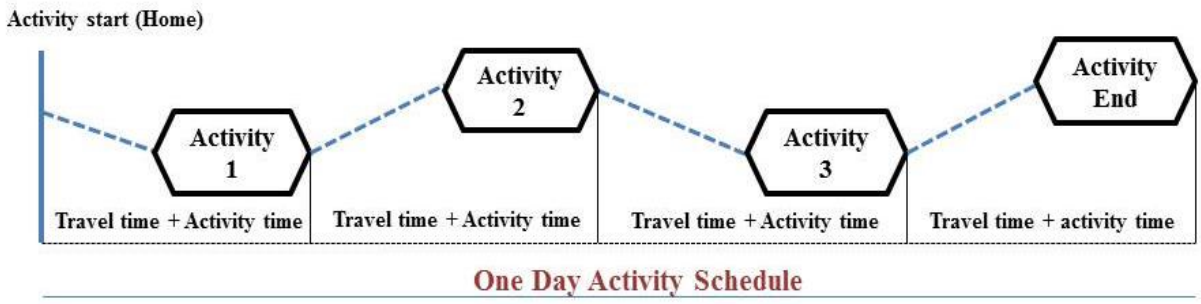


Figure 3-3 One-day activity pattern concept used in survey

Henceforth, questions asked in the survey are discussed. First question is asked about total number of activities they performed in a day. Respondents have to choose the number of activities from 2 to maximum of 8. Consequently, they need to fill the characteristics of each activity that many times the number they chose. Next question is about which working day they are reporting from Monday to Friday.

3.3.5 Questions about time pressure

Next block in Qualtrics survey comprised of the set of questions asked for each activity separately. The concept of activity and its associated trip is explained in simple statement and then respondents are asked about the type of activity either it is work or leisure. There is list of ten possible activity types as demonstrated in Appendix-I including *"other"* as a 11th option in case any type is missed. The list of activity types is also adapted from the travel demand survey for Flanders (Onderzoek verplaatsingsgedrag vlaanderen). Next question asked is related to planning of the activity; either it was planned before the execution day or not. In addition, actual start and finish time of the activity and planned start and finished time are inquired. Fact behind asking this question is the need to know the difference between actual and perceived reported time pressure. Next, a question is asked about the feeling of time pressure during the travel to the activity location. Time pressures, during the activity and during the travel to activity are dealt with separate concepts in this survey because one of the research questions of this study aims to know their influence separately. The next question is instrumental in the survey as it inquires if the respondents were able to complete that activity in the planned time. It is assumed that if an activity is not completed in the planned time, it will cause some amount of time pressure. If the person selects "no", then there are more inquiries about the reason behind this delay. Firstly, respondents are asked about the estimated excess time they will need to complete that activity. Afterwards, reason behind the delay in activity start time is questioned and it is anticipated that following possible options could be viable.

- Congestion (1)
- Missed or delayed Public Transport connection (2)

- Previous activity terminated later than expected (3)
- None (4)
- Other (5)

Next question is about investigating the reason of delay end time and the possible choices are:

- It started later than expected (1)
- It took more time than expected (2)
- Respondent got some additional/unplanned tasks to do (3)

Furthermore, it was also probed either respondent postponed the activity later that day, to next day or aborted as it is. Alternatively, if respondent will reply with completing the activity within planned time then they are asked additional questions about time pressure during the activity planned time. Whether they felt time pressure completing the tasks of activity or they did not. Investigating more in detail, respondents were asked about the time period when they felt time pressure: after start period, intermediate period and near end period. It is mentioned in the literature study under section 2.2 (Lallement, 2010) that how people tend to cope with time pressure. Coping strategy was also inquired from the respondents as they have to choose from accelerating, filtering the important activities and aborting the activities. Afterwards, respondents are asked question about the trip mode they choose for that activity. Following seven choices were provided:

- Private Car (1)
- Walk (2)
- Public Transport (3)
- Bike (4)
- Taxi (5)
- Car Pooling (6)
- Other (7)

To investigate the reason behind the car as trip mode, further queries were made about travel time from the activity location to the nearest bus and train stations. In continuation with questions associated with travel mode car, respondents were forced to think and choose among travel time, time pressure and complexity of agenda. All other options were eliminated in the question statement to keep respondent attention on these three aspects our study is interested in (Annexure-I Q32 and Q33). Next two questions are about the trip mode satisfaction level and to investigate about their perceived fast mood. Satisfaction level is presented over *likert* scale level of 5, from extremely satisfied to extremely dissatisfied. After knowing their satisfaction level, their perceived fast transport mode is questioned. It is interesting to know the fact if people are not satisfied and want to shift to another mode.

3.3.6 General perception of time pressure and mode selection

After questioning about each trip and activity characteristics separately, in the third block of the online survey, four more general questions were requested. First was general perception of time pressure and there are five choices (Statements) given which represent the feeling of time pressure.

These statements are equal to the *likert scale* of "almost always to almost never" having the feeling of time pressure. These statements are given as:

- Time is always scarce, I have to drop few activities due to time scarcity (almost always=1)
- Time is limited but I am able to complete even if it is later than scheduled time (usually=2)
- Time is limited but I can able to manage all the activities on time (occasionally=3)
- I always have enough time, there is spare time left after I complete my daily agenda plan (usually not=4)
- Time does not matter for the activities to accomplish (almost never=5)

The second question in this block is about the coping strategies for time pressure. Four strategies are adapted from the literature as explained in the section 2.2. One extra strategy is added for experiment, which is related to change in mode of choice under time pressure. Other strategies are named as *acceleration*, *filtration* of important tasks, *postponing* the activities and finally *aborting* activities. The third question in this block is ordering their frequent modes for taking trips to decreasing preference. The last question is also about ordering their decreasing preference but under influence of time pressure and complexity of agenda.

3.4 Survey implementation

The survey was implemented in two languages English and Dutch. As mentioned in the methodology, simple random sampling technique was used. Survey was distributed among the university students, contacts of the author and supervisor to get target response number (200-300). The survey was distributed officially through the IMOB administration office and students were advised to forward this survey to their parents for filling. The survey was implemented from 29-Feb-2016 to 17-03-2016. Despite of sending reminders the number of completely filled survey was 158. Therefore, data set contain 158 observations for survey indicators.

3.4.1 Test survey

After preparation of the survey, survey was tested to get overview and critics on the survey content. Test survey was conducted from 26-02-2016 to 29-02-2016. Two persons were chosen from targeted respondents and 2 from the field of transportation science to comment on it critically. Reviews of general respondents were motivating as they find this research very interesting and they did not complain about survey length. Few suggestions from the test respondents were incorporated in the final survey. However, comments from the persons related to transportation science complained about the survey length nonetheless due to the spread of activities up to eight it was not possible to reduce this. Length of the survey is potential limitation of this survey for drop out ratio. Preparing, testing and implementing survey took time more than it was originally planned. Therefore, in the following section updated timeline for thesis part-II is presented

3.4.2 Updated time frame

Dates are modified in the time frame for the thesis part-II as presented in the Figure 3-4. Survey design and implementation was originally planned to complete till middle of February but designing and testing were completed in the end of February and implementation took place till 17-march-2016.

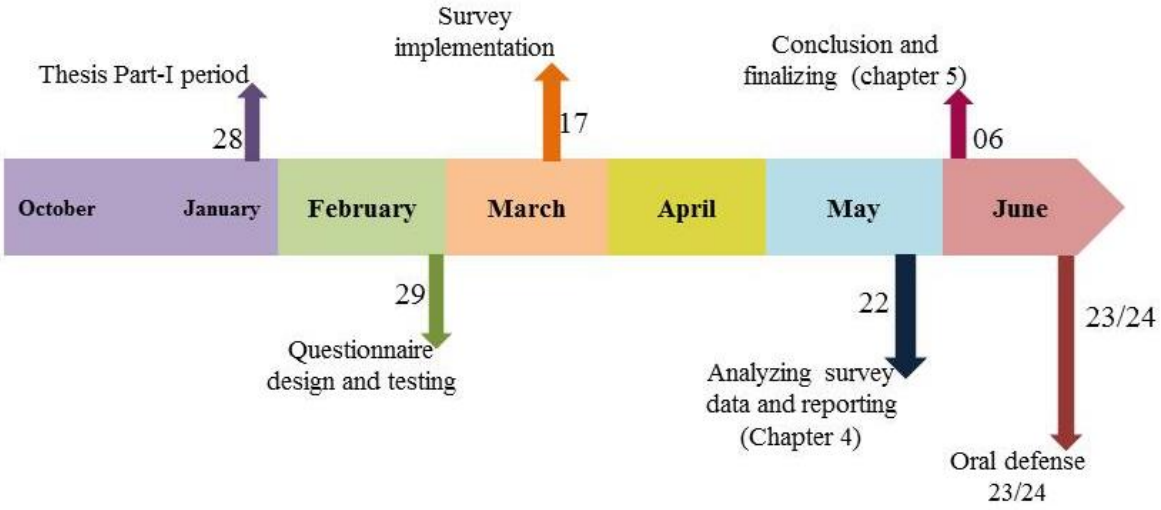


Figure 3-4Time frame thesis part-II

4 ANALYSIS AND INTERPRETATION

4.1 Statistical analysis: Concept and description

This chapter describes few key concepts which are further used in process of analysis. These concepts are briefly explained from the literature to make easier for readers to understand the terms used in the analysis.

4.1.1 Regression analysis

A simple linear regression involves set of independent variables and it refers that true mean of dependant variable changes with constant rate as the estimates of independent variable increase or decrease. This functional relationship between the mean of independent variable (Y) and set of independent variables ($X_1, X_2, X_3 \dots \dots . . X_k$) is represented by equation of straight line:

$$Y_i = \beta_\circ + \beta_1 X_{i1} + \beta_2 X_{i2} + \cdots \beta_k X_{ik} + \varepsilon_\circ \qquad (4\text{-}1)$$

$\beta_\circ$ is the intercept and represents the value of Y_i, when all other variables are ($X_1, X_2, X_3 \dots \dots . . X_k$) = 0. Whereas, $\beta_1, \beta_2, \dots, \beta_k$ represent the slopes on the line identifying the rate of change in Y_i per unit change in $X_1, X_2, X_3 \dots \dots . . X_k$. $\varepsilon_\circ$, represents the random error term which describes discrepancy in the approximation. Additionally, the error term has 0 mean and common variance σ^2 and it is pairwise independent. Where subscript i=1,2,3,..,n represents the observational unit or data points. X_{i1}, however represents the nth observation on independent variable and it is measure without error. Values of $X_1, X_2, X_3 \dots \dots . . X_k$ are the set of known parameters and $\beta_1, \beta_2, \dots, \beta_k$ are the parameters to be estimated from the data. The error term is assumed to be normally distributed in determining or testing the significance. Likewise, Y_i is also normally distributed (Chatterjee & Hadi, 2015; Rawlings, Pantula, & Dickey, 2006).

4.1.2 Logit model

Logistic regression model is used to find the relationship between discrete choices (binary, ordinal and nominal) and explanatory variables. It is pertinent to mention, logistic regression indicates linear relationship between logit and the specified set of parameters. However, logit is the log of odds. Let π be the probability of respondents saying "no" for being able to complete their activity on time. Then the odds are $\frac{\pi}{1-\pi}$. For binary logistic models, the response of variable, which are *TP_act*, *TP_travel* and *PTP_345_mapto_1* in this study, will take one value from two possible values. For example, TP_act = 1 if time pressure is not reported by respondent and TP_act = 2 otherwise. If there are k number of explanatory variables and i number of responses for individual whereas, $i = 1,2,3, \dots, n$ (Allison, 2012), then the logistic model is represented as:

$$logit(\pi) = \log\left(\frac{\pi}{1-\pi}\right) = \alpha + \beta_1 x_{i1} + \beta_2 x_{i2} + \cdots \beta_k x_{ik} \qquad (4\text{-}2)$$

Whereas, $\beta_1, \beta_2, \ldots \beta_k$ indicates the parameter estimates (vector of slope parameters) to be calculated in the model, and also referred to as log-odds or logit. However, α refers to the parameter of the intercept. Logistic procedure in SAS is enable to model the probability of "lower response level" (n.d.). Furthermore, logistic regression uses analysis of "maximum likelihood (MLE)" rather than "ordinary least squares (OLS)" for the parameter estimation. Binomial response variable does not require necessarily to be normally distributed rather it use distribution from exponential family in this regression model ("6.2 - Binary Logistic Regression with a Single Categorical Predictor | STAT 504," 2016).

4.1.3 Variable selection

Notably, the important problem in process of building the model is choosing from large sets of covariates, those variable which shall be included in the model. The criterion to include the variables in the model varies with different types of problems and disciplines. The most common method is minimization of variables until the model is found which estimates the "numerical stability" and "generalization" of results. Alternative view point of some statistician is that model should include whole set of variables irrespective of their significance to avoid baffling. However, this approach may lead to numerical instability and large standard error. Consequently, purposeful selection of variables is important in process of building a statistical model (Bursac, Gauss, Williams, & Hosmer, 2008). The commonly used methods for the selection of variables are forward, backward and stepwise selection methods which are used in computing logistic model in SAS 9.4. These three methods are briefly discussed in following.

a. **Forward selection**: In this method a chi-square statistic for each effect is computed and the procedure starts with no effects in the model. This method keeps adding the effect which has largest value of chi-squared test as well as significant until no variable left to be included in the model. Once an effect is entered to the model it will not be removed. It eliminates the effects which are not significant (Bursac et al., 2008).
b. **Backward elimination**: In this method Wald test statistic for each parameter are computed and the parameter with least significant effect is excluded first from the model. This step keep repeating until all non-significant parameters are excluded and model persist with the significant effects only (Bursac et al., 2008).
c. **Stepwise selection**: Stepwise selection method works in similar manner as forward selection except the fact that effects already entered in model do not necessarily remain. "Effects are entered into and removed from the model in such a way that each forward selection step may be followed by one or more backward elimination steps. The stepwise selection process terminates if no further effect can be added to the model or if the effect just entered into the model is the only effect removed in the subsequent backward elimination"(Bursac et al., 2008).

Depending upon number and type of variables, different selection methods are used in this in various models. Usage of the selection methods is explained in sections where these methods are used.

4.1.4 Quasi complete separation

In computing logistic model on SAS, author came across with this phenomenon of quasi complete separation many times. Therefore, it was imperative to study this phenomenon from literature to solve the issue in problem. Brief introduction and its solutions are mentioned in this section. Problem started when author found following warning message in SAS log:

WARNING: There is possibly a quasi-complete separation of data points in step 0. The maximum likelihood estimate may not exist.

WARNING: The LOGISTIC procedure continues in spite of the above warning. Results shown are based on the last maximum likelihood iteration. Validity of the model fit is questionable.

Quasi-complete separation phenomenon occurs when the response variable perfectly predicts the category or subgroups of predictor variable. For example, if the entire set of respondents who reported Thursday also reported that they feel time pressure (TP_act1 = 2). Consequently, response variable (TP_act1) perfectly separating that reported work day category. Other possible reason might be small set of sample size that coincidentally all response variable predicts only specific category. If the sample size was large enough, then it would be possible to get the observations for the respondent reported Thursday and also reported feeling of time pressure. Mathematically, maximum likelihood estimate does not exist for that predictor (W_day). In literature there are some techniques provided as a solution (Bruin, 2011):

- Easy strategy to solve this warning is "do-nothing". Due to the fact that maximum likelihood estimates for other variables are still valid. The drawback to this strategy is not getting the estimates for that predictor to predict response variable effectively.
- Excluding the variable is another solution too but it is not recommended as it can lead to biased estimates for other parameters
- Another solution is to merge the categories of the variable if it is feasible according to data requirements
- Exact command is also used in case if dataset is small. The problem, author see in this case is, this strategy works for only categorical variable having two categories. As in literature it is not seen with more categories. The example code is given as:

```
proc logistic data = work.saasdataset;
model TP_act1 = age TP1 TP_travel;
exact TP_travel1 / estimate= both;
run;
```

- There is another strategy called firth (bias-correction) logistic regression and it is the most recommended solution. It includes the penalization of likelihood estimation (Bruin, 2011).

```
proc logistic data = work.saasdataset;
model TP_act1 = age TP1 TP_travel / firth;
run;
```

4.2 Data cleaning and preparation

Data cleaning is done to omit errors and mistakes in the data either in form of wrong data entry or miscoding or missing data (Rowley, 2014). This survey consisted of detailed investigation to find out the significant effect of time pressure on people's choice of mode. Loop of eight activities in the dataset has contributed to the long list of variables to check significance on perceived time pressure. Few variables in the dataset are needed to be modified before use. Following two variables are modified:

- b_year => Birth year needed to be converted in age. Therefore, a new variable age was created using following code in SAS

  age = **2016**-b_year

- trip_mi => Trip mode for (i=1:8) for each trip is changed in following manner. Categories are merged in order to increase the number of respondents. Number of respondents were low in categories "Bike=4", "Taxi=5", "Carpooling=6" and "other=7". Henceforth, category of bike is merged with walk as "slow mode" and all other three are into one as "other=4". Coding in SAS for new variable "T_modei is given as:

  T_modei=trip_mi
  IF trip_mi=4 (bike) THEN T_modei=2 (Walk);
  IF trip_mi=5 (Taxi) or trip_mi=6 (Carpooling) or trip_mi=7 (Other) THEN T_modei=4 (Other);
  Where (i=1:8)

Additionally, before data can be used in the models it was required to prepare for its useful implication. Data was imported from the Qualtrics in form of coded choices. Therefore, time was saved from coding the data. There were some data entry mistakes existed by the respondents in filling the exact time. The required format for exact time was 24:00H. However, some respondents made mistakes in entering ":" and instead used semicolons, commas etc. Data was sorted and modified manually. Afterwards, data was provided with the short but relevant columns names to identify variables. Data was then imported in *SAS enterprise guide* to generate the simple frequency report for the descriptive analysis. Later, data was imported in *SAS 9.4* version to process logistics regression.

4.2.1 Time pressure (TP) calculations

The variables to be investigated are perceived time pressure (TP_act1:8) and time pressure (TP) during the travel to activity location. Alternatively, respondents also have to report their planned and actual start and finish time for each activity. Time pressure is calculated with an assumption that if people could not finish or start the activity on time it corresponds to some amount of time pressure. Based on this assumption, TP calculations are performed in following two methods.

Method 1: $$TP = \frac{A_{ft} - A_{st}}{P_{ft} - P_{st}} \quad (4\text{-}3)$$

Method 2: $$TP\_duration = \left(P_{ft} - P_{st}\right) - \left(A_{ft} - A_{st}\right) \quad (4\text{-}4)$$

A_{ft}: Actual finish time of activity
A_{st}: Actual start time of activity
P_{ft}: Planned finish time of activity
P_{st}: Planned start time of activity

Above mentioned methods are performed for eight activities of each respondent, as given variables in dataset from "TP1" to "TP8" and "TP_duration1" to "TP_duration8". The tool used to calculate time pressure is *SAS enterprise guide* by using the *query builder option*. Actual and planned times were inquired from the respondents for each activity. For TP calculation, if the ratio is less than one "<1" this indicates "no time pressure". Corresponding interpretation is, actual time spent on activity is less than the planned activity and respondent has availability of spare time in this case. Likewise, if the ratio computed is larger than one (>1) this indicates that there is time pressure. Therefore, actual

time spent on the activity exceeds the planned time for activity. However, if ratio equals to 1 indicates there is no time pressure and actual activity time is exactly same as planned. Formulae used in *SAS enterprise guide* are stated below:

TP1 = (t1.Afinish_time1 - t1.Astart_time1) / (t1.Pfinish_time1 - t1.Pstart_time1)
TP2 = (t1.Afinish_time2 - t1.Astart_time2) / (t1.Pfinish_time2 - t1.Pstart_time2)
TP3 = (t1.Afinish_time3 - t1.Astart_time3) / (t1.Pfinish_time3 - t1.Pstart_time3)
TP4 = (t1.Afinish_time4 - t1.Astart_time4) / (t1.Pfinish_time4 - t1.Pstart_time4)
TP5 = (t1.Afinish_time5 - t1.Astart_time5) / (t1.Pfinish_time5 - t1.Pstart_time5)
TP6 = (t1.Afinish_time6 - t1.Astart_time6) / (t1.Pfinish_time6 - t1.Pstart_time6)
TP7 = (t1.Afinish_time7 - t1.Astart_time7) / (t1.Pfinish_time7 - t1.Pstart_time7)
TP8 = (t1.Afinish_time8 - t1.Astart_time8) / (t1.Pfinish_time8 - t1.Pstart_time8)

Alternatively, in case of method 2, if "TP_duration" value takes negative value then respondent has some time pressure, in this case actual time duration is greater than planned time duration for activity. Additionally, if value of "TP_duration" takes a positive value then respondent did not experience any time pressure rather he has some spare time. Notably, there are some observations which take "0" value. It corresponds to no time pressure as respondent was able to complete activity on time. Outcome number in the newly created column is expressed in seconds. Formulae used for TP_duration are stated below:

TP_duration1 = (t1.Pfinish_time1 - t1.Pstart_time1) - (t1.Afinish_time1 - t1.Astart_time1)
TP_duration2 = (t1.Pfinish_time2 - t1.Pstart_time2) - (t1.Afinish_time2 - t1.Astart_time2)
TP_duration3 = (t1.Pfinish_time3 - t1.Pstart_time3) - (t1.Afinish_time3 - t1.Astart_time3)
TP_duration4 = (t1.Pfinish_time4 - t1.Pstart_time4) - (t1.Afinish_time4 - t1.Astart_time4)
TP_duration5 = (t1.Pfinish_time5 - t1.Pstart_time5) - (t1.Afinish_time5 - t1.Astart_time5)
TP_duration6 = (t1.Pfinish_time6 - t1.Pstart_time6) - (t1.Afinish_time6 - t1.Astart_time6)
TP_duration7 = (t1.Pfinish_time7 - t1.Pstart_time7) - (t1.Afinish_time7 - t1.Astart_time7)
TP_duration8 = (t1.Pfinish_time8 - t1.Pstart_time8) - (t1.Afinish_time8 - t1.Astart_time8)

Additionally, to investigate the combine effect of all activities of individuals in the final model, minimum of TP_duration and maximum of TP of all eight activities is computed in two new variables: "maxTP" and "minTP_duration". These variables explain highest time pressure during the whole agenda at-least one time. Coding for creating these variables in SAS is presented as:

```
data work.sasdataset;
set tp.sasdataset;
maxTP= max(TP1, TP2, TP3, TP4, TP5, TP6, TP7, TP8);
minTP_duration= min(TP_duration1, TP_duration2, TP_duration3, TP_duration4, TP_duration5,
TP_duration6, TP_duration7, TP_duration8);
run;
```

4.3 Profiling and descriptive analysis

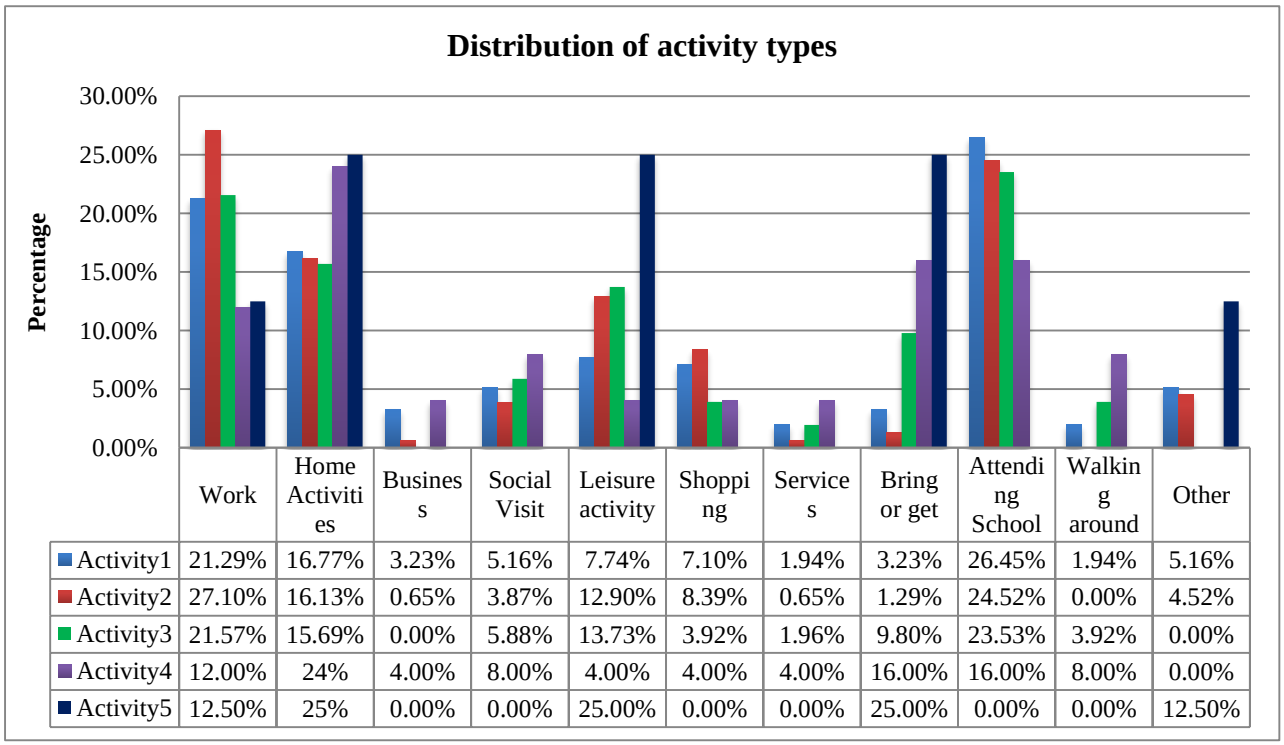
Description of data is the first step in analysing data. Descriptive analysis profiles the characteristics of the sample collected (Rowley, 2014). In this section simple percentages and frequencies are described so that variability in dataset can be congregated. The summary for important research indicators of 158 responses are accumulated in the Table 4.1. Additionally, the choices are not included in description table which were not reported by any respondent. For example, among the categories of education level choices such as "Primary School", "General secondary others (Technical, professional, arts, and sports) not fully completed" and "None" are removed as they were not reported by any respondent.

Table 4-1: Description of general survey indicators

No.	Variable	Description
1	Location type	45 respondents reported "**Urban area**", 61 are from "**Rural area**" and 52 reported from "**Suburban area**", corresponding percentages are 28.48%, 38.61% and 32.91% respectively
3	Gender	Frequency of the "Male" respondents is 76 and "Females" participants are 82. Corresponding percentages are 48% and 52%.
4	Education level	1 respondent reported about "General Secondary school (not fully completed)" and 36 reported that they have completed "General Secondary school". 10 people have completed "General secondary others (Technical, professional, arts, sports....)", 21 people have "Higher non university degree" and 90 respondents pursuing or have "University degree". Respective percentages are 0.63, 22.78, 6.33, 13.29 and 56.96%.
5	Marital status	103 respondents reported single, 42 are married, 11 in living together relationship and 2 reported as Divorced. Their respective percentages are 65.19, 26.58, 7 and 1.27%.
6	Living children in parents' house	Out of 158 respondents 39 reported that they have children and among these number 14 respondents reported that he/she has 1 child who live with them, 14 reported 2 children live with them, 3 reported that 3 children live with them, 2 reported that 4 children live with them and only one respondent reported 5 children live with them. Respective percentages are 41.18, 41.18, 9, 6 and 3%.
7	Non-professional activity	84 respondents reported "student", 3 reported that they were on "Pension" and 1 for each respondent reported that "Looking for job", "Unfit to work and "Other". Respective percentages are 93.33, 3.33 and 1.11% for each.
8	Professional activity	68 people responded to have professional activity further distribution is described as; 5 people reported as blue-collar in government job and 5 reported as blue-collar in private sector. However, 44 reported as office job in government sector and 12 people reported doing office job in private sector.
9	Employment sectors	Highest number of respondents is from the "Education" sector as counted 41. 10 people responded that they belong to scientific and technical activities. Respective percentages are 60.29 and 14.71. This shows less variability in employment sector is attained.
10	Monthly net household income	We have balance number of respondents in all categories. 39 people reported monthly income less than 1000€ (24.68%), 21 people responded their income level between the range 1001-2000€ (13.29%), 33 people have income range between 3001-4000€ (20.89%), 13 people has income range 4001-5000€ (19.62%), whereas, 13 people responded their income range above 5000€ (19.62)
11	Number of activities	104 out of 158 respondents reported 2 activities (65.82%). 26 reported 3 activities in a day (16.46%), 17 reported 4 activities in the day (10.76%), 3 people reported 5 same reported 6 activities. 1 person reported 7 and 1 reported 8 activities in the day
12	Working day reported	80 persons reported for "Thursday" (51.61%), 22 people reported for "Monday" and same number reported for "Friday" (14.19%). 10 (6.45%) persons reported for "Tuesday" and 21 person reported "Wednesday" (13.55%)
13	Perceived Time pressure (PTP)	20.25% (32) respondents reported almost always feel time pressure, 34.18% (54) respondents stated that they usually feel time pressure, 29.75% (47) respondent feel time pressure occasionally, 10.13% (16) respondents usually do not feel time pressure and 5.7% (9) almost never feel time pressure.
14	General time pressure coping strategy	30 (18.99%) people reported that they "Accelerate things" to cope time pressure, 11 (6.96%) people reported that they change to "Efficient mode" to save time, 80 (50.63%) people reported that they "Filter" important things to do and leave others, 36 (22.78%) people reported that they "Postpone things" to another day. Only one respondent (0.63%) reported that he/she "Abort" the activity If it gives too much time pressure.
15	Frequent travel modes for trips.	95 of the respondents chose their frequent trip mode "Car" on first priority and 25 reported that "walk" is their first priority. 14 people give public transport to their first priority. 2nd highest priority is given to "Bike" 34 (21.5%) people, further in 2nd priority list contains public transport 32 (20.25%) followed by walk 30 (19%). Least frequent transport modes used are Carpooling and Taxi having 5th and 6th priority in the list.
16	Travel mode choice under time pressure	People reported that they will opt for car as first priority if they are under time pressure (126 respondents out of 158), 2nd opted choice is carpooling (42 respondents out of 158) and 3rd opted choice is Public transport (43 respondents out of 158)

A set of variables was investigated for each activity in agenda depending on the number of activities selected by each respondent. Respondents had to fill this set of variables for each activity. It is not possible to describe in description table along with general variables. Therefore, description of important variables up to five activities is presented in form of graphs with their percentage distribution in following sections

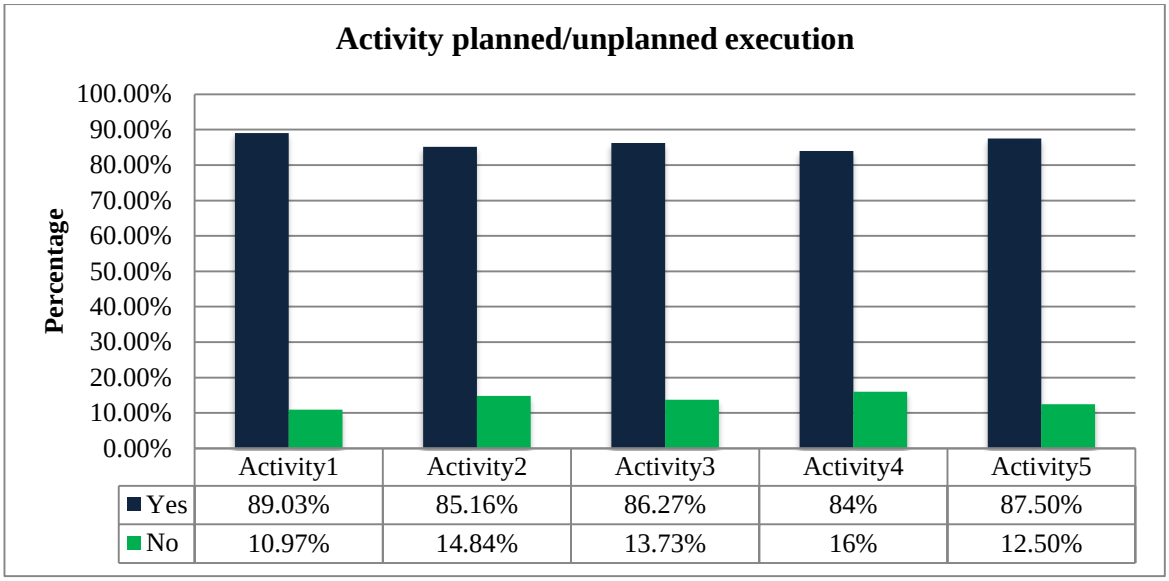
- **Activity Types in agenda:** Figure 4-1presents the distribution of activity types up-to five activities in agenda. *Attending school* and the *work* have highest rate of occurrence up to 3rd activity in the agenda. *Home* activity and *Bringing and getting* someone or something have highest occurrence at fourth place in the agenda.



	Work	Home Activities	Business	Social Visit	Leisure activity	Shopping	Services	Bring or get	Attending School	Walking around	Other
Activity1	21.29%	16.77%	3.23%	5.16%	7.74%	7.10%	1.94%	3.23%	26.45%	1.94%	5.16%
Activity2	27.10%	16.13%	0.65%	3.87%	12.90%	8.39%	0.65%	1.29%	24.52%	0.00%	4.52%
Activity3	21.57%	15.69%	0.00%	5.88%	13.73%	3.92%	1.96%	9.80%	23.53%	3.92%	0.00%
Activity4	12.00%	24%	4.00%	8.00%	4.00%	4.00%	4.00%	16.00%	16.00%	8.00%	0.00%
Activity5	12.50%	25%	0.00%	0.00%	25.00%	0.00%	0.00%	25.00%	0.00%	0.00%	12.50%

Figure 4-1Distribution of activity types up to five activities in the agenda

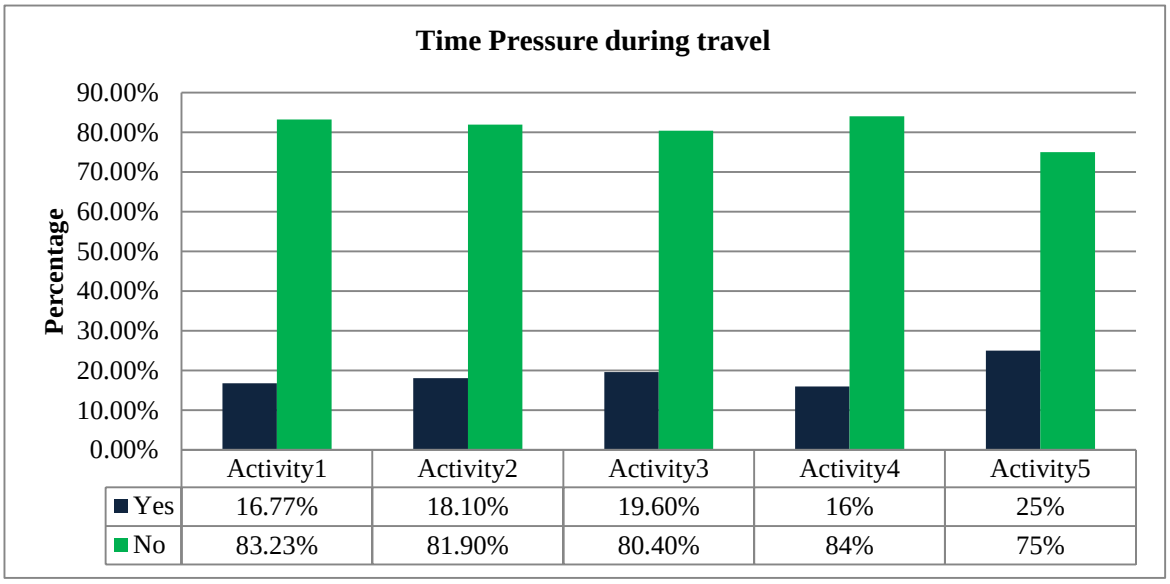
- **Planned/ unplanned execution of activities in agenda:** Figure 4-2 represents that execution of planned activities is very high among all five activities in agenda as compared to the unplanned execution of activities. To investigate detailed behaviour, cross table was computed between planned/unplanned execution of activity (pl_execution1) and time pressure in activity (TP_act1). Distribution of responses in cross table determined that people reported time pressure more for activities which were planned. For instance, in first activity only 9 respondents reported time pressure and only 3 of them reported time pressure for unplanned activities.



	Activity1	Activity2	Activity3	Activity4	Activity5
Yes	89.03%	85.16%	86.27%	84%	87.50%
No	10.97%	14.84%	13.73%	16%	12.50%

Figure 4-2 Distribution of planned/unplanned execution of five activities in the agenda

- **Time pressure (TP) during travel to activity location in agenda**: Figure 4-3 represents that feeling of time pressure during the travel to activity location is reported very less as compared to the no time pressure. Most of the people do not feel rushed to the activity location irrespective of the activity type and activity number in agenda. Chi-square association test indicated that time pressure during the travel is not influenced by interest variables such as planned/unplanned execution, trip mode, activity type etc.

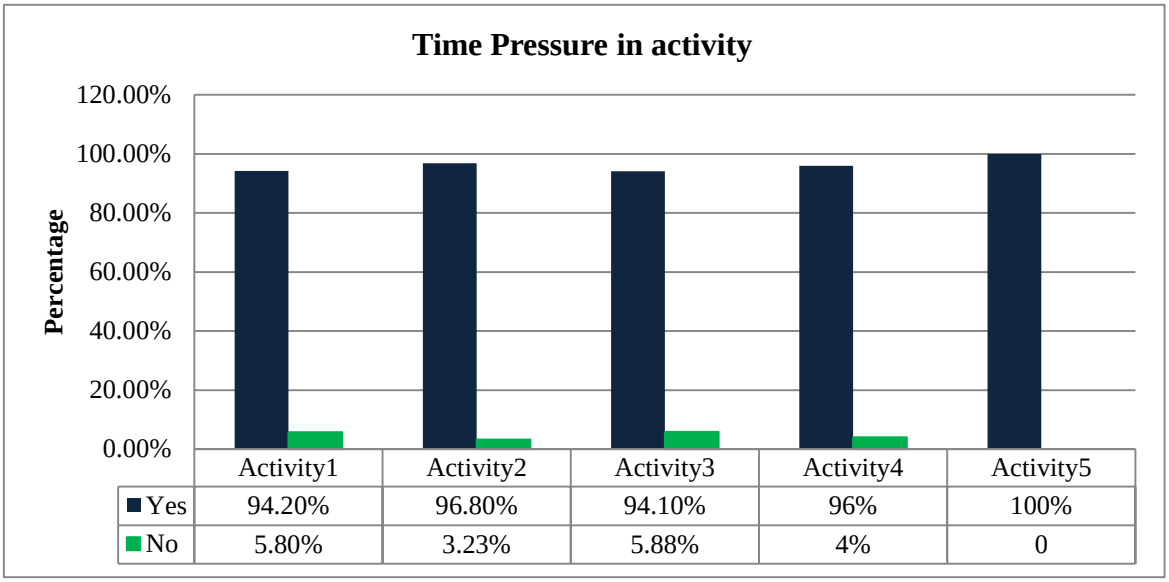


	Activity1	Activity2	Activity3	Activity4	Activity5
Yes	16.77%	18.10%	19.60%	16%	25%
No	83.23%	81.90%	80.40%	84%	75%

Figure 4-3Distribtion of time pressure (TP) during travel to five activities location

- **Time pressure (TP) in agenda:** Time pressure for activities is very important variable in this research and it was expected to get many responses from the respondents to have feeling of time pressure for activity. Surprisingly, people did not report about feeling of time pressure. However, TP calculation resulted in more number of respondents who actually had time pressure. Therefore, it is concluded that even if respondent have time

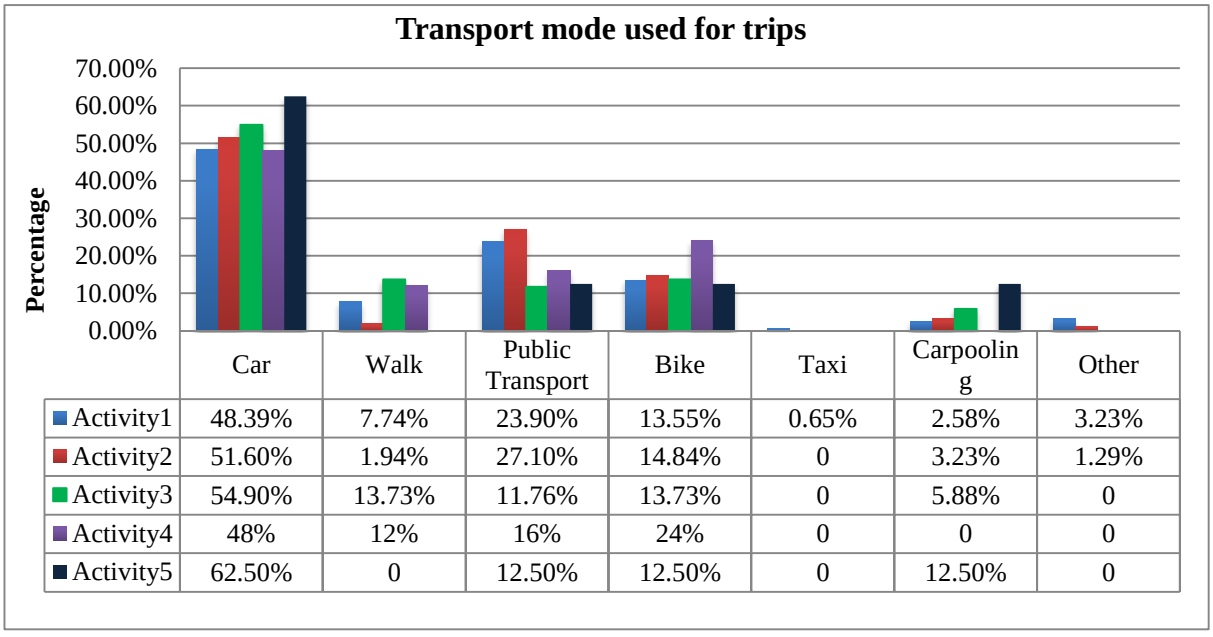
pressure they do not perceive it. Only 9 people in first activity reported about feeling of time pressure and in the subsequent activities reported number is even less than 9. Due to small number of perceived time pressure, models could not predict good relationship with other explanatory variables. Figure 4-4 represents the distribution of feeling of time pressure. In this survey indicator "No" corresponds to the feeling of time pressure.



	Activity1	Activity2	Activity3	Activity4	Activity5
Yes	94.20%	96.80%	94.10%	96%	100%
No	5.80%	3.23%	5.88%	4%	0

Figure 4-4 Distribution of time pressure in agenda up to five activities

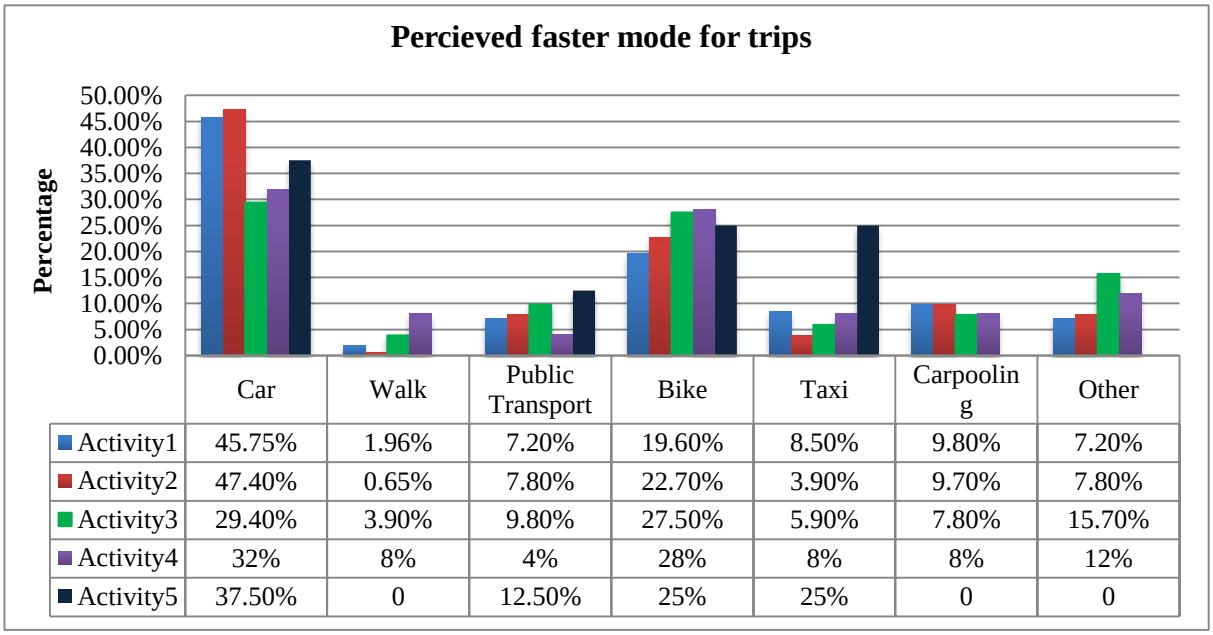
- **Transport mode choice for agenda:** Figure 4-5 represents the distribution of transport mode choice over five activities in the agenda. Highest percentage of car user is present in all five activities and for the fifth activity it is highest in the agenda. Use of bike and public transport is balanced between five activities and they are frequent used transport mode after the car.



	Car	Walk	Public Transport	Bike	Taxi	Carpooling	Other
Activity1	48.39%	7.74%	23.90%	13.55%	0.65%	2.58%	3.23%
Activity2	51.60%	1.94%	27.10%	14.84%	0	3.23%	1.29%
Activity3	54.90%	13.73%	11.76%	13.73%	0	5.88%	0
Activity4	48%	12%	16%	24%	0	0	0
Activity5	62.50%	0	12.50%	12.50%	0	12.50%	0

Figure 4-5Mode choice in agenda

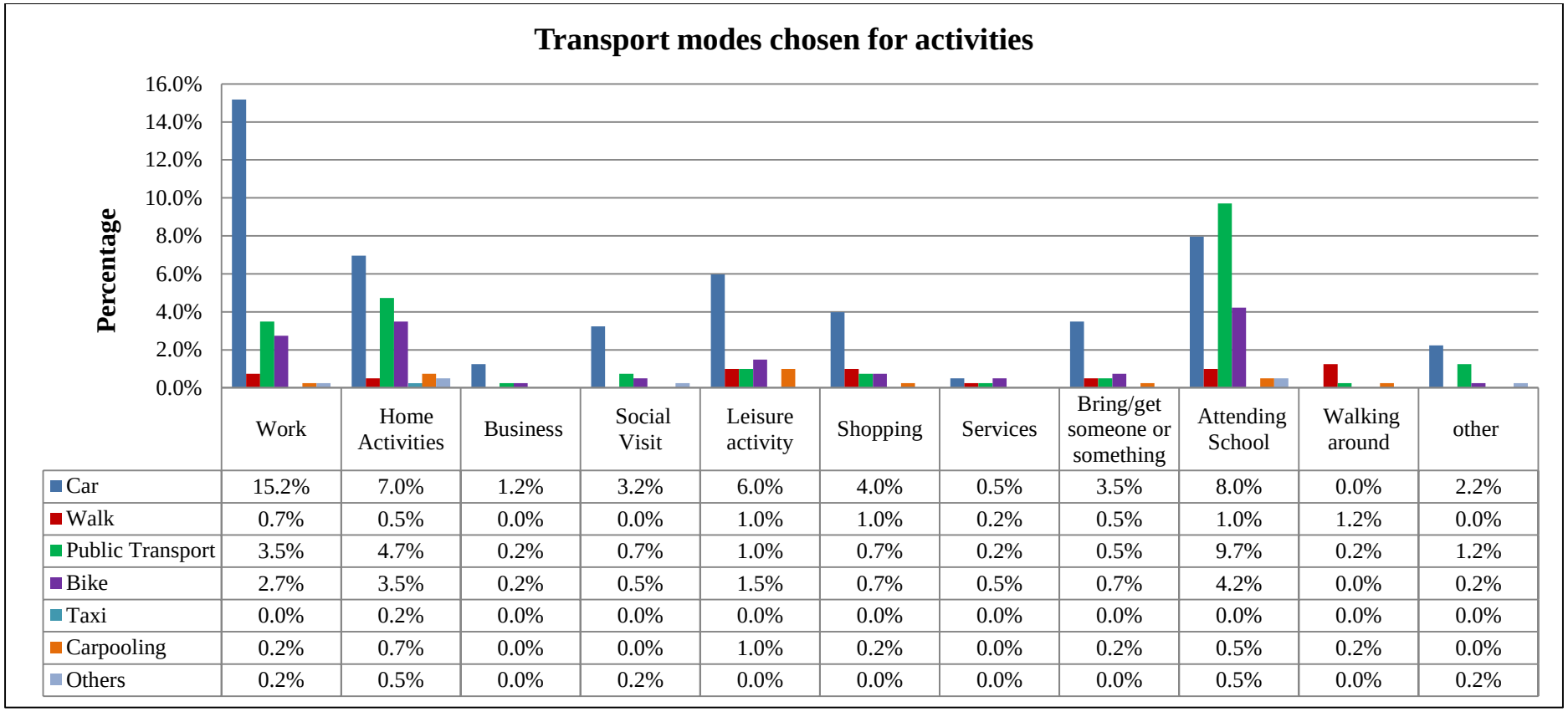
- **Perceived faster mode choice:** Respondents were required to report their perceived faster mode other than the current mode used for the trips. Car is the obvious fastest mode chosen by the respondents for their agenda. Second most chosen mode is bike and it is because of existence of large number of students in the data, 84 in number out of total 158 observations. Bike is trending mode among student for their trips.



	Car	Walk	Public Transport	Bike	Taxi	Carpooling	Other
Activity1	45.75%	1.96%	7.20%	19.60%	8.50%	9.80%	7.20%
Activity2	47.40%	0.65%	7.80%	22.70%	3.90%	9.70%	7.80%
Activity3	29.40%	3.90%	9.80%	27.50%	5.90%	7.80%	15.70%
Activity4	32%	8%	4%	28%	8%	8%	12%
Activity5	37.50%	0	12.50%	25%	25%	0	0

Figure 4-6Perceived faster mode choice in agenda up to five activities

To look better into the mode choice for trips, all the activities in the agenda are combined with their transport mode used. Total number of activities in 158 observations is 402 and graph is created between mode choice and the activity types. Figure 4-7 represents that car is the frequently used mode for all types of activities but for work and attending school it is highest. Bike is the most frequent used mode (even more than car) for the activity type “attending school”. This is because of large number of student respondents.



	Work	Home Activities	Business	Social Visit	Leisure activity	Shopping	Services	Bring/get someone or something	Attending School	Walking around	other
Car	15.2%	7.0%	1.2%	3.2%	6.0%	4.0%	0.5%	3.5%	8.0%	0.0%	2.2%
Walk	0.7%	0.5%	0.0%	0.0%	1.0%	1.0%	0.2%	0.5%	1.0%	1.2%	0.0%
Public Transport	3.5%	4.7%	0.2%	0.7%	1.0%	0.7%	0.2%	0.5%	9.7%	0.2%	1.2%
Bike	2.7%	3.5%	0.2%	0.5%	1.5%	0.7%	0.5%	0.7%	4.2%	0.0%	0.2%
Taxi	0.0%	0.2%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Carpooling	0.2%	0.7%	0.0%	0.0%	1.0%	0.2%	0.0%	0.2%	0.5%	0.2%	0.0%
Others	0.2%	0.5%	0.0%	0.2%	0.0%	0.0%	0.0%	0.0%	0.5%	0.0%	0.2%

Figure 4-7Distribution of mode choice for each activity type

Discussion: it is mentioned in the section of questionnaire design that time pressure was investigated in detail, through asking the reason of delaying start and end time for activities. There are few variables which were investigated in the survey but could not be used for further analysis due to under reporting. In this section simple description is elucidated. The question why the activity end time was delayed was answered by small number of respondents (8 for first activity) and frequently opted reason is "it took more time than planned". Majority of respondents stated postponing the activity to another day as the solution to time pressure. Time pressure within the activity is also reported very less as compared to the no time pressure. Coping strategy proposed by most of the respondent within each activity is by accelerating their tasks. Another question was asked from the car users that if all reasons are kept constant other than travel time, time pressure and complexity agenda, which option among these three is the reason for choosing car. Majority of the respondents answered travel time is the reason. These variables are not used in the analytical analysis though they were part of the questionnaire. This research is novel in its purpose, therefore, it was difficult to decide at time of survey designing phase which variable should be part of the questionnaire.

4.4 Predictive and analytical analysis

4.4.1 Model selection attempts

Modelling refers to making sense of the behaviour of variable of interest using certain mathematically expressions (Rawlings et al., 2006).

After computation of the TP calculations, data needed to be fitted in models. Model selection comes first before model fitting. It is important to check the utility of data against mathematical model used (Martcheva, 2015). Data may have either quantitative values in variables or categorical variables and sometimes mix of both. Selecting which regression will suit the dataset was imperative stage in this case and it took two weeks in finalizing what model will best suit dataset. In this study majority of the variables are class variables except the TP computed variables: "TP1:8", "TP_duration1:8" (Section 4.2.1) and age. At first, keeping in view the actual time pressure (computed variables), which are continuous in character, it was decided to use regression model.

Regression Model: TP1:8 and TP_duration1:8 are the continuous variables which were initially decided to be used as response variable in linear regression. However, all other variables in the dataset are categorical, which is not suitable format in the regression model. Variables with two level categories can be used in Regression procedure (Stockburger, 2014). Therefore, variables having two level categories were used the same in regression model. Moreover, variables with categories higher than two cannot be included in the regression directly as they cannot be interpreted meaningfully. The treatment for these categorical variables (with "n" number of categories) is transformation in n-1 categories. Each variable then serves as dichotomous variable that is useful in regression model. For instance, activity type (act_type1) has 11 activities then 10 dichotomous variables are created. The process of creating dichotomous variables is called "*dummy coding*" (Stockburger, 2014). Likewise, all categorical variables in the dataset having higher than two categories were transformed by dummy coding. Above 400 dummy variables were created in SAS in order to regress the categorical variables with TP1:4 and TP_duration1:4. Only four activities in the agenda were used due to the low number of observations reported in the dataset for above 5 to 8 activities. Four models were computed for four

activities in the agenda using "TP1:4" as a response variable. It is assumed that time pressure is positive for the respondents having TP1 value greater than one and negative for values less than one. Therefore, the interpretation of the parameter estimates of regression model gives illogical explanations.

For instance, parameter estimate for the activity which is already planned before the day of execution is $\beta_{pl\_execution} = 0.432$ (pl_execution=yes=1). Therefore, it is interpreted as: "activity which is planned before the execution day increases the time pressure by 0.432". However, the difficulty in interpretation is about variable values as TP1 explains both: "having time pressure" and "not having time pressure". Considering this problem, results of regression model does not give logical explanation. Hence it was decided to drop the regression model procedure. Henceforth, variable named TP_act1:8 and TP_travel1:8 were considered for logistic regression as they are binary response variable. The example SAS code for regression procedure for first activity is provided in the Appendix-IV.

Logistic Regression Model: If outcome response is binomial than linear and nonlinear regression are not suitable. For such response variables, methods such as logistics/logit and probit analysis are used (Motulsky & Christopoulos, 2004). In present study the outcome responses are TP_act, TP_travel and PTP. TP_act is the variable with two responses, 1 and 2. The original question was, "were you able to complete your activity on the specified time". Respondents who answered "yes" means they do not have any time pressure and this is coded as 1. Likewise, who answered "no" means they have time pressured. Question was probed repeatedly for each activity. However, in case of TP_travel, time pressure is reported by respondents during the travel to the activity location. In this case "Yes" is coded as 1 and "No" is coded as 2.

TP_act and TP_travel is considered response variable in logistic model for separate activities. TP_act1:8 refers to the perceived time pressure for each activity: whether it is completed on time or not. TP_travel1:8 refer to perceived time pressure during the travel to the activity location. Motivations for modelling these binary response variables (TP_act1:8 and TP_travel1:8) for each activity were:

- Modelling the perceived time pressure in activity and during the travel for each activity will develop a meaningful pattern of time pressure over daily agenda.
- Additionally, actual calculated time pressure will be used as predictive variable alongside with trip mode.
- It was expected that *actual time pressure* can predict *perceived time pressure*; alternatively, if this statement is true then trip mode can be predicted from actual time pressure.

Keeping these contemplations, logistic models for 4 activities were computed using binary response variables TP_act1:4 and TP_travel1:4. Corresponding results of these eight models were different from expectations. Brief description of results of above mentioned eight models is given in the following points.

- **Model1=> TP_act1**: The overall model fit statistics has significance level of 5%. Consequently, giving us the notion that reported feeling of time pressure in first activity is

predicted by planned/unplanned execution of activity only. The odds of having feeling of time pressure for first activity lowers when it is planned before the execution date by 0.67 (odds ratio).

- **Model2=> TP_act2:** Analysis of maximum likelihood estimates which is penalized because of the firth option, represented two parameters are significant in the model. First professional activity and the other was age. Parameter age has significance level of 90% and professional activity however, was significant on 95% level of confidence. The odds of having feeling of time pressure for second activity in agenda is higher in people having professional activity by 20.7 (Odds ratio). Likewise, odds of having feeling of time pressure for second activity lowers with increase in age. A person who is older has less feeling of time pressure by 0.88 (Odds ratio).
- **Model3=> TP_act3:** In this model, no variable is significant except the intercept itself. The odds of feeling time pressure for third activity in the agenda is always lowers by 0.07.
- **Model4=> TP_act4:** Output statistics of the model indicated that only intercept was significant parameter in the model. Odds of feeling time pressure is always lowers in fourth activity of the day by exp (-3.14)=0.043.
- **Model5=> TP_travel1:** Time pressure within activity (TPwithin_act) and actual time pressure (TP1) parameters are significant in this model. Global model fit statistics table described that the model is fit to the significance level of 99% as P-value of Wald test= 0.0083. The odds of having feeling of time pressure within the activity increased if person feel time pressure during the travel to location of first activity by 4.82 times. However, actual time pressure decreases if there is increase in feeling of time pressure during the travel to activity location by 0.74 times.
- **Model6=> TP_travel2:** Time pressure within activity (TPwithin_act) was the only parameter which was significant along with intercept in this model. Significance level for Time pressure within activity (TPwithin_act) is 0.01%. The odds of having feeling of time pressure within activity increases if person feel time pressure during the travel to location of second activity in agenda 4.45 times.
- **Model7=> TP_travel3:** Table 3 analysis of effects described the location type has significant effect on the feeling of time pressure during the travel to the third activity location but the categories inside the location type (Urban, rural and suburban) have different influence on the response variable. Interpretation from the parameter estimate for people living in urban area is defined as: "odds of feeling of time pressure is exp(1.73)=5.64 on significance level of 0.1%". However, rural area is not significant and it had the parameter estimate = -0.5389.

  Additionally**,** time pressure within activity (TPwithin_act) is strong predictor of time pressure during the travel to location of third activity (TP_travel3) as in cases of first two activities. Parameter estimate for TP within activity is 2.422 that indicate the increasing effect on time pressure during the travel to the activity location.
- **Model8=> TP_travel4:** In this model none of the variables is significant except the intercept that indicates, time pressure during the travel to the fourth activity location always lowers by 0.21 times. However, time pressure within activity (TPwithin_act4) is not significant like in other three activities. Potential reason for this fact is small number of responses (only 4) chosen for having feeling of time pressure (TP_travel4).

Model results illustrated (Appendix V) that the interest variables, actual time pressure, actual activity duration, transport mode and planned /unplanned execution of activity (TP1:4,

TP_duration1:4, trip_m1:4 and pl_execution) are not significant variables for both time pressure in activity and travel to the activity location. Results from these eight models indicated no significant pattern of specific set of variables for four activities in the agenda. Additionally, activity types could not be specified in the sequence of four activities in agenda for the dataset. Consequently, results do not specify logical interpretation. Furthermore, each activity is different from the other that is why model was not decent to trust results. Therefore, it is decided to find another way to model perceived time pressure (PTP) from the data set.

4.5 Selection procedure of final model

Henceforth, it is decided to model the perceived time pressure (PTP) which is general opinion of respondent to feel time pressure for overall agenda, with explanatory variables. Variable named PTP, which initially consisted of 5 choices/classes. These choices were probed to know respondent's feeling of time pressure about overall agenda. These five options described in sections 3.3.6 and 4.3, are reduced to binary response 0 and 1. Statements "*Time is always scarce, I have to drop few activities due to time scarcity*" and "*Time is limited but I am able to complete even if it is later than scheduled time*" are grounded for assumption of feeling of time pressure and correspond to 0. However, other three statements (*Time is limited but I can able to manage all the activities on time, I always have enough time, there is spare time left after I complete my daily agenda plan and Time does not matter for the activities to accomplish*) were mapped to 1 that indicates "no" time pressure. Consequently, Variable named PTP_345_mapto_1 is created in SAS enterprise guide using the following formula in query builder.

$$PTP\_345\_mapto\_1 = int(t1.PTP / 3)$$

Response variable is considered as combined effect over reported day agenda. Therefore, explanatory variables used in the models also have combined effect for activities in the agenda. For instance, computed time pressure and activity duration (TP1:8 and TP_duration1:8) are available in data for separate activity. To combine the effect of these variable maximum of actual time pressure (maxTP) and minimum of activity duration (minTP_duration) for eight activities, two new variables were created in SAS dataset. SAS code arrangement is presented as:

```
maxTP= max(TP1, TP2, TP3, TP4, TP5, TP6, TP7, TP8)
minTP_duration= min(TP_duration1, TP_duration2, TP_duration3, TP_duration4, TP_duration5,
TP_duration6, TP_duration7, TP_duration8)
```

The reason of taking maximum of TP refers the highest value for time pressure for 8 activities of each respondents is included in this variable (as ">1" value indicates time pressure: section 4.2.1). Likewise, minimum of activity duration (minTP_duration) refers to activity duration for which the time pressure is highest (as "<0" values indicates having time pressure for that duration: section 4.2.1). These two variables are the interest variables in final model. Additionally, as research road map postulates that actual time pressure will predict perceived time pressure. Finally, it is decided to create final model which uses general perception of time pressure (PTP_345_mapto_1) as a response variable.

Step 1: Model building is started with descriptive statistics which are requested to stress the number of missing values using "proc means" option. SAS code for this step is given as:

```
proc means data = sasdataset n nmiss min max mean std;
var loc_type mar_status edu_level LN_children NH_income W_day gender YN_children prof_act
No_act FTM1 TP_coping PTM_UTP1;
run;
```

The purpose of performing the means step is to check the missing values in the dataset and identifying the variables with less missing values to use in model.

Step 2: Along with simple description, table analysis is also performed on all categorical variables with the response variable. Tables analysis used the chi-square test to recognize the association between explanatory and response variable. Result of this analysis elucidates the significant variables are only educational level (edu_level) and gender with P-values 0.0252, 0.0862 respectively. All other variables do not have any significant influence on response variable (PTP_345_mapto_1). SAS code for the step is presented as:

```
/* Table analysis final model*/
proc freq data=work.sasdataset;
tables (loc_type mar_status edu_level LN_children NH_income W_day gender YN_children
prof_act No_act FTM1 FTM2 TP_coping PTM_UTP1)* PTP_345_mapto_1 / chisq;
run;
```

Step 3: In third stage, response variable is modelled with each variable separately to check their direct effect. Model used is "Binary Logit Model", as data contains the binary response variable (PTP_345_mapto_1, 0=Yes and 1=No). Variable alongside their P-values (significance) are described in the Table 4-2.

Table 4-2 P-values for all variables to check significance with response variable separately

No.	Variable Name	Description	P-value
1	loc_type	Type of location, Urban =1, Rural= 2 and suburban=3	0.4172
2	NH_income	Net monthly household income (1=<1000€, 2=1001-2000, 3= 2001-3000, 4=3001-4000, 5=4001-5000, 6= >5000)	0.5964
3	age	Age of the respondent calculated from the birth year	0.6601
4	maxTP	Calculated actual maximum time pressure from reported time of eight activities (With reference to section 4.2.1)	0.2007
5	minTP_duration	Calculated actual time pressure for activity duration from reported activity time of eight activities (With reference to section 4.2.1)	0.4457
6	gender	Gender of the respondent 1= Male and 2=Female	0.0872
7	FTM1	Frequent transport mode prefers to use for trips priority 1 (1=car, 2=walk, 3=public transport, 4=Bike, 5=Taxi, 6=carpooling)	0.9230
8	mar_status	Marital status of the respondents single=1, Married = 2, living togather=3, Divorced=4, Widowed=5	0.5880
9	YN_children	Having children 1= yes and 2=No	0.3058
10	prof_act	Having professional activity (yes=1, No=2)	0.1992
11	TP_coping	Coping strategies for time pressures: accelerating things=1, choosing efficient transport=2, filtering activities=3 postponing=4 aborting=5	0.5627
12	PTM_UTP1	Perceived Transport mode under time pressure (First priority) (case scenario) priority 1 (1=car, 2=walk, 3=public transport, 4=Bike, 5=Taxi, 6=carpooling)	0.6132
13	edu_level	Educations level categories defined in Annexure-I and III	0.1450

14	No_act	Number of activities in the day reported from 2 to 8 (2=1, 3=2,.>8=8)	0.9984
15	W_day	Working day reported Monday =1, Tuesday= 2, Thursday=3, Wednesday=4, Friday=5	0.3301

Step 4: After performing the logistic regression on each variable separately, next step was adding the variable in the significant model (model with gender). Gender being most significant variable is essential in model and other variables were added and removed based on their global effect on the model. Model was run with two variables then continued adding different variable until the final combination of variables is obtained. There were few variables which were excluded from the model, either they were decreasing the global significance of variables or producing the quasi complete separation (Section 3.4) in the warning message. For instance, edu_level is the variable when it is combined with gender in model it gives the warning of quasi complete separation. To resolve this issue, there are two options:

1. Removing the edu_level variable will solve this issue or
2. Using *firth* option with logistic regression

Removing the edu_level is better option because this variable is already insignificant for the model and if it is deleted from the model then only disadvantage is effect of education level on time pressure cannot be measured. This problem could have been solved if sample size was larger. For this study it is not possible due to the limited amount of available time and resources to collect more responses.

Firth option was also experimented, but in this case it resulted in another warning, consequently providing justification to eliminate the variable. Likewise, "mar_status" was eliminated from the model. Some interaction effects are also incorporated in the final model, after experimenting various combinations, only best ones are kept and other are discarded as they were either making the model insignificant or giving the warning of quasi complete separation. In the following section best model is interpreted.

4.6 Best Model

SAS code: SAS code for the best model is presented hereby.

```
ods rtf file='C:\hasselt M.sc\Smester-IV\Thesis_PartII\finalbest.rtf';
ods graphics on;
PROC LOGISTIC DATA=work.sasdataset plots=(all);
class gender NH_income prof_act YN_children W_day FTM1 PTM_UTP1 loc_type / param=ref;
MODEL PTP_345_mapto_1 (event='0') = loc_type gender NH_income maxTP minTP_duration
FTM1 PTM_UTP1 age YN_children prof_act W_day gender*prof_act gender*YN_children
YN_children*prof_act / expb
    selection=stepwise
    slentry=0.1
    slstay=0.15
    rsq
LINK=LOGIT;
run;
ods graphics off;
ods rtf close;
```

Results: Model type is binary logit and it has used 149 responses out of 158. 9 observations were deleted due to missing values for the response or explanatory variables. 66 responses reported "No" time pressure which is coded as 1 in response variable and 83 responses said "Yes" for feeling of time pressure which is coded as 0. Following tables shows the model statistics, interpreted in next section.

Table 4-3Model fit statistics for final model

Model Fit Statistics		
Criterion	**Intercept Only**	**Intercept and Covariates**
AIC	206.614	205.245
SC	209.618	211.253
-2 Log L	204.614	201.245

Table 4-4 Global model fit statistics for final model

Testing Global Null Hypothesis: BETA=0			
Test	**Chi-Square**	**DF**	**Pr > ChiSq**
Likelihood Ratio	3.3689	1	0.0664
Score	3.3591	1	0.0668
Wald	3.3322	1	0.0679

Table 4-5 Type 3 analysis of effects for final model

Type 3 Analysis of Effects			
Effect	**DF**	**Wald Chi-Square**	**Pr > ChiSq**
gender	1	3.3322	0.0679

Table 4-6Analysis of maximum likelihood estimates for final model

Analysis of Maximum Likelihood Estimates							
Parameter		**DF**	**Estimate**	**Standard Error**	**Wald Chi-Square**	**Pr > ChiSq**	**Exp(Est)**
Intercept		1	0.5245	0.2343	5.0121	0.0252	1.690
gender	Male	1	-0.6091	0.3337	3.3322	0.0679	0.544

Interpretation of result: It is pertinent to mention that when the code is run with automatic selection procedure (Backward, Forward and stepwise), only gender comes out to be significant effect in the model. Consequently, in reporting the general perception about time women have more feeling of time pressure. Interpretation of the parameter estimates is given below.

- Odds of general perception about the time pressure is always higher by 1.69 (exp(0.525)) if gender in unknown. If the percentage of people, responded for PTP is examined from the survey then the above mentioned statement can be true as 83 people responded about feeling of time pressure. However, when respondents were inquired about time pressure for separate activities in the agenda, their response for feeling of time pressure is very low. This is strange result that for separate activities they do not feel time pressure but for whole agenda itself they reported in sufficient amount about PTP. Following possibility is concluded from the mentioned behaviour of respondents :
    - Time pressure is perceived for whole agenda because of the fact the respondents need to meet a deadline for next day(s). Therefore for the activities in separate they did not feel time pressure. For example if a person feels time pressure for the whole day but (s)he does not report for each activity in the day than causation of PTP for whole

agenda is the deadline which is on next day or within next days. Once a deadline is reached time pressure drops.

- Men always have odds of less perceived time pressure by 0.54, on contrary, the probability that women feel time shortage is 1.85 (1/0.54) times larger than men. Parameter estimate for men is -0.61 and it is significant on 90% level. Probabilities for men and women are calculated as:

$$P\ (Male) = \frac{\exp(0.53-0.61)}{\exp(0.53-0.61)+1} = 0.48$$

$$P\ (Female) = \frac{\exp(0.53-0.61(0))}{\exp(0.53-0.61(0))+1} = 0.63$$

Probability of women is to feel time pressure is 63% and for men is 48% and this result is contradictory to literature as in literature women feel more time pressure than men.

Additionally, to investigate in detail about the influences of other variables, the model was run without any selection (i.e. stepwise) procedure. Global model fit is not significant, however examination of the table of analysis of maximum likelihood estimates shows that the P-values of certain categories of variables are significant in the best final model. Table 4-7 represents that up to significance level of 0.1, gender, income level (only category 2001-3000€), minimum activity duration (minTP_duration), frequent transport mode used (FTM1= Public transport only), perceived chosen transport mode under time pressure (PTM_UTM1= Public transport) and working day reported (W_day=Tuesday) are significant.

Table 4-7P-values of all variables in the best model to investigate in detail

Analysis of Maximum Likelihood Estimates							
Parameter		**DF**	**Estimate**	**Standard Error**	**Wald Chi-Square**	**Pr > Chi Sq**	**Exp(Est)**
Intercept		1	1.7523	2.0347	0.7416	**0.3891**	5.768
loc_type	Urban	1	-0.6188	0.5574	1.2325	**0.2669**	0.539
loc_type	Rural	1	-0.7506	0.5209	2.0762	**0.1496**	0.472
gender	Male	1	-1.3678	0.5671	5.8167	**0.0159**	0.255
NH_income	<1000€	1	-0.9941	0.8484	1.3730	**0.2413**	0.370
NH_income	1001-2000€	1	-1.2704	0.8402	2.2863	**0.1305**	0.281
NH_income	2001-3000€	1	-1.5088	0.7993	3.5631	**0.0591**	0.221
NH_income	3001-4000€	1	-0.4022	0.8036	0.2506	**0.6167**	0.669
NH_income	3001-5000€	1	-0.2143	0.8915	0.0578	**0.8101**	0.807
maxTP		1	0.9152	0.7225	1.6045	**0.2053**	2.497
minTP_duration		1	0.000111	0.000061	3.3431	**0.0675**	1.000
FTM1	Car	1	-7.6794	5.2117	2.1712	**0.1406**	0.000
FTM1	Walk	1	-7.2444	5.1858	1.9515	**0.1624**	0.001
FTM1	Public Transport	1	-8.3540	5.2233	2.5579	**0.1097**	0.000
FTM1	Bike	1	-6.6051	5.3063	1.5494	**0.2132**	0.001
FTM1	Taxi	1	-1.0482	2.2009	0.2268	**0.6339**	0.351
PTM_UTP1	Car	1	7.4541	4.9832	2.2375	**0.1347**	1726.939
PTM_UTP1	Walk	1	5.3569	4.9884	1.1532	**0.2829**	212.065
PTM_UTP1	Public Transport	1	8.9573	5.1413	3.0354	**0.0815**	7764.146
PTM_UTP1	Bike	1	6.8400	5.1841	1.7409	**0.1870**	934.482
PTM_UTP1	Taxi	1	4.0398	4.2350	0.9099	**0.3401**	56.817
age		1	-0.0309	0.0265	1.3622	**0.2432**	0.970
YN_children	Yes	1	0.7113	1.6311	0.1902	**0.6628**	2.037
prof_act	Yes	1	0.5186	0.8100	0.4100	**0.5220**	1.680

Analysis of Maximum Likelihood Estimates								
Parameter			**DF**	**Estimate**	**Standard Error**	**Wald Chi-Square**	**Pr > Chi Sq**	**Exp(Est)**
W_day	Monday		1	0.2290	0.8284	0.0764	**0.7822**	1.257
W_day	Tuesday		1	2.5960	1.3144	3.9006	**0.0483**	13.409
W_day	Wednesday		1	0.5371	0.8023	0.4482	**0.5032**	1.711
W_day	Thursday		1	-0.1294	0.6290	0.0423	**0.8370**	0.879
gender*prof_act	Male	Yes	1	0.5424	0.9653	0.3157	**0.5742**	1.720
gender*YN_children	Male	Yes	1	0.5596	1.0352	0.2922	**0.5888**	1.750
prof_act*YN_children	Yes	Yes	1	-0.6731	1.4417	0.2180	**0.6406**	0.510

Interpretation of the parameter estimates which are significant on level of 85% (0.15) is given as:

- Intercept is not significant in this case and has P-value = 0.3891, that is logical outcome as the possible starting point for other variables to have significance, a person should not have any feeling of time pressure when other variables are zero (unknown). Table 4.7 represents the parameter estimate value of increasing effect ($log\left(\frac{\pi}{1-\pi}\right) = 1.75$) which is not significant in this model.
- Gender is significant on level of 0.05 indicating strong influence on PTP. Parameter estimate (-1.37) for gender is changed from the model with selection method model. Gender effect is interpreted as follows: if the person is a male than the odds feeling time pressure are decreased by 0.25; For the women the value is 1/0.25=4: that represents, for women feeling of time pressure is 4 times more than men.
- For the net household income category of 2001-3000€, parameter estimate is –1.51(-exp(-1.51)=0.22). Therefore, odds of feeling of time pressure in agenda is less when the person has income between 2001-3000€. This is illogical having other categories insignificant. Checking the cross tabulation do not give that explanation as income level are well distributed among the response choices. It may be considered this category is significant because of the combination of other variables producing its influence on response variable.
- Third significant parameter is minTP_duration of the activity. Minimum of time pressure due to activity duration difference represents the maximum TP value for the person. Parameter estimate for minTP_duration= 0.00011, therefore odds of feeling of time pressure is barely changed with this effect but this variable has the significance level of 0.06.
- Category of location type "*rural*" has very weak significance level 0.15%. Parameter estimate for living in rural locality is -0.75 which represents the decreasing effect on perceived time pressure. Odds ratio for the parameter estimate is 0.47 indicating that the probability that people perceive 0.47 times less time pressure if they live in rural area than other locality.
- Moreover, *frequent transport mode* (FTM1) used and the preferred transport mode under high time pressure (PTM_UTP1) both have category of public transport as significant on the level of 0.1. Parameter estimate for FTM=Public transport equals -8.3540 and odds is almost equals to 0 (0.0002). Consequently, the interpretation for the parameter estimate is, people have less feeling of time pressure when they are using public transport by 0.0002. This indicates that it is a weak predictor of perceived time pressure for this dataset. Likewise, preferred transport mode under high time pressure has the significant category same as FTM1 has. Parameter estimate for public transport = 8.9573, that refers to feeling of time pressures is increased when they prefer to use public transport as a mode. Markedly, car (Auto) for both variables (FTM1 and PTM_UTP1) is significant at 0.15 level, which is clearly very low significance level. When car is used as mode, feeling of time pressure is decreased as odds of decreasing effect is =0.0004. Alternatively, when car is used under high time pressure and the agenda is complex then odds of perceiving increased time pressure is very large by 1719.8. Parameters estimates might give illogical results for this dataset but it can be least considered that public transport and car as a mode can have influence on perceived time pressure (PTP).

5 DISCUSSION AND CONCLUSIONS

This chapter consists of two sections. Firstly, descriptive and analytical analysis is discussed critically and then second part clearly states the conclusion of this research.

5.1 Discussion

The research road map for the study was initially specified to model the perceived time pressure and predict it with the actual time pressure reported. Afterwards, *mode choice* was planned to be predicted from the actual time pressure. The dataset of this study consisted of 158 observations in total. 48% (76) are male and 52 % (82) are females in the data. Respondents having professional activity are 43% (68) and among nonprofessional respondents 93% (84) are students. Moreover, among the professional respondents 60% belong to education sector and 14.7% are related to professional scientific and technical activities. Consequently, biasness of data toward education sector is portrayed.

It is important to mention the expected outcome from this research before finalizing the conclusions of the study.

- Literature suggested that feeling of time pressure are more in women with full time professional activity and having children than in men. Women with high education are under influence of time pressure more than men. As education has prestigious impact on men to manage time pressure. However, married men are under less influence of time pressure as compared to women (section 2.9.3). Time pressure should confirm the same influences while exploring respondent's daily activity agenda.
- Perceived time pressure (PTP) on the other hand is a new term to investigate in this research. Studies demonstrated that perceived difficulty or perceived time pressure generally influence the behaviour. Moreover, it is generally found out about the perceived feeling of difficulty in using public transport is more than the actual difficulty (section 2.9.4). Grounded on this assumption, it was hypothesized that perceived time pressure will influence more than actual time pressure and that it is predictable from actual time pressure.
- PTP has prominent influence on mode choice for the activities in agenda. If previous statement becomes true than it is possible to predict mode choice by actual time pressure.
- Additional assumption in this study is about the complexity of the agenda, (which is determined by the number of activities in one-day schedule) has influence on PTP. i.e. More number of activities in the agenda yield more time pressure.

PTP in the survey was investigated using two methods. Firstly, it was determined for each activity in the agenda separately and secondly the general perception about time for whole day/agenda was probed. Initially overall perception about time was probed through five psychological statements to represent the respondent's mind on likert scale from "almost always felt" to "almost never felt". PTP variable was converted to binary response variable (PTP_345_mapto_1) in order to use in a logistic model. "*Almost always=1*" and "*usually=2*" feeling of time pressure are categorised into "yes" which is coded in SAS code as "0". However, feeling of *"occasionally=3"*, *"usually not=4"* and *"almost never=5"* are categorised to "no" which is coded in SAS code as "1". *PTP_345_mapto_1* is the

response variable in the final model. It was modelled against each relevant variable. Dataset of this research resulted opposite to the expectations. Socio-demographic variables (Professional activity, educational level, marital status, having children) are not significant except gender and one category of income. Significance of category of income level *"2001-3000€"* is strange result but it indicates that the people with moderate income feel less time pressured than people with other categories of income. Likewise, living in rural area predicts that people feel less time pressure and majority of respondents living in rural area reported to use car as their frequent used mode. However, significance level for location type category is not very critical (0.15%).

Besides, the key variable, actual time pressure (maxTP) is also not significant. On contrary, expectation was that study would be able to predict the PTP. However, results of the model are notwithstanding with expectations and actual time pressure is unable to predict the PTP. In addition, the TP calculated through difference of duration of activity (minTP_duration) has a significant effect on PTP. Even though activity duration is significant but its effect is very weak. In terms of log(odds) the additive increasing effect in feeling of time pressure is only 0.0001 which is very low. Corresponding odds ratio on the other hand is equal to 1, signifying no effect on the PTP. Potential reason behind this fact might be the duration of activity having time pressure (activity having actual time greater than planned time) is quite small, reported by respondents.

Frequent mode choice is the mode which respondent habitually use for most of his/her trips in the day. The question about *preferred transport mode under time pressure* was requested to know respondent's priority under time pressure and complex agenda. Public transport in both variables is significant category under significance level 0.1%. However, category of car is significant under 0.15% level. Albeit, they are weak predictor for this dataset but it is indication toward the fact that PTP is influenced by people's mode choice. The prediction estimates can be improved with the good set of observation.

Dataset in this research is believed to be poor because of the fact that it took quite an effort to reach the final model. A lot of information is lost during the process. The model could not be built with separate activities in agenda due to insufficient number of observations with reported PTP. Dataset contained 103 respondents who reported only 2 activities in the day. The possibilities behind the fact is that respondents reported PTP in sufficient number for whole agenda but in very low number for each activity separately are given in the following.

- Time pressure is perceived for whole agenda because of the fact the respondents need to meet a deadline for next day(s). Therefore for the activities in agenda they actually did not feel time pressure.
- Due to the length of survey respondents avoided to report their actual number of activities. For only two activities in agenda they did not reported but for the whole day they reported PTP. This issue can be solved by using PDAs or daily schedule diaries filling with help of presence of interviewer on large scale, in activity based travel demand surveys.

Mentioned problems occurred due to the fact that more than half number of student population in the dataset. Moreover, data is also biased toward education sector only (75%). Data contains very low variability with respect to socio demographics. By all means, if it is possible to improve the variability in the dataset, then it is possible to improve the parameter estimates. In scope of this

research, there is indication of the set of variables which contributes in predicting perceived time pressure (PTP) in the agenda. Corresponding set of variables contains *gender, net household income, locality, activity duration, working day, mode choice* and *preferred transport mode under TP*.

5.1.1 Additional research outcomes

During the process of modelling and data analysing few interesting concepts and relationships are revealed, which were not expected and are described below:

- Surprisingly, in the process of predicting time pressure during the travel toward activity location, a very interesting relationship is discovered about human behaviour. It might be useful for the future research. The relationship is very strong for three activities in the agenda and it states that if people feel time pressured during the travel (TP_travel1:3) to the activity location than there is more likely to feel time pressure within activity (TPwithin_act1:3). Therefore these two variables are strongly correlated.
- Another interesting fact revealed is about coping strategies of time pressure. 50% of the survey population reported the choice "*I usually filter the important activities to be done for the day and leave less important, if I feel time pressured*". Considering the statement carefully, demonstrates that "*filtering the important tasks"* is closely related to the satisficing, which corresponds to the theory of bounded rationality by Simon, 1956 (section 2.3). According to the theory people opt for the satisfactory solutions rather than the ideal ones due to the environmental limitations and difficulty in individual information processing. Thereby, coping strategy confirms the universal behaviour theory in this survey.

5.2 Conclusion and recommendations

This research explores the influence of socio-demographic variables, actual time pressure and mode choice on the perceived time pressure in daily agenda. The results of the study are presented below.

- People usually perceive less time pressure than the actual time pressure (time pressure computed from the reported difference between planned and actual time) for each activity in the agenda. However, for whole agenda reported PTP number exceeds actual TP.
- Among socio-demographic variables only *gender* and category of *net household income* (2001-3000€) have influence on perceived time pressure (PTP) for the agenda. Notably, PTP is lower women than men and this statement is in agreement with literature. Other variables such as having children, professional activity and marital status do not have influence, which is contrary to the literature.
- Actual time pressure has no significant effect on PTP. However, time pressure due to difference of activity duration has significant effect but its parametric effect to change PTP is very small. Moreover, there is equally likely chance to decrease in PTP with actual TP.
- People living in rural areas feel less PTP and they use car more.
- Among frequent used transport modes, car and public transport also exhibited significant effect on PTP. Nevertheless, car is weak predictor and public transport is statistically

significant on 0.1% level. Use of public transport and car result in less perceived time pressure (PTP). Both parameters have decreasing effect on PTP but public transport has higher significance level.

- Public transport and car both are significant preferred transport modes under high time pressure and complex agenda. Similar to frequent used mode choice car is weak predictor than public transport. However, parametric estimates indicate high increasing effect on PTP. Consequently, car and public transport highly likely chosen mode under time pressure and they highly increase the PTP.
- There is strong positive relationship found between time pressure during the travel to the activity location and time pressure within activity. That indicates, if a person feels time pressure during the travel to the activity location then it is likely to feel time pressured within activity. This relationship was not intended in research scope. It might helpful in future research.
- The theory of bounded rationality (Satisficing) is also confirmed in this study as an additional outcome. Majority of people tend to cope their time through satisficing.
- **Definition of perceived time pressure (PTP) in daily agenda:** PTP is the feeling of individual of not being able to reach wanted level of utility at certain time. This time deadline is specified by either third party or individual himself. Intensity of the time pressure cannot be measured from difference in planned and actual duration of the activity in agenda. Because PTP is influenced by the psychological factors which are different for different individuals. Set of psychological variables consisted of *locality, time pressure due to activity duration (if it is more than planned), income level, mode choice, preferred transport mode under TP and gender difference*. Individuals however, satisfice to cope with PTP. Therefore, PTP is denoted in scientific form as:

$$PTP = f(\text{Psych factors}, (\text{available time} - \text{required time}))$$

Although the dataset has biased survey population and parametric estimates are not outstanding, but there is clear indication of influences of above mentioned variables on PTP. The research roadmap was defined to predict PTP from actual time pressure which is not possible as actual time pressure is different from the reported time pressure. Therefore, people perceive differently than the actual calculation of time pressure. However, time pressure due to difference of activity duration has influence on PTP which has weak parametric effect. This is positive indication for the future research if dataset is improved. There are chances to find significance with good and nonbiased dataset. The research roadmap also required the prediction of mode choice from the actual time pressure in case actual time pressure predicts PTP. This research concluded the alternative solution as frequent transport has significant influence on PTP, although parametric estimates are not much practicable. Subsequent liability is on poor data quality in this research. This type of research is conducted for the first time in the field of transportation and it is likely to find better results in future studies. It is recommended to conduct another confirmatory research with better set of observations.

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7 APPENDICES

Appendix-I

Tijdsdruk in de dagelijkse agenda (Time Pressure in Daily Agenda)

Q1 Dear Respondent, This questionnaire is developed to study the effect of time pressure in your daily agenda and on mode choice. This study is conducted first time and to fulfill requirement for Master thesis in Transportation science at University of Hasselt. Your cooperation is much appreciated. It is strongly recommended to answer this questionnaire on desktop rather than smart phone for better accessibility. I apologize for taking 20-25 minutes of your valuable time. I thank you for your participation. Kind regards, Tooba Batool

Q3 Please identify the type of location where you live?
- Urban (1)
- Rural (2)
- Suburban (3)

Q4 What is your Birth year

Q5 Please specify your Gender
- Male (1)
- Female (2)

Q6 Please specify your education level/achieved diploma
- Primary School (1)
- General Secondary school (not fully completed) (2)
- General secondary others (Technical, professional, arts, sports....) not fully completed (3)
- General Secondary school (completed) (4)
- General secondary others (Technical, professional, arts, sports....) completed (5)
- Higher non university degree (6)
- University Degree (7)
- None (8)

Q7 Please specify your marital status
- Single (1)
- Married (2)
- Registered as living together (3)
- Divorced (4)
- Widowed (5)

Q8 Do you have children?
- Yes (1)
- No (2)

Answer If Do you have children? Yes Is Selected

Q9 Number of childern

- ❍ 1 (1)
- ❍ 2 (2)
- ❍ 3 (3)
- ❍ 4 (4)
- ❍ 5 (5)
- ❍ 6 (6)
- ❍ >6 (7)

Answer If Do you have children? Yes Is Selected

Q10 Please specify Number of children living with you (at least 30% of time)

- ❍ 1 (1)
- ❍ 2 (2)
- ❍ 3 (3)
- ❍ 4 (4)
- ❍ 5 (5)
- ❍ 6 (6)
- ❍ >6 (7)

Answer If Do you have children? Yes Is Selected

Q11 Please specify the birth year for each child living with you subsequently

1 (1)
2 (2)
3 (3)
4 (4)
5 (5)
6 (6)

Q12 Do you have any professional activity?

- ❍ Yes (1)
- ❍ No (2)

Answer If Do you have any professional activity? No Is Selected

Q13 You do not have professional activity because of, please specify among following options?

- ❍ Student (1)
- ❍ Looking for job (2)
- ❍ Pension (3)
- ❍ Unfit to work (Medical reason) (4)
- ❍ Working in own house (5)
- ❍ Volunteering activity out of home (7)
- ❍ Other (6) _____

Answer If Do you have any professional activity? Yes Is Selected

Q14 Your professional activity, please specify among following options

	Sector	Legal status

	Government (1)	Private sector (2)	Employed (1)	Self-employed (2)
Blue collar (manual work or workers, labor etc) (1) Office job (2)				

Answer If Do you have any professional activity? Yes Is Selected

Q15 Please identify your employment sector

- ❍ Agriculture, forestry and fishing (1)
- ❍ Mining and quarrying (2)
- ❍ Manufacturing (3)
- ❍ Electricity, gas, steam and air conditioning supply (4)
- ❍ Water supply; sewerage, waste management and remediation activities (21)
- ❍ Construction (6)
- ❍ Wholesale and retail trade; repair of motor vehicles and motorcycles (22)
- ❍ Transportation and storage (9)
- ❍ Accommodation and food service activities (10)
- ❍ Information and communication (11)
- ❍ Financial and insurance activities (23)
- ❍ Real estate activities (14)
- ❍ Professional, scientific and technical activities (15)
- ❍ Administrative and support service activities (16)
- ❍ Public administration and defense; compulsory social security (17)
- ❍ Education (18)
- ❍ Human health and social work activities (19)
- ❍ Arts, entertainment and recreation (20)
- ❍ Other service activities (13)
- ❍ Activities of households as employers; undifferentiated goods- and services-producing activities of households for own use (12)
- ❍ Activities of extraterritorial organizations and bodies (8)

Q16 Please specify your net monthly household income?

- ❍ Less than €1000 (1)
- ❍ 1001-2000€ (2)
- ❍ 2001-3000€ (3)
- ❍ 3001-4000€ (4)
- ❍ 4001-5000€ (5)
- ❍ More than 5000€ (6)

Q17 Please recall travel based activities on your previous working day and specify the number of trips?

- 2 (1)
- 3 (2)
- 4 (3)
- 5 (4)
- 6 (5)
- 7 (6)
- 8 (7)
- More than 8 (8) _____

Q18 Please specify the working day you are reporting?

- Monday (1)
- Tuesday (2)
- Wednesday (3)
- Thursday (4)
- Friday (5)

Q19 Please specify the characteristics of your activity number ${lm://CurrentLoopNumber}, Note: your information about activity and travel to that activity location are separately asked, please focus on the text written Please specify the purpose of your trip number ${lm://CurrentLoopNumber}?

- Work (either paid or volunteering) (1)
- Home Activities (Household care, reading, sleeping, ...) (2)
- Business (i.e. visiting client) (3)
- Social Visit (4)
- Leisure activity (Sports/culture) (5)
- Shopping (6)
- Services (7)
- Bringing/getting someone or something (8)
- Attending School (9)
- Walking around (i.e walk, drive without reason) (10)
- other (11) _____

Q20 Was this activity planned before the day of execution ?

- Yes (1)
- No (2)

Q21 Please answer the following questions?Note: time should be described in 24:00 form, please change the time in boxes according to your time

Your expected travel time in minutes (min.) to reach the activity location (2)

Actual time spent on the travel in minutes (min) to the activity location (4)

What was the planned start time of the activity? (1)

Actual time you started the activity (3)

When did you plan to finish your activity (5)

When did you actually finished your activity (6)

Q22 Did you feel rushed during the travel to reach destination due to time scarcity?
- ❍ Yes (1)
- ❍ No (2)

Q23 Were you able to complete all your tasks of the activity in mentioned planned time? Note: Activity consists of several tasks i.e. During home activity you can perform different tasks (sleeping, eating, watching TV,...)
- ❍ Yes (1)
- ❍ No (2)

Answer If Did you complete your activity in planned time? No Is Selected

Q24 How much more time you would have needed to complete this activity (Please specify in minutes)

Answer If Did you complete your activity in planned time? No Is Selected

Q25 Your reason to delay the activity start time
- ❍ Congestion (1)
- ❍ Missed the Public Transport connection or it was late (2)
- ❍ Previous activity terminated later than expected (3)
- ❍ None (4)
- ❍ Other (5) _____

Answer If Did you complete your activity in planned time? No Is Selected

Q26 Your reason to delay the activity end time
- ❍ It started later than expected (1)
- ❍ It took more time than expected (2)
- ❍ I got some additional/unplanned tasks to do (3)

Answer If Did you complete your activity in planned time? No Is Selected

Q27 Did you postpone part/tasks of the activity to
- ❍ Another day (1)
- ❍ Later on the same day (2)
- ❍ Abort as it is (3)

Answer If Did you complete your activity in planned time? Yes Is Selected

Q28 Did you feel time pressured during completing the tasks in activity
- ❍ Yes (1)
- ❍ No (2)

Answer If Did you complete your activity in planned time? Yes Is Selected And Did you feel time pressured during completing the tasks of activity Yes Is Selected

Q29 How you will describe the period in which you feel more time pressured during completing the activity tasks
- ❍ After start period (1)
- ❍ Intermediate period (2)
- ❍ Near end period (3)

Answer If Did you complete your activity in planned time? Yes Is Selected And Did you feel time pressured during completing the tasks of activity Yes Is Selected

Q30 How did you manage to cope with time pressure

- ❍ I accelerated things and managed to complete all the tasks (1)
- ❍ I filtered important tasks to do for that activity (2)
- ❍ I had to abort some of the tasks as it is (3)

Q31 Which travel mode did you use for the largest part of your trip?

- ❍ Private Car (1)
- ❍ Walk (2)
- ❍ Public Transport (3)
- ❍ Bike (4)
- ❍ Taxi (5)
- ❍ Car Pooling (6)
- ❍ Other (7) _____

Answer If Mode of travel you used? Private Car Is Selected

Q32 Travel time (in minutes) to the nearest public transport station from the location of activity

Bus station (1)

Train station (2)

Answer If Mode of travel you used? Private Car Is Selected

Q33 Apart from comfort, convenience or the need of car at work (you need to take your tools weighing 25kg), is there any other reason not to use other mode, please select from the list

- ❑ Travel Time (1)
- ❑ Time Pressure (2)
- ❑ Complexity of acgenda (3)
- ❑ Other (4) _____

Q34 Are you satisfied with the travel mode you are currently using ?

- ❍ Extremely satisfied (1)
- ❍ Somewhat satisfied (2)
- ❍ Neither satisfied nor dissatisfied (3)
- ❍ Somewhat dissatisfied (4)
- ❍ Extremely dissatisfied (5)

Q35 What do you think is the fastest mode other than you are currently using and will help in saving time?

- ❍ Private car (1)
- ❍ Walk (2)
- ❍ Public Transport (3)
- ❍ Bike (4)
- ❍ Taxi (5)
- ❍ Carpooling (6)
- ❍ Other (7) _____

Q36 How would you qualify the time you had available on the working day you described?

- Time is always scarce, I have to drop few activities due to time scarcity (1)
- Time is limited but I am able to complete even if it is later than scheduled time (2)
- Time is limited but I can able to manage all the activities on time (3)
- I always have enough time, there is spare time left after I complete my daily agenda plan (4)
- Time does not matter for the activities to accomplish (5)

Q37 Assume that you have more mandatory activities than you expected and you feel time pressured, how would you cope with it?

- I usually accelerate things and try to manage in available time even if it is short (1)
- I usually use efficient travel mode to save time and complete the daily task (2)
- I usually filter the important activities to be done for the day and leave less important, if I feel time pressured (3)
- I usually postponed some of activities for another day if available time is shorter than I expect (4)
- I usually abort the activity that is giving me too much time pressure (5)

Q38 For your most frequent trips please order the travel modes to decreasing preferences? (1 is given to your first priority)

_____ Private Car (1)
_____ Walk (2)
_____ Public Transport (3)
_____ Bike (4)
_____ Taxi (5)
_____ Carpooling (6)

Q39 If you have to execute more activities than usual and you have to make a tour to reach the respective activity locations without coming home in between and you are under time pressure, which mode you will prefer, please classify in decreasing order of preference?

Q2 Please provide your E-mail address to send copy of findings of the study

Appendix-II

Tijdsdruk in de dagelijkse agenda (Time Pressure in Daily Agenda)

Q1 Beste respondent, Deze enquête is er om het effect van tijdsdruk in de dagelijkse agenda op de keuze van vervoerswijze te onderzoeken. Deze studie wordt nu voor het eerst uitgevoerd en hoort bij een masterthesis in mobiliteitswetenschappen aan de Universiteit Hasselt. Uw medewerking wordt zeer op prijs gesteld. Het is aanbevolen om deze enquête op een desktopcomputer in te vullen in plaats van een smartphone, omwille van toegankelijkheid. Graag verontschuldig ik me voor het nemen van 20-25 minuten van uw waardevolle tijd. Ik dank u voor uw medewerking. Met vriendelijke groeten,
Tooba Batool

Q3 In welk type locatie woont u?.
- ❍ Stedelijk (1)
- ❍ Platteland (2)
- ❍ Voorstedelijk (3)

Q4 Wat is uw geboortejaar?

Q5 Wat is uw geslacht?
- ❍ Mannelijk (1)
- ❍ Vrouwelijk (2)

Q6 Duid uw hoogst behaald diploma of getuigschrift aan.
- ❍ Lager onderwijs (1)
- ❍ Middelbaar onderwijs: algemeen vormend (niet volledig afgewerkt) (2)
- ❍ Middelbaar onderwijs: andere (technisch, beroeps, kunst, sport, …) niet volledig afgewerkt (3)
- ❍ Middelbaar onderwijs: algemeen vormend (volledig afgewerkt) (4)
- ❍ Middelbaar onderwijs: andere (technisch, beroeps, kunst, sport, …) volledig afgewerkt (5)
- ❍ Hogere niet-universitair onderwijs (6)
- ❍ Universitair onderwijs (7)
- ❍ Geen (8)

Q7 Wat is uw burgerlijke staat?
- ❍ Ongehuwd (1)
- ❍ Gehuwd (2)
- ❍ Geregistreerd samenwonend (3)
- ❍ Gescheiden (4)
- ❍ Weduwe(naar) (5)

Q8 Heeft u kinderen?
- ❍ Ja (1)
- ❍ Nee (2)

Answer If Do you have children? Yes Is Selected

Q9 Aantal kinderen

- 1 (1)
- 2 (2)
- 3 (3)
- 4 (4)
- 5 (5)
- 6 (6)
- > 6 (7)

Answer If Do you have children? Yes Is Selected

Q10 Hoeveel kinderen wonen er bij u (tenminste 30% van de tijd)?

- 1 (1)
- 2 (2)
- 3 (3)
- 4 (4)
- 5 (5)
- 6 (6)
- > 6 (7)

Answer If Do you have children? Yes Is Selected

Q11 Wat is het geboortejaar van elk kind dat bij u woont?

1 (1)
2 (2)
3 (3)
4 (4)
5 (5)
6 (6)

Q12 Oefent u een beroepsactiviteit uit?

- Ja (1)
- Nee (2)

Answer If Do you have any professional activity? No Is Selected

Q13 Omwille van welke reden bent u niet beroepsactief? Kies uit de volgende opties:

- Scholier, student (1)
- Werkzoekend (2)
- Gepensioneerd (3)
- Arbeidsongeschikt (4)
- Uitsluitend werkzaam in eigen huishouden (5)
- Vrijwilligerswerk buitenshuis (7)
- Andere (6) _____

Answer If Do you have any professional activity? Yes Is Selected

Q14 Duid de juiste opties aan die van toepassing zijn op uw job.

	Sector		Wettelijke status	
	Overheid (1)	Privesector (2)	Werknemer (1)	Zelfstandige (2)
Arbeider (1)				
Bediende (2)				

Answer If Do you have any professional activity? Yes Is Selected

Q15 Wat is uw sector van tewerkstelling?

- ❍ Landbouw, bosbouw en visserij (1)
- ❍ Mijnbouw (2)
- ❍ Industrie (3)
- ❍ Elektriciteit en gas (4)
- ❍ Water en afvalverwerking (21)
- ❍ Bouw (6)
- ❍ Groothandel en retail of reparatie van motorvoertuigen (22)
- ❍ Transport en opslag (9)
- ❍ Accommodatie en maaltijden (10)
- ❍ Informatie en communicatie (11)
- ❍ Financiën en verzekeringen (23)
- ❍ Vastgoed (14)
- ❍ Professionele, wetenschappelijke en technische activiteiten (15)
- ❍ Administratie en ondersteunende diensten (16)
- ❍ Overheid en defensie (17)
- ❍ Onderwijs (18)
- ❍ Gezondheidszorg en sociaal werk (19)
- ❍ Kunst, ontspanning en recreatie (20)
- ❍ Andere diensten (13)
- ❍ Huishouden als werkgever; ongedefinieerde productieactiviteiten of diensten voor eigen gebruik (12)
- ❍ Activiteiten voor buitenlandse organisaties (8)

Q16 Wat is uw netto maandelijks gezinsinkomen?

- ❍ Minder dan 1000 € (1)
- ❍ 1001-2000 € (2)
- ❍ 2001-3000 € (3)
- ❍ 3001-4000 € (4)
- ❍ 4001-5000 € (5)
- ❍ Meer dan 5000 € (6)

Q17 Hoeveel verplaatsingen heeft u op uw laatste werkdag gemaakt?
- 2 (1)
- 3 (2)
- 4 (3)
- 5 (4)
- 6 (5)
- 7 (6)
- 8 (7)
- Meer dan 8 (8) _____

Q18 Geef aub aan voor welke weekdag uw antwoorden van toepassing zijn?
- Maandag (1)
- Dinsdag (2)
- Woensdag (3)
- Donderdag (4)
- Vrijdag (5)

Q19 We bekijken steeds een verplaatsing naar een locatie samen met de actviteiten die daar wordt uitgevoerd.Gegevens over de verplaatsing en de activiteitenreeks worden echter apart opgevraagd: let aub goed op de vraag.Gelieve de kenmerken van uw activiteitenreeks nummer ${lm://CurrentLoopNumber} te specifieren. Nota: Er wordt telkens informatie gevraagd over een (verplaatsing,activiteitenreeks) paar. Doel van de verplaatsing naar de locatie van activiteitenreeks nummer ${lm://CurrentLoopNumber}?
- Werk (betaald werk of vrijwilligerswerk) (1)
- Bezigheden thuis (huishoudelijke activiteiten, lezen, slapen, …) (2)
- Zakelijke verplaatsing (bv. Bezoek van klant) (3)
- Sociaal bezoek (4)
- Vrije tijd (ontspanning, sport,cultuur) (5)
- Winkelen, boodschappen doen (6)
- Diensten (bijvoorbeeld dokter, bank,...) (7)
- Iets/iemand wegbrengen/afhalen (8)
- Onderwijs volgen (9)
- Wandelen, rondrijden, joggen (10)
- Iets anders (11) _____

Q20 Was deze activiteit gepland vóór de dag van uitvoering?
- Ja (1)
- Nee (2)

Q21 Beantwoord alstublieft de volgende vragen. Nota:: tijdstippen moeten worden genoteerd in 24:00 vorm, verander de tijd in de vakjes naar het juiste tijdstip.

Je verwachte reistijd in minuten (min.) om de locatie van de activiteit te bereiken (2)
De werkelijke reistijd in minuten (min.) om de locatie van de activiteit te bereiken (4)
Wat was de geplande begintijd van de activiteit? (1)
De werkelijke begintijd van de activiteit (3)
Wanneer was de geplande eindtijd van de activiteit? (5)
Wanneer was de werkelijke eindtijd van de activiteit? (6)

Q22 Voelde u zich gehaast tijdens het reizen naar uw bestemming door tijdsgebrek?
- ❍ Ja (1)
- ❍ Nee (2)

Q23 Was u in staat om alle taken van de activiteit uit te voeren in de vermelde geplande tijd? Nota: een activiteit bestaat uit verschillende taken. Bijvoorbeeld: tijdens een huisactiviteit kunt u verschillende taken, zoals slapen, eten en tv kijken, uitvoeren.
- ❍ Ja (1)
- ❍ Nee (2)

Answer If Did you complete your activity in planned time? No Is Selected

Q24 Hoeveel meer tijd zou u nodig hebben gehad om de activiteit te kunnen afronden? (Geef aan in minuten)

Answer If Did you complete your activity in planned time? No Is Selected

Q25 Wat was de reden om de begintijd van de activiteit uit te stellen
- ❍ Files (verkeersopstopping, congestie) (1)
- ❍ Openbaar vervoer: te laat of aansluiting gemist (2)
- ❍ De voorgaande activiteit duurde langer dan verwacht (3)
- ❍ Geen (4)
- ❍ Andere reden (5) _____

Answer If Did you complete your activity in planned time? No Is Selected

Q26 Uw reden om de eindtijd van de activiteit uit te stellen
- ❍ De activiteit begon later dan verwacht (1)
- ❍ De activiteit duurde langer dan verwacht (2)
- ❍ Ik kreeg een aantal extra/ongeplande taken te doen (3)

Answer If Did you complete your activity in planned time? No Is Selected

Q27 Heeft u delen of taken van de activiteit uitgesteld naar
- ❍ Een andere dag (1)
- ❍ Later op dezelfde dag (2)
- ❍ Gelaten zoals het is (3)

Answer If Did you complete your activity in planned time? Yes Is Selected

Q28 Voelde u tijdsdruk tijdens het volbrengen van taken in de activiteit?
- ❍ Ja (1)
- ❍ Nee (2)

Answer If Did you complete your activity in planned time? Yes Is Selected And Did you feel time pressured during completing the tasks of activity Yes Is Selected

Q29 Wanneer voelde u meer tijdsdruk tijdens het volbrengen van activiteitstaken?
- ❍ Onmiddellijk na de start (1)
- ❍ Ergens midden tussen start en einde (2)
- ❍ Bij het einde (3)

Answer If Did you complete your activity in planned time? Yes Is Selected And Did you feel time pressured during completing the tasks of activity Yes Is Selected

Q30 Hoe ging u met de tijdsdruk om?

- ❍ Ik versnelde taken, zodat het lukte om alle taken af te krijgen (1)
- ❍ Ik heb enkel de belangrijkste taken voor de activiteit uitgevoerd (2)
- ❍ Ik moest enkele taken afbreken (3)

Q31 Welke vervoerswijze heeft u gebruikt voor het langste deel van uw verplaatsing?

- ❍ Auto (1)
- ❍ Te voet (2)
- ❍ Openbaar vervoer (3)
- ❍ Fiets (4)
- ❍ Taxi (5)
- ❍ carpoolen (6)
- ❍ Andere (7) _____

Answer If Mode of travel you used? Private Car Is Selected

Q32 Reistijd (in minuten) tussen de dichtstbijzijnde openbaar vervoershalte en de activiteitslocatie

Bushalte (1)

Treinstation (2)

Answer If Mode of travel you used? Private Car Is Selected

Q33 Is er, naast comfort, gemak of het gebruik van de auto tijdens het werk (u moet bijvoorbeeld meer dan 25kg aan materiaal meenemen, …), een andere reden om geen andere vervoerswijze te kiezen?

- ❑ Reistijd (1)
- ❑ Tijdsdruk (2)
- ❑ Complexiteit van de agenda (3)
- ❑ Anders (4) _____

Q34 Bent u tevreden met de vervoerswijze die u momenteel gebruikt?

- ❍ Zeer tevreden (1)
- ❍ Tevreden (2)
- ❍ Niet tevreden, noch ontevreden (3)
- ❍ Ontevreden (4)
- ❍ zeer ontevreden (5)

Q35 Wat is volgens u de snelste vervoerswijze buiten de vervoerswijze die u nu gebruikt, die kan bijdragen in het besparen van tijd?

- ❍ Auto (1)
- ❍ Te voet (2)
- ❍ Openbaar vervoer (3)
- ❍ Fiets (4)
- ❍ Taxi (5)
- ❍ Carpoolen (6)
- ❍ Andere (7) _____

Q36 Hoe zou u de tijd kwalificeren die u beschikbaar had op de door u beschreven werkdag?

- Tijd is altijd schaars, ik moet een aantal activiteiten laten vanwege tijdsgebrek (1)
- Tijd is gelimiteerd, maar ik kan alles gedaan krijgen, ook al is het later dan gepland (2)
- Tijd is gelimiteerd, maar ik kan alles op tijd afkrijgen (3)
- Ik heb altijd genoeg tijd, er is extra tijd over als ik alle dagelijkse plannen heb uitgevoerd (4)
- Tijd speelt geen rol in het uitvoeren van de activiteiten (5)

Q37 Stel dat u meer activiteiten heeft dan verwacht en u voelt tijdsdruk, hoe zou u daar dan mee omgaan?

- Normaal versnel ik zaken en probeer ik alles af te ronden in de beschikbare tijd, ook al is het kort (1)
- Normaal gebruik ik een efficiënte vervoerswijze om tijd te besparen en alle dagelijkse taken uit te kunnen voeren (2)
- Normaal gesproken, als ik tijdsdruk voel, filter ik de belangrijkste activiteiten om te doen voor die dag en laat ik de minder belangrijke liggen (3)
- Normaal stel ik enkele activiteiten uit naar een andere dag als de beschikbare tijd korter is dan gedacht (4)
- Normaal breek ik de activiteit die me te veel tijdsdruk geeft af (5)

Q38 Orden de vervoerswijzen in afnemende voorkeur voor de meest voorkomende ritten (1 is voor de eerste voorkeur)

_____ Auto (1)
_____ Te voet (2)
_____ Openbaar vervoer (3)
_____ Fiets (4)
_____ Taxi (5)
_____ Carpoolen (6)

Q39 Welke vervoerswijze heeft uw voorkeur als u meer activiteiten moet uitvoeren dan gebruikelijk en u onder tijdsdruk bent, waarbij u een tour maakt om verschillende activiteitenlocaties te bereiken, zonder tussentijds thuis te komen? Geef aan in volgorde van afnemende voorkeur

Q2 Geef alstublieft uw e-mail adres op om een kopie van de onderzoeksresultaten te ontvangen

Appenix-III

1	Variables	Description
2	loc_type	location type (Urban =1, Rural= 2 and suburban=3)
3	B_year	Birth year
4	prof_act	Professional Activity (yes=1, No=2)
5	mar_status	single=1, Married = 2, living together=3, Divorced=4, Widowed=5
6	BC_GP	Blue collar, Government or private
7	OJ_GP	Office job, Government or private
8	BC_ES	Blue collar, Employed or self employed
9	OJ_ES	office job, Employed or self employed
10	emp_sector	Employment sector
11	NH_income	Net monthly household income (1=<1000€, 2=1001-2000, 3= 2001-3000, 4=3001-4000, 5=4001-5000, 6= >5000)
12	No_act	number of activities (1=2, 2=3,---8= >8)
13	No_actO	Number of activities others option
14	W_day	Reported working day (Monday =1, Tuesday= 2, Thursday=3,Wednesday=4, Friday=5)
15	act_type1	Activity type
16	pl_execution1:8	Activity planning before execution day
17	Pstart_time1:8	Planned start time
18	Etravel_time1:8	Estimated travel time
19	Astart_time1:8	Actual start time
20	Atravel_time1:8	Actual travel time
21	Pfinish_time1:8	Planned finish time
22	Afinish_time1:8	Actual finish time
23	TP_travel1	Time Pressure during travel
24	TP_act1	Time Pressure in activity (1=NO, 2=Yes)
25	extra_time1	Extra time needed to complete the activity
26	dst_reason1	Reason for delay start time
27	det_reason1	Reason for delay end time
28	ppone_act1	Postponing activity later, next day or abort
29	TPwithin_act1	Time Pressure within activity
30	TP_period1	Time pressure intensity during the activity
31	TP_coping1	Time pressure coping strategy
32	trip_m1	Mode used for the activity/trip
33	Ttime_BS1	Travel time to nearby bus station in case respondent chosen car
34	Ttime_TS1	Travel time to nearby train station in case respondent chosen car
35	sat_TM1	satisfaction scale for trip mode (Extremely satisfied=1, somewhat satisfied=2,)
36	Pfast_TM1	perceived faster trip mode (1=car, 2=walk, 3=public transport, 4=Bike, 5=Taxi, 6=carpooling, 7=other)
37	PTP	Perceived Time Pressure
38	TP_coping	General time pressure coping strategy (accelerating things=1, choosing efficient transport=2, filtering activities=3 postponing=4 aborting=5)
39	FTM1	Frequent transport mode prefer to use for trips priority 1 ((1=car, 2=walk, 3=public transport, 4=Bike, 5=Taxi, 6=carpooling))

40	PTM_UTP1	Perceived chosen transport mode under Time Pressure (case scenario) priority 1 (1=car, 2=walk, 3=public transport, 4=Bike, 5=Taxi, 6=carpooling)
41	TP1:8	Calculated actual time pressure from reported time of eight activities (Method 1)
42	TP_duration!:8	Calculated actual time pressure from reported time of eight activities (Method 2)
43	maxTP	Calculated actual maximum time pressure from reported time of eight activities Max(TP1:8)
44	minTP_duration	Calculated actual maximum time pressure from reported time duration of eight activities. Min(TP_duration1:8)
45	age	Calculated variable from B_year
46	gender	1 = Male, 2=Female
47	YN_children	Having children or not (Yes=1, No=2)
48	LN_children	Number of children living with parents
49	nonprof_act	Student=1, looking for job=2, pension=3, unfit for work=4, working in house=5, other=6, volunteer work outside home=7

Appendix-IV

SAS code Enterprise guide

```
PROC SQL;
  CREATE TABLE WORK.QUERY_FOR_FILTER_FOR_TPORIG AS
  SELECT QUERY_FOR_FILTER_FOR_TPORIG;
       /* TP_duration1 */
         ((t1.Pfinish_time1 - t1.Pstart_time1) - (t1.Afinish_time1 - t1.Astart_time1)) AS TP_duration1,
       /* TP_duration2 */
         ((t1.Pfinish_time2 - t1.Pstart_time2) - (t1.Afinish_time2 - t1.Astart_time2)) AS TP_duration2,
       /* TP_duration3 */
         ((t1.Pfinish_time3 - t1.Pstart_time3) - (t1.Afinish_time3 - t1.Astart_time3)) AS TP_duration3,
       /* TP_duration4 */
         ((t1.Pfinish_time4 - t1.Pstart_time4) - (t1.Afinish_time4 - t1.Astart_time4)) AS TP_duration4,
       /* TP_duration5 */
         ((t1.Pfinish_time5 - t1.Pstart_time5) - (t1.Afinish_time5 - t1.Astart_time5)) AS TP_duration5,
       /* TP_duration6 */
         ((t1.Pfinish_time6 - t1.Pstart_time6) - (t1.Afinish_time6 - t1.Astart_time6)) AS TP_duration6,
       /* TP_duration7 */
         ((t1.Pfinish_time7 - t1.Pstart_time7) - (t1.Afinish_time7 - t1.Astart_time7)) AS TP_duration7,
       /* TP_duration8 */
         ((t1.Pfinish_time8 - t1.Pstart_time8) - (t1.Afinish_time8 - t1.Astart_time8)) AS TP_duration8,
       /* TP1 */
         ((t1.Afinish_time1 - t1.Astart_time1) /( t1.Pfinish_time1 - t1.Pstart_time1)) AS TP1,
       /* TP2 */
         ((t1.Afinish_time2 - t1.Astart_time2) / (t1.Pfinish_time2 - t1.Pstart_time2)) AS TP2,
       /* TP3 */
         ((t1.Afinish_time3 - t1.Astart_time3) / (t1.Pfinish_time3 - t1.Pstart_time3)) AS TP3,
       /* TP4 */
         ((t1.Afinish_time4 - t1.Astart_time4) / (t1.Pfinish_time4 - t1.Pstart_time4)) AS TP4,
       /* TP5 */
         ((t1.Afinish_time5 - t1.Astart_time5) / (t1.Pfinish_time5 - t1.Pstart_time5)) AS TP5,
       /* TP6 */
         ((t1.Afinish_time6 - t1.Astart_time6) / (t1.Pfinish_time6 - t1.Pstart_time6)) AS TP6,
       /* TP7 */
         ((t1.Afinish_time7 - t1.Astart_time7) / (t1.Pfinish_time7 - t1.Pstart_time7)) AS TP7,
       /* TP8 */
         ((t1.Afinish_time8 - t1.Astart_time8) / (t1.Pfinish_time8 - t1.Pstart_time8)) AS TP8
    FROM WORK.QUERY_FOR_FILTER_FOR_TPORIG_0003 t1;
QUIT;
PROC SQL;
  CREATE TABLE WORK.QUERY_FOR_FILTER_FOR_TPORIG_0003 AS
  SELECT QUERY_FOR_FILTER_FOR_TPORIG_0003;
/* PTP_345_mapto_1 */
         (int(t1.PTP / 3)) AS PTP_345_mapto_1
    FROM WORK.FILTER_FOR_TPORIGIONAL___COPY t1;
QUIT;
```

SAS 9.4 code

/SAS code for regression model/

```
*/ods rtf file='C:\hasselt M.sc\Smester-IV\Thesis_PartII\f.rtf';
proc reg data=work.sasdataset1;
MODEL TP1 = LN_children  No_act YN_children BC_GP OJ_GP BC_ES OJ_ES pl_execution1
TP_travel1 TP_act1 TPwithin_act1 caruse1_1 caruse2_1 caruse3_1 caruse4_1
```

```
dummy_dow_monday dummy_dow_tuesday dummy_dow_wednesday dummy_dow_thursday
dummy_dow_friday dummy_acttype1_work dummy_acttype1_homeactivity
dummy_acttype1_business dummy_acttype1_socialvisit
    dummy_acttype1_leisure dummy_acttype1_shopping dummy_acttype1_services
dummy_acttype1_bringget dummy_acttype1_school dummy_acttype1_walkaround
dummy_acttype1_other dummy_loctype_urban
    dummy_loctype_rural dummy_loctype_suburban dummy_edu_primary
dummy_edu_secondaryntcomp dummy_edu_secondaryotherntcomp dummy_edu_secondarycomp
dummy_edu_secondaryothercomp
    dummy_edu_nonuniversity dummy_edu_university dummy_edu_other dummy_marstatus_single
dummy_marstatus_married dummy_marstatus_livingtogether
    dummy_marstatus_divorced dummy_marstatus_widowed dummy_nonprof_student
dummy_nonprof_lookingjob dummy_nonprof_pension dummy_nonprof_unfit
dummy_nonprof_workhome dummy_nonprof_volunteer
    dummy_nonprof_other dummy_tmsat1_ES dummy_tmsat1_SS dummy_tmsat1_NSD
dummy_tmsat1_SD dummy_tmsat1_ED dummy_pfastmode1_car dummy_pfastmode1_walk
dummy_pfastmode1_publictrans
    dummy_pfastmode1_bike dummy_pfastmode1_taxi dummy_pfastmode1_carpooling
dummy_pfastmode1_other dummy_coping_accelrate dummy_coping_eftm dummy_coping_filter
    dummy_coping_postpone dummy_coping_abort dummy_tmode1_car dummy_tmode1_walkbike
dummy_tmode1_pt dummy_tmode1_other dummy_ptp_high dummy_ptp_low dummy_ptp_no
    dummy_ptp_lessntp dummy_ptp_extnotp dummy_sector_construction dummy_sector_transport
dummy_sector_IandC dummy_sector_otherservice dummy_sector_profresearch
    dummy_sector_administration dummy_sector_education dummy_sector_health
dummy_sector_wholesale dummy_sector_financial dummy_income_less1000
dummy_income_bt1001to2000
    dummy_income_bt2001to3000 dummy_income_bt3001to4000 dummy_income_bt4001to5000
dummy_income_gt5000 dummy_dst1_congestion dummy_dst1_misdconnectn
dummy_dst1_previousact dummy_dst1_none
    dummy_dst1_other dummy_det1_latestrt dummy_det1_tookmore dummy_det1_unplndact
dummy_ppone1_nxtday dummy_ppone1_latrsameday dummy_ppone1_abort
dummy_tperiod1_aftrstrt
    dummy_tperiod1_intermediate dummy_tperiod1_nearend dummy_coping1_accelrate
dummy_coping1_filter dummy_coping1_abort dummy_FTM1_car dummy_FTM1_walk
dummy_FTM1_pt
    dummy_FTM1_bike dummy_FTM1_taxi dummy_FTM1_carpooling dummy_FTM1_car
dummy_FTM2_walk dummy_FTM2_pt dummy_FTM2_bike dummy_FTM2_taxi
dummy_FTM2_carpooling
    dummy_FTM3_car dummy_FTM3_walk dummy_FTM3_pt dummy_FTM3_bike
dummy_FTM3_taxi dummy_FTM3_carpooling dummy_PTM_UTP1_car dummy_PTM_UTP1_walk
dummy_PTM_UTP1_pt
    dummy_PTM_UTP1_bike dummy_PTM_UTP1_taxi dummy_PTM_UTP1_carpooling
dummy_PTM_UTP2_car dummy_PTM_UTP2_walk dummy_PTM_UTP2_pt
dummy_PTM_UTP2_bike dummy_PTM_UTP2_taxi
    dummy_PTM_UTP2_carpooling dummy_PTM_UTP3_car dummy_PTM_UTP3_walk
dummy_PTM_UTP3_pt dummy_PTM_UTP3_bike dummy_PTM_UTP3_taxi
dummy_PTM_UTP3_carpooling
            /           SELECTION=stepwise
            VIF
    ;
run;
ods rtf close;
/*Best model TP_act1*/
ods rtf file='C:\hasselt M.sc\Smester-IV\Thesis_PartII\tp_act1.rtf';
ods graphics on;

PROC LOGISTIC DATA=work.sasdataset plot=(all)
            ;
    CLASS mar_status W_day gender YN_children prof_act pl_execution1 TP_travel1 T_mode1
PTP_45_mapsto_1 / param=ref;
```

```
    MODEL TP_act1 (event='2') = mar_status gender TP_duration1 W_day YN_children prof_act
No_act pl_execution1 TP_travel1 T_mode1 act_type1 PTP_45_mapsto_1 /
selection=backward
LINK=LOGIT
    ;
RUN;
ods graphics off;
ods rtf close;

/*Best model TP_act2 */
ods rtf file='C:\hasselt M.sc\Smester-IV\Thesis_PartII\TP_act2.rtf';
ods graphics on;
PROC LOGISTIC DATA=work.sasdataset plot=(all);
    CLASS loc_type gender YN_children prof_act No_act pl_execution1_0001 TP_travel2 act_type2
PTP_45_mapsto_1 T_mode2 / param=ref;
    MODEL TP_act2 (event='2') = loc_type gender age YN_children prof_act pl_execution1_0001
TP_travel2 PTP_45_mapsto_1 /
    firth
    slentry=0.1
    slstay=0.15
    rsq
LINK=LOGIT
    ;
RUN;
proc freq data= work.sasdataset;
tables trip_m1*pfast_TM1 trip_m1*sat_TM1;
run;
ods graphics off;
ods rtf close;

/*Best model with TP_act3 */
ods rtf file='C:\hasselt M.sc\Smester-IV\Thesis_PartII\TP_act3.rtf';
ods graphics on;
PROC LOGISTIC DATA=work.sasdataset plot=(all);
    CLASS loc_type gender YN_children prof_act pl_execution3 TP_travel3 PTP_45_mapsto_1
T_mode3 / param=ref;
    MODEL TP_act3 (event='2') = loc_type gender TP3 TP_duration3 age YN_children
pl_execution3 TP_travel3 PTP_45_mapsto_1 /
selection=stepwise
slentry=0.1
    slstay=0.15
    rsq
LINK=LOGIT
    ;
RUN;
ods graphics off;
ods rtf close;

/*Best model with TP_act4 */
ods rtf file='C:\hasselt M.sc\Smester-IV\Thesis_PartII\TP_act4.rtf';
ods graphics on;
PROC LOGISTIC DATA=work.sasdataset plot=(all);
    CLASS mar_status no_act W_day gender YN_children prof_act pl_execution4 TP_travel4 /
param=ref;
    MODEL TP_act4 (event='2') = W_day age no_act gender TP4 TP_duration4 YN_children
prof_act pl_execution4 /
    selection=stepwise
    slentry=0.1
    slstay=0.15
    rsq
```

```
LINK=LOGIT
    ;
RUN;
ods graphics off;
ods rtf close;
/*Best model for TP_travel1 */
ods rtf file='C:\hasselt M.sc\Smester-IV\Thesis_PartII\TP_travell.rtf';
ods graphics on;
PROC LOGISTIC DATA=work.sasdataset plot=(all);
            ;
    CLASS loc_type edu_level gender No_act pl_execution1 TP_act1 TPwithin_act1 TP_coping
T_mode1 PTP_45_mapsto_1 / param=ref;
    MODEL TP_travel1 (event='1') = loc_type mar_status gender TP1 TPwithin_act1 TP_duration1
age No_act pl_execution1 T_mode1 PTP_45_mapsto_1 /
    selection=stepwise
    slentry=0.1
    slstay=0.15
    rsq
LINK=LOGIT
    ;
RUN;
ods graphics off;
ods rtf close;
/*Best model TP_travel2 */
ods rtf file='C:\hasselt M.sc\Smester-IV\Thesis_PartII\TP_travel2.rtf';
ods graphics on;
PROC LOGISTIC DATA=work.sasdataset plot=(all)
            ;
    CLASS     mar_status gender prof_act YN_children TPwithin_act2 TP_act2 FTM1
PTP_45_mapsto_1 pfast_TM2 / param=ref;
    MODEL TP_travel2 (event='1') = loc_type gender TPwithin_act2 TP_duration2 YN_children
age prof_act FTM1 TP_act2 PTP_45_mapsto_1 pfast_TM2 /
    selection=stepwise
    slentry=0.1
    slstay=0.15
    rsq
LINK=LOGIT
    ;
RUN;
ods graphics off;
ods rtf close;
/*Best model TP_travel3 */
ods rtf file='C:\hasselt M.sc\Smester-IV\Thesis_PartII\TP_travel3.rtf';
ods rtf file='C:\hasselt M.sc\Smester-IV\Thesis_PartII\TP_travel3.rtf';
ods graphics on;
PROC LOGISTIC DATA=work.sasdataset plots=(all);
CLASS  loc_type mar_status edu_level W_day gender YN_children prof_act TPwithin_act3 No_act
pl_execution3 TP_act3 TP_coping FTM1 T_mode3 act_type3 PTP_45_mapsto_1 pfast_TM3
sat_TM3 / param=ref;
MODEL TP_travel3 (event='1') = loc_type edu_level TPwithin_act3 gender TP3 TP_duration3 age
W_day YN_children prof_act No_act pl_execution3 TP_act3 TP_coping FTM1 T_mode3 act_type3
PTP_45_mapsto_1 pfast_TM3 sat_TM3 /
    selection=stepwise
    slentry=0.1
    slstay=0.15
    rsq
LINK=LOGIT
    ;
RUN;
ods graphics off;
```

```
ods rtf close;


/*Best model TP_travel4 */
ods rtf file='C:\hasselt M.sc\Smester-IV\Thesis_PartII\TP_travel4.rtf';
ods graphics on;
PROC LOGISTIC DATA=work.sasdataset plots=(all);
    CLASS edu_level loc_type W_day gender YN_children prof_act TPwithin_act4 No_act
pl_execution4 / param=ref;
    MODEL TP_travel4 (event='1') = W_day TPwithin_act4 gender TP4 TP_duration4 age
YN_children prof_act No_act pl_execution4 T_mode4 /
selection=stepwise
    slentry=0.1
    slstay=0.15
    rsq
LINK=LOGIT
    ;
RUN;
ods graphics off;
ods rtf close;

/* Logit model with separate variable*/
PROC LOGISTIC DATA=work.sasdataset plot=(all);
    class loc_type / param=ref;
    MODEL PTP_345_mapto_1 (event='0') = loc_type /
    rsq
LINK=LOGIT;
RUN;

PROC LOGISTIC DATA=work.sasdataset plot=(all);
    class NH_income / param=ref;
    MODEL PTP_345_mapto_1 (event='0') = NH_income /
    rsq
LINK=LOGIT;
RUN;
PROC LOGISTIC DATA=work.sasdataset plot=(all);
    class mar_status / param=ref;
    MODEL PTP_345_mapto_1 (event='0') = mar_status / firth
    rsq
LINK=LOGIT;
RUN;
PROC LOGISTIC DATA=work.sasdataset plot=(all);
    MODEL PTP_345_mapto_1 (event='0') = age /
    rsq
LINK=LOGIT;
RUN;

PROC LOGISTIC DATA=work.sasdataset plot=(all);
    MODEL PTP_345_mapto_1 (event='0') = maxTP /
    rsq
LINK=LOGIT;
RUN;
PROC LOGISTIC DATA=work.sasdataset plot=(all);
    MODEL PTP_345_mapto_1 (event='0') = minTP_duration /
    rsq
LINK=LOGIT;
RUN;
PROC LOGISTIC DATA=work.sasdataset;
    class gender / param=ref;
    MODEL PTP_345_mapto_1 (event='0') = gender /
```

```
    rsq
LINK=LOGIT;
RUN;

PROC LOGISTIC DATA=work.sasdataset plot=(all);
    class FTM1 / param=ref;
    MODEL PTP_345_mapto_1 (event='0') = FTM1 /
    rsq
LINK=LOGIT;
RUN;


PROC LOGISTIC DATA=work.sasdataset;
    class LN_children / param=ref;
    MODEL PTP_345_mapto_1 (event='0') = LN_children  /
    rsq
LINK=LOGIT;
RUN;

PROC LOGISTIC DATA=work.sasdataset;
    class prof_act / param=ref;
    MODEL PTP_345_mapto_1 (event='0') = prof_act /
    rsq
LINK=LOGIT;
RUN;
PROC LOGISTIC DATA=work.sasdataset;
    class TP_coping / param=ref;
    MODEL PTP_345_mapto_1 (event='0') = TP_coping /
    rsq
LINK=LOGIT;
RUN;

PROC LOGISTIC DATA=work.sasdataset;
    class PTM_UTP1 / param=ref;
    MODEL PTP_345_mapto_1 (event='0') = PTM_UTP1 /
    rsq
LINK=LOGIT;
RUN;
PROC LOGISTIC DATA=work.sasdataset;
    class edu_level / param=ref;
    MODEL PTP_345_mapto_1 (event='0') = edu_level /
    rsq
LINK=LOGIT;
RUN;

PROC LOGISTIC DATA=work.sasdataset;
    class No_act / param=ref;
    MODEL PTP_345_mapto_1 (event='0') = No_act /
    rsq
LINK=LOGIT;
RUN;

PROC LOGISTIC DATA=work.sasdataset;
    class W_day / param=ref;
    MODEL PTP_345_mapto_1 (event='0') = W_day /
    rsq
LINK=LOGIT;
RUN;
```

Appendix-V

Profile of agenda up-to five activities (Frequency counts and percentages)						
#	**Variable**	**Activity 1**	**Activity2**	**Activity3**	**Activity4**	**Activity5**
1	**Type of activity**					
	Work	21.29% 33	27.10% 42	21.57% 11	12% 3	12.5% 1
	Home Activities	16.77% 26	16.13% 25	15.69% 8	24% 6	25% 2
	Business	3.23% 5	0.65% 1	- 	4% 1	-
	Social Visit	5.16% 8	3.87% 6	5.88% 3	8% 2	-
	Leisure activity	7.74% 12	12.90% 20	13.73% 7	4% 1	25% 2
	Shopping	7.10% 11	8.39% 13	3.92% 2	4% 1	-
	Services	1.94% 3	0.65% 1	1.96% 1	4% 1	-
	Bringing/getting someone or something	3.23% 5	1.29% 2	9.80% 5	16% 4	25% 2
	Attending School	26.45% 41	24.52% 38	23.53% 12	16% 4	-
	Walking around	1.94% 3	- 	3.92% 2	8% 2	-
	Other	5.16% 8	4.52% 7	- 	- 	12.5% 1
	Total frequency count	155	155	51	23	8
2	**Planned or unplanned execution**					
	Yes	89.03% 138	85.16% 132	86.27% 44	84% 21	87.5% 7
	No	10.97% 17	14.84% 23	13.73% 7	16% 4	12.5% 1
	Total frequency count	155	155	51	25	8
3	**Time pressure during travel**					
	Yes	16.77% 26	18.1% 28	19.6% 10	16% 4	25% 2
	No	83.23% 129	81.9% 127	80.4% 41	84% 21	75% 6
	Total frequency count	155	155	51	25	8
4	**Time pressure in activity**					
	No	94.2% 146	96.8% 150	94.1% 48	96% 24	100% 8
	Yes	5.8% 9	3.23% 5	5.88% 3	4% 1	-
	Total frequency count	155	155	51	25	8
5	**Transport Mode**					
	Car	48.39% 75	51.6% 80	54.9% 28	48% 12	62.5% 5
	Walk	7.74% 12	1.94% 3	13.73% 7	12% 3	
	Public Transport	23.9% 37	27.1% 42	11.76% 6	16% 4	12.5% 1
	Bike	13.55% 21	14.84% 23	13.73% 7	24% 6	12.5% 1
	Taxi	0.65%	-	-	-	-

		1				
	Carpooling	2.58% 4	3.23% 5	5.88% 3	-	12.5% 1
	Other	3.23% 5	1.29% 2	-	-	
	Total frequency count	155	155	51	25	8
6	**Satisfaction level with current transport mode**					
	Extremely satisfied	43.5% 67	43.9% 68	52.9% 27	64% 16	87.5% 7
	Somewhat Satisfied	40.9% 63	41.3% 64	27.5% 14	28% 7	12.5% 1
	Neither satisfied nor dissatisfied	10.4% 16	10.97% 17	11.8% 6	8% 2	-
	Somewhat dissatisfied	4.6% 7	3.23% 5	7.8% 4	-	-
	Extremely dissatisfied	0.65% 1	0.65% 1	-	-	-
	Total frequency count	154	155	51	25	8
7	**Transport mode that is faster than the current they are using**					
	Car	45.75% 70	47.4% 73	29.4% 15	32% 8	37.5% 3
	Walk	1.96% 3	0.65% 1	3.9% 2	8% 2	-
	Public Transport	7.2% 11	7.8% 12	9.8% 5	4% 1	12.5% 1
	Bike	19.6% 30	22.7% 35	27.5% 14	28% 7	25% 2
	Taxi	8.5% 13	3.9% 6	5.9% 3	8% 2	25% 2
	Carpooling	9.8% 15	9.7% 15	7.8% 4	8% 2	-
	Other	7.2% 11	7.8% 12	15.7% 8	12% 3	-
	Total frequency count	153	154	51	25	8

Analysis of Maximum Likelihood Estimates (Model-1)						
Parameter		DF	Estimate	Standard Error	Wald Chi-Square	Pr > ChiSq
Intercept		1	-1.4663	0.6405	5.2409	0.0221
pl_execution1	1	1	-1.5702	0.7648	4.2153	0.0401

Analysis of Penalized Maximum Likelihood Estimates (Model-2)						
Parameter		DF	Estimate	Standard Error	Wald Chi-Square	Pr > ChiSq
Intercept		1	-3.8062	2.4817	2.3523	0.1251
loc_type	1	1	1.5055	1.3850	1.1815	0.2770
loc_type	2	1	1.9803	1.3388	2.1880	0.1391
gender	1	1	0.1839	0.8399	0.0479	0.8267
age		1	-0.1139	0.0619	3.3817	0.0659
YN_children	1	1	1.2549	1.0855	1.3365	0.2477
prof_act	1	1	2.0035	1.0601	3.5720	0.0588
pl_execution1_0001	1	1	0.3546	1.3207	0.0721	0.7883
TP_travel2	1	1	0.7146	0.8204	0.7587	0.3837
PTP_45_mapsto_1	0	1	0.9817	1.3789	0.5068	0.4765

Analysis of Maximum Likelihood Estimates (Model-3)					
Parameter	DF	Estimate	Standard Error	Wald Chi-Square	Pr > ChiSq
Intercept	1	-2.6626	0.5972	19.8811	<.0001

Analysis of Maximum Likelihood Estimates (Model-4)					
Parameter	DF	Estimate	Standard Error	Wald Chi-Square	Pr > ChiSq
Intercept	1	-3.1355	1.0215	9.4217	0.0021

Analysis of Maximum Likelihood Estimates (Model-5)						
Parameter		DF	Estimate	Standard Error	Wald Chi-Square	Pr > ChiSq
Intercept		1	-1.8176	0.3281	30.6939	<.0001
TP1		1	-0.2950	0.1829	2.5996	0.1069
TPwithin_act1	1	1	1.5729	0.5655	7.7368	0.0054

Analysis of Maximum Likelihood Estimates (Model-6)						
Parameter		DF	Estimate	Standard Error	Wald Chi-Square	Pr > ChiSq
Intercept		1	-1.8281	0.2539	51.8275	<.0001
TPwithin_act2	1	1	1.4917	0.6382	5.4623	0.0194

Analysis of Maximum Likelihood Estimates (Model-7)						
Parameter		DF	Estimate	Standard Error	Wald Chi-Square	Pr > ChiSq
Intercept		1	-1.6955	0.6885	6.0638	0.0138
loc_type	1	1	1.7348	0.9733	3.1766	0.0747
loc_type	2	1	-1.3409	1.2505	1.1498	0.2836
TPwithin_act3	1	1	2.4223	1.2726	3.6230	0.0570

Analysis of Maximum Likelihood Estimates (Model-8)					
Parameter	DF	Estimate	Standard Error	Wald Chi-Square	Pr > ChiSq
Intercept	1	-1.5581	0.5501	8.0223	0.0046

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Time Pressure and Flexibility in Daily Agendas

Richting: **Master of Transportation Sciences-Mobility Management**
Jaar: **2016**

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Batool, Tooba

Datum: **6/06/2016**