DEVELOPING AN ACTIVITY PATTERN CHOICE MODEL FOR INDIVIDUALS IN WESTERN PROVINCE

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Thesis submitted in partial fulfilment of the requirements for the degree Master of Science in Civil Engineering

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DECLARATION

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Abstract

Transport demand models assess impacts of transport policies and transport infrastructure. In recent times transport modellers have been moving towards disaggregate activity based models from widely used aggregate trip/tour based models. Hence the unit of analysis has shifted from vehicle flows/trips between zones to individual's activity patterns which in turn has aided in modelling complex human behavioural responses to current policy decisions. With Sri Lanka also moving towards activity based modelling in the near future identifying a suitable method to represent activity patterns of individuals is a key aspect. The research addresses the issue by developing an activity pattern choice model using home visit survey (HVS) data for individuals in Western Province.

Based on HVS data activity patterns for each member was developed with each pattern consisting of spatial and temporal representation. 3 main categories (Education, Work & Other) were clearly identified and each member was assigned a category based on the most prominent trip in the pattern. The 3 categories were further categorized based on aspects of number of tours, purpose, diversions and time. 17 subgroups were identified which consisted of 5 work, 4 educational & 8 other pattern groups.

The identified 17subgroups were used to develop the activity pattern choice model based on socio economic data. Initially a multi-level structure was considered. But due to the fuzziness of the results each level was considered as a single level and hence estimated separately. Each level consists of 2 choices and one choice is estimated relative to the other. Estimation of the 7 level choice model was carried out using "Apollo" module in R programming language.

The developed choice model at upper levels of education and work patterns displays a high level of accuracy. But lower level of the model mainly the patterns related to other pattern groups displays fuzziness and hence displays a lower level of accuracy at these levels.

Keywords: Activity patterns, Choice model, Logit estimation, Apollo module

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TABLE OF CONTENTS

LIST OF FIGURES

Page

LIST OF TABLES

Page

LIST OF ABBREVIATIONS

Abbreviation	Description
HVS	Home visit survey
LL	Log likelihood

LIST OF APPENDICES

1 INTRODUCTION

1.1 Research background

The impacts of transport policies and transport infrastructure are conventionally assessed using transport demand models. Impacts are based on attributes of both the transport systems as well as the users. There are mainly two types of demand models.

1. Trip based models (both aggregate & disaggregate)/4-step model
2. Activity based models

The traditional 4 step model which is an aggregate modelling approach was used initially to assess impacts of investments in transport infrastructure. The requirement of the model was to predict long term travel demand and hence the model's unit of analysis was vehicle flows or trips between zones. The model addresses the questions of whether to travel or not/frequency? (generation)where? (distribution)mode choice? (mode) and route? (assignment)

But with the policy shift from long term to short term, the demand models were required to predict behavioural responses. Hence the traditional aggregate trip based model was modified to disaggregate trip based model with the unit of analysis being changed to individual trips.

Both the aggregate & disaggregate trip based models consideration of travel itself as a demand has limited its capabilities in capturing the underlying reasons for travel. Hence the trip based models fails to capture complex travel and activity patterns that have arisen due to technological, social & behavioural developments (Ettema, 1996).

With the shift in model requirement to understanding of individual travel behaviour, transport modellers have moved towards activity based models. The activity based models capture travel as a derived demand from participating in activities distributed in time and space and hence considers individuals activity patterns as the unit of analysis.

A typical activity-based model contains the following features:

- Population synthesis

- Daily activity pattern formulation
- Tour formulation
- Time of day and mode choice
- Network assignment

(ATAP, 2016; Castiglione, 2015)

As described in (Ben-Akiva & Bowman, 1998) an individual's travel pattern can be modelled in the following 3 ways shown in figure 1.1.

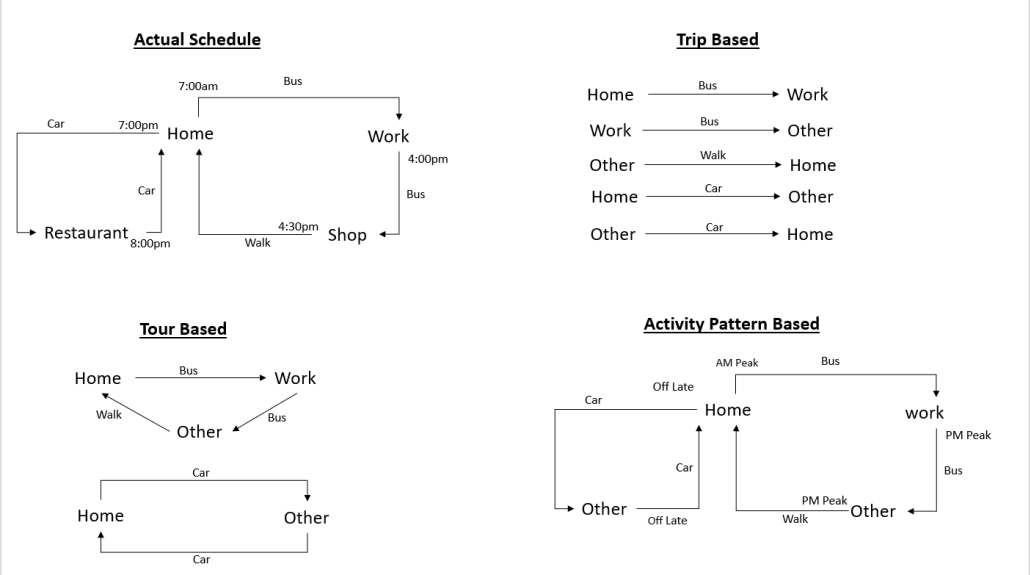


Figure 1-1: Daily schedule representation in different model types

Figure 1.1 shows the following hypothetical daily schedule of an individual. The person departs home at 7am and travels to work by bus. He leaves work at 4 pm and travels to shop by bus. He leaves the shop at 4:30pm and walks home. He leaves the home at 7pm and travels by car to restaurant and returns home at 8pm.

Trip based representation divides the actual schedule to each trip. Hence the actual schedule will be represented by 5 trips. Trip based model represents trip movement direction using trip production and trip attraction

Tour based representation divides the actual schedule to each tour. A tour constitutes a journey which starts and ends at the same location. Hence the actual schedule will

be represented by 2 tours. Furthermore, tour based models consider movement direction and spatial constraints.

Activity pattern based representation will link all the tours of an individual with high level of detail in time dimension.

1.2 Significance of research

Currently demand models created for Sri Lanka are trip based models. Sri Lanka will also move towards state of the art modelling method of activity based modelling in the near future. With the strategies such as flexible work hours, work from home, congestion pricing etc. expected to be prominent in the future its evaluation requires modelling of individual behaviour and hence the need for activity based models. An important aspect of the model development is identifying a suitable method to represent individual activities. This research will focus on activity pattern formulation step of the activity based model development.

1.3 Objectives

1. Identifying suitable activity patterns based on household survey data of western province
2. Developing a choice model to generate an activity pattern for an individual in western province to understand travel behaviour

1.4 Methodology

A detailed literature review was carried out to identify concepts of choice modelling and different activity pattern representation methods.

Activity Patterns were developed based on Home Visit Survey data and activity pattern groups and activity pattern distribution in groups were derived.

Activity pattern choice model was developed by determining the choice model structure and estimating the choice models using “Apollo” module of R programming language.

Figure 1.2 indicates the flowchart of adopted research methodology.

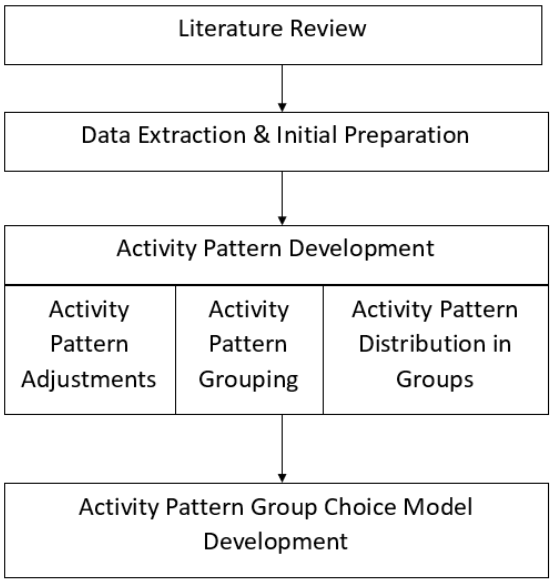


Figure 1-2: Flowchart of methodology

1.5 Thesis outline

The thesis contains 6 chapters and 3 appendices.

The present chapter provides an overview of the research area, objectives and methodology adopted.

Chapter 2 presents the literature review providing an overview of previous work carried out in the research area related to aspects of activity pattern representation and concepts of choice modelling.

Chapter 3 analyses the home visit survey dataset used in the research.

Chapter 4 presents the identification of activity patterns which is linked with the first research objective.

Chapter 5 presents the development of the activity pattern choice model which is linked with the second research objective.

Chapter 6 summarises the conclusions drawn from the research and lists down recommended future research directions.

2 LITERATURE REVIEW

2.1 Introduction

The main objective of the research is to develop a choice model that can generate an individual's activity patterns. This chapter will review existing literature on the areas related to the research objective. This chapter reviews literature on trip based models, its limitations and need for activity based models, activity demand & modelling, activity pattern generation, activity pattern representation and logit estimation.

2.2 Trip based modelling and activity based modelling

Decision making regarding transport systems requires information regarding the impacts at present and future due to any proposed policy or investment (Castiglione, 2015). Transport modelling is a tool that is used to mathematically represent supply and demand aspects of transportation system (Möller, 2014). The scope of the model can range from national to local based on the need for modelling.

The popular trip based models mainly consist of 4 stages namely trip generation, distribution, mode choice and assignment. Trip generation, distribution & mode choice stages represents the demand aspects and the final stage of trip assignment deals with the supply aspect (Chu et al., 2012). The trip based models which considers trips as unit of analysis can be aggregate if the analysis of trips is at zonal levels and can be disaggregate if at household or individual level.

The first step of trip generation estimates the frequency or the need for travel. Trip productions and attractions are estimated for each zone based on zonal characteristics such as population, employment, auto ownership etc. Growth factor modelling, regression analysis and cross classification have been identified as methods of trip generation estimation with most models simplifying it by categorizing the estimations based on trip purposes (work, education and other) being home based or not (Ortúzar & Willumsen, 2011).

The trip distribution step links the trip ends of derived trips generated in the previous step to develop the origin destination matrix. This step addresses the question of destination or where to travel. Growth factor method, Fratar method and gravity model have been used to derive the origin destination matrices (Ortúzar & Willumsen, 2011).

The Mode choice will divide the derived origin-destination matrix based on the available mode choice for travel which addresses the question of how travelling will take place. Models have been simplified by grouping modes to private mode, public mode and goods transportation mode. Diversion curves and choice models have been used to derive origin destination matrix for each of the identified modes. Both these methods use the concept of relative attractiveness of the modes based on cost, travel time and other mode characteristics and user attributes (Ortúzar & Willumsen, 2011).

The final step of assignment step will determine the route for travel which when aggregated will provide performance information on the transport network and infrastructure which are used for assessing impacts (Hensher & Button, 2007). All or nothing, stochastic assignment, capacity restraint and equilibrium assignment have been identified as methods for assignment. The method used will be based on modelling of multiple routes and congestion effects (Ortúzar & Willumsen, 2011).

Most models have feedback from later steps to earlier steps to update travel times, congestion levels etc. and will have multiple iterations before acceptance of model's results (Ortúzar & Willumsen, 2011).

Trip based models are adequate to assess long term capital infrastructure but with the shift in focus towards transport demand management policies (i.e. flexible work hours, congestion pricing) the model requirement has shifted towards understanding travel behaviour (Bhat & Koppelman, 2003).

(Castiglione, 2015) & (Chu et al., 2012) identifies the following limitations of trip based models that resulted in need for activity based models to satisfy the shift in the modeling requirement.

1. Ignoring travel as a demand derived from activity participation.

The whole trip based modelling process is based on traveling which has limited its applicability in context of alternative ways of satisfying activity participation needs (i.e. working from home instead of travelling)

2. Issues due to spatial aggregation

The assumption that all trips in a particular zone (origin or destination) generates from its zonal centroid limits its applicability in intra zonal trips (trips within the zone) and is an oversimplification of reality.

3. Issues due to temporal aggregation

The modelling of time in trip based models is restricted to few time periods (i.e AM peak, PM peak, Off peak). Hence it cannot capture the travel time variance, congestion levels etc. within the time periods.

4. Issues due to demographic aggregation

Trip based models categorizes zones/households/individuals based on income, auto ownership etc. which assumes homogenous travel behaviour within each category.

5. Individual decision making in household context

Trip based models fails to capture influences and effects on travel behaviour between each household member and assumes independent decision making of each individual.

6. Considering trip as unit of analysis

This limits the ability of trip based models to capture spatial temporal relationship between trips and hence aspects of trip scheduling, trip chaining cannot be adequately captured.

7. Sequential process of trip based models

Trip based models assumes that an individual's decision making process is in the order of model's order (whether make trip or not, destination, mode, route) which is not true for all individuals.

Activity based models can overcome the above limitations due to its following features.

1. Considering an individual's activity patterns as unit of analysis with the consideration of travel being a result of individual's need to participate in activities (Chu et al., 2012)

2. Modelling individuals with spatial and temporal constraints and social and household influences (Hensher & Button, 2007)
3. Represent activities and characteristic choices (i.e. location, duration) using simulated functions (ATAP, 2016)
4. Activity representation in greater detail in spatial and temporal dimensions (i.e. modelling of activities carried out across 24 time period) (Chu et al., 2012)
5. Focus on activity scheduling and sequence of activity patterns (Castiglione, 2015; Chu et al., 2012)

A typical activity based model consist of population synthesis, daily activity pattern formulation, tour formulation, time of day and mode choice, network assignment (ATAP, 2016; Castiglione, 2015).

The initial step in a typical activity based model is population synthesis where a synthetic population is created based on an available sample and aggregate targets. This enables modelling future scenarios by creating a future population using collected present sample and predicted future targets (Castiglione, 2015).

Daily activity patterns are formulated for individuals in synthetic population based on spatial, temporal and other dimensions (Castiglione, 2015). It enables capturing of non travel aspects (i.e. stay at home all day) in addition to travel aspects (ULTRANS & HBA Specto Incorporated, 2011).

Using the derived activity patterns, tours are formulated based on individual's household relationships and constraints (Castiglione, 2015).

It is followed by time of day, mode choice and network assignment which models individual's temporal, mode and route choices (ATAP, 2016; Castiglione, 2015). Most of these steps are based on discrete choice modelling with randomness in selection of these choices introduced using Monte Carlo and other probabilistic processes (Ortúzar & Willumsen, 2011). (Mannering et al., 1994) & (Bhat, 1996) have used hazard duration models to model activity duration aspect of time of day choice.

2.3 Review of literature on activity demand and modelling

(Chapin, 1974) states that basic human desires (ranging from survival to satisfying ego) is the motivation behind activity demand. He further explains the role of household and its different characteristics (i.e. size, age, gender, member relationships) in terms of both the influence and the constraints that they impose.

(Hägerstrand, 1970) identified 3 types of constraints.

1. Coupling – constraint posed by another person being present
2. Authority – restrictions by institutions
3. Capability – limits of technology and human nature

(Hägerstrand, 1970) further states in his concept of time-space prism that movement in the space-time continuum has an associated cost and a time.

The concept of maximizing utility has been used to model the above mentioned activity demands and constraints. (Evans, 1972) model which includes utility functions of activities and (Inzerilli & Jara-Díaz, 1994) model which transform purchase of goods to trip making are some examples of the use of utility maximization for modelling. But these models fall short of addressing aspects related to activity scheduling (Ben-Akiva & Bowman, 1998).

The framework developed by (Ben-Akiva & Lerman, 1985) shows how household decisions, of which activity patterns are one aspect, also has interactions with external influences of urban development and transport system performance.

2.4 Review of literature in activity pattern generation

Representative activity patterns, which can be defined as grouping of similar activity patterns, can be considered as the base for an activity pattern generation model (Kulkarni & McNally, 2000). (Recker, 1983) and (Pas, 1983) highlights that activity patterns that are subjected to daily variations can be identified using classifying them into several pattern types. (Vaughn et al., 1997) shows that socioeconomic characteristics of individual's closely related to his/her choice of daily activity pattern.

Several approaches have been used to develop the relationship between representative activity patterns and socio-economic characteristics. (Wang, 1996)'s approach was to

relate socio economic characteristics to representative activity patterns by specifying 6 lifecycle groups and defining representative activity patterns by clustering each group independently.

Another approach is to specify activity patterns first and then link and group them according to socio economic characteristics. (Kulkarni & McNally, 2000) states that while this approach is efficient it can also result in loss of subtle differences in activity patterns.

(Kulkarni & McNally, 2000) also proposes approach which is a hybrid of the above two approaches. By using (Vaughn et al., 1997) findings that significant proportion of variation in activity patterns being attributed to age and employment status, (Kulkarni & McNally, 2000) has divided the individuals to 3 groups based on these 2 factors. Next representative activity pattern for each group is identified by classifying activity patterns in each group.

2.5 Review of literature in activity pattern representation

2.5.1 Travel representation

(ULTRANS & HBA Specto Incorporated, 2011) doesn't recognize travel as a separate activity and assumes that travel is represented by change in location. Hence the model is much simpler.

(Hafezi et al., 2019) has identified travel as a separate activity and specifies that representation of travel separately enables future updating of congested travel times.

2.5.2 Time/frequency representation

(Pas, 1998) uses the number of stops instead as a substitute for representation of temporal dimension.

(Ben-Akiva & Bowman, 1998) states that the resolution of the time dimension should be defined in a way in which the model is able to capture effects of responses to scenarios such as congestion pricing, policies to shift of traffic congestion etc.

(ULTRANS & HBA Specto Incorporated, 2011) has defined the temporal dimension by dividing the time of day based on peak, off peak times.

Table 2-1: Time period considered in CSTDM

Code	Time Period
1	Early Off-peak (3am-6am)
2	AM Peak (6am-10am)
3	Midday (10am-3pm)
4	PM Peak (3pm-7pm)
5	Late Off-peak (7pm-3am)

Source: (ULTRANS & HBA Specto Incorporated, 2011)

In Sri Lankan context the time periods defined in (Galgamuwa et al., 2016) may be applicable.

Table 2-2: Time periods for Sri Lankan context

Time Period	Time
Morning Off-peak	12am – 7am
Morning Peak	7am - 9am
Interpeak 1	9am – 12noon
School Peak	12noon – 3pm
Interpeak 2	3pm-5pm
Evening peak	5pm – 8pm
Night Off-peak	8pm - 12am

Source: (Galgamuwa et al., 2016)

With the use of time use data where each individual's 24 hour activity schedule is available, the temporal dimension has been defined using time slices of 5 minute interval (Hafezi et al., 2019) and 15 minute interval (De Silva, 2011).As the interval of the time slices becomes finer the model will be more sensitive but at the expense of patterns being more complex and hence requiring a larger computation time.

2.5.3 Spatial representation

(ULTRANS & HBA Specto Incorporated, 2011) does not specifically include a code for spatial representation in an individual's activity pattern and assumes that code for an activity will inherently include the spatial representation for that activity. This

ensures that the activity pattern is simpler and hence the computational times are relatively less.

(De Silva, 2011) goes a step further and includes a coded location for spatial representation. By considering home, work, leisure and other as the locations. This results in a more accurate activity pattern representation but at the expense of increase in complexity and computational times.

(Ding, 2009) uses actual coordinates of the activity for spatial representation. An individual's location is defined based on northing, easting & zenith (x, y, z). This is the most accurate representation of an individual's activity pattern in terms of spatial representation. But with the increase of the sample size the complexity of patterns and computational times will increase significantly.

2.6 Review of literature in logit estimation

"Utility" is a concept used to represent how attractive an alternative is to an individual. The utility function consists of individual characteristics, alternatives attributes and the function parameters. An individual will choose the alternative that maximizes the utility.

The utility function shown below consists of two components, namely the measurable component and the error component which accounts factors that are difficult to measure due to the complexity of human behavior.

$U_{(a,i)} = V_{(a,i)} + E_{(a,i)}$

Where:

$U_{(a,i)}$ – Utility of alternative 'a' for individual 'i'

$V_{(a,i)}$ – Measurable component of utility of alternative 'a' for individual 'i'

$E_{(a,i)}$ – Error component of utility of alternative 'a' for individual 'i'

The error term is a randomly varying value which in turn makes the sum of measurable component and the error component to be also randomly varying. This ensures that selection of the alternative with the maximum utility has an associated probability.

This which is referred to as “random utility maximizing hypothesis” can be formulated as shown below.

$P[a^*, i] = P[U(a^*,i) > U(a, i) \; \forall \; a \in A - \{a^*\}]$

Where:

a^* – Selected alternative

A – Set of all alternatives

The probability function depends on the form of the error term distribution. According to the central limit theorem the most appropriate form for the error terms is the normal distribution which results in the probability function known as the probit expression. But due to the complexity of the probit function in practice the Weibull distribution is used to represent the error terms. The result is the logit expression shown below.

$$P[a*, i] = \frac{\exp\,[\lambda V(a*, i)]}{\sum_{a \in A} \exp\,[\,\lambda V(a, i)]}$$

Where:

λ - Dispersion parameter

Maximum likelihood technique is used for the estimation of function parameters with the use of computer programs.

(ULTRANS & HBA Specto Incorporated, 2011) & (De Silva, 2011) both have used “ALOGIT” program for the estimation of function parameters. (Hess & Palma, 2019a; Hess & Palma, 2019b) introduces a module named “Apollo” that runs in R-programming language that also can perform logit estimation. Unlike ALOGIT, Apollo is freely accessible and is customizable and hence provides a platform to model uncommon, complex model types (Hess & Palma, 2019).

3 DATA

The data required for the research was derived from data collected in the CoMTrans home visit survey 2013.

3.1 Home Visit Survey (HVS)

The home visit survey collected information relating to travel activities of residents and their respective socio economic characteristics. The travel activities includes details relating to an individual's trips such as origin, departure time, arrival time, destination, mode, some mode characteristics(i.e. waiting time, ride time, fare etc.).In terms of socio economic characteristics the details relating to both household and member information has been obtained. This is currently the largest and comprehensive personal travel survey carried out in Sri Lanka.

The target sample size of the HVS survey was 3% of the population of Western Province with the final processed data set including data related to 35,850 households. Obtained information was restricted to members of the age of 5 years and above in households. Random sampling technique had been used for selection of the sample.

Other purpose trips not been fully captured in some instances is one of the drawbacks of the dataset.

3.2 Applicability of HVS data for the research

The HVS data was collected as base data for transport and urban planning in western province. The collected HVS data has been extensively used in transport demand modelling in the country.

The research's first objective of identifying activity patterns requires individual activity/travel details with respect to space (origin and destination) and time (arrival and departure times) dimensions. The trip database of the HVS dataset contains these activity/travel details.

The research's second objective of development of activity pattern choice model requires socio economic data that can be linked with individual's activities. The household member database of the HVS dataset contains the socio economic data of

all individuals of the trip database. Hence the two datasets provide a link between activity details and socio economic characteristics.

The HVS dataset contains about 10 million trips made by individuals in Western province with trip purpose distributions of 27% home based work, 23% home based education, 29% home based other and 21% non-home based (JICA, 2014).Hence the HVS dataset contains fairly representative and balanced data related to work, education and other purposes.

Therefore, the HVS dataset was used instead of primary data collection, due to its suitability with respect to the research objectives.

3.3 Data analysis

Most of the considered characteristics are categorical with age being the only continuous data type. The related descriptive statistics for age is shown below.

- Mean – 31.9
- Standard error of mean – 0.065
- Median – 30
- Mode – 12
- Standard deviation – 18.344
- Variance – 336.496

Comparison of age distribution for HVS data and 2012 census data for Western province is shown in figure 3.1. It is observed that the selected HVS dataset is representative of the population.

Based on the age distribution, 35% of the individuals are under 20 years which is expected to represent education patterns predominantly and 58% are of the 20 to 60 years age group which is expected to be the main contributor for work and other patterns. Hence each of the main activity purposes are significantly represented in the sample dataset.

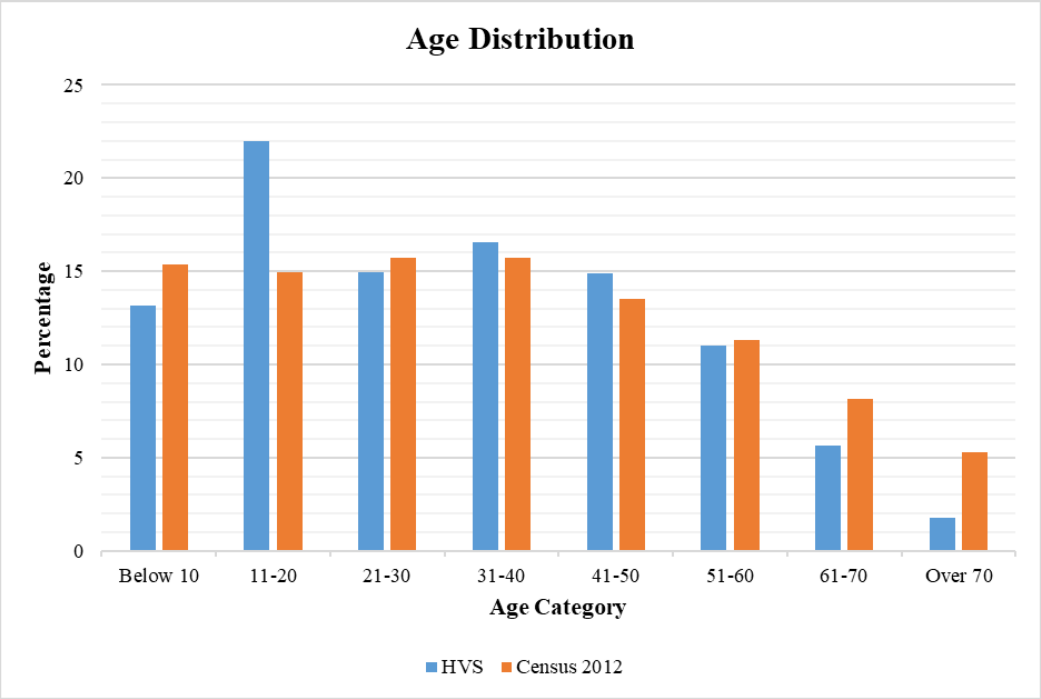


Figure 3-1: Age distribution

Source: Census 2012 - (Department of Census and Statistics, 2015)

The frequency distribution for other categorical data are shown in table3.1.

Table 3-1: Frequency distribution for categorical data

Attribute	Code	Description	Percentage
Gender	1	Male	57.57 %
	2	Female	42.43 %
Household Income	1	< Rs.40,000	71.17 %
	2	Rs.40,000 - Rs.79,999	22.49 %
	3	Rs.80,000 - Rs.119,999	4.03 %
	4	Rs.120,000 - Rs.159,999	1.19 %
	5	Rs.160,000 - Rs.199,999	0.47 %
	6	Rs.200,000 - Rs.299,999	0.37 %
	7	Rs.300,000 - Rs.399,999	0.13 %
	8	Rs.400,000 -	0.07 %
	9	Unknown	0.07 %

Attribute	Code	Description	Percentage
Social Status	1	Working (Full Time)	38.44 %
	2	Working (Part Time)	10.23 %
	3	Kindergarten	0.46 %
	4	Student (grade 1-5)	12.05 %
	5	Student (grade 6-8)	7.9 %
	6	Student (grade 9-10)	4.91 %
	7	Student (O/L)	3.16 %
	8	Student (A/L)	3.86 %
	9	Student (Graduate)	0.98 %
	10	Student (Postgraduate)	0.02 %
	11	Student (PhD)	0 %
	12	Other Students	0.76 %
	13	Unpaid family worker	0.53 %
	14	Housewife	10.02 %
	15	Retired	3.78 %
	16	Unemployed	2.53 %
	17	Other	0.38 %
Education Status	1	None	1.55 %
	2	Grade 5	16.9 %
	3	Grade 8	13.8 %
	4	Grade 10	13.12 %
	5	O/L	27.47 %
	6	Vocational training	0.97 %
	7	A/L	18.48 %
	8	Trade school/Professional qualification	1.41 %
	9	Degree/Professional course	4.76 %
	10	Postgraduate Diploma	0.57 %
	11	Postgraduate Degree	0.64 %
	12	PhD	0.08 %

Attribute	Code	Description	Percentage
	13	Other	0.24 %
	99	Unknown	0.02 %
Occupation	1	Manager, Senior office, Legislator	7.03 %
	2	Professor, Lecturer, Teacher	4.62 %
	3	Researcher, Engineer, Medical doctor	2.11 %
	4	Government employee, Technician	9.62 %
	5	Brooker, Sale/Business service agent	3.95 %
	6	Clerk	8.95 %
	7	Travel attendants, Guides, Chefs	1.24 %
	8	Salesperson at shop, stall market	8.97 %
	9	Policeman, Fire fighters, Security guards	2.72 %
	10	Farmers, Fishermen, Forestry workers	2.37 %
	11	Workers in construction, Textile	9.06 %
	12	Drivers, Operators	10.94 %
	13	Helper	2.83 %
	14	Labourer	14.71 %
	15	Street vendor	2.29 %
	16	Armed force	0.72 %
	17	Other	7.87 %
	99	Unknown	0.01 %
Auto Ownership	1	Motorcycle	28.66 %
	2	Three-wheeler	10.26 %
	3	Car/Jeep	6.06 %
	4	Van	2.52 %
	5	Pickup	0.25 %
	6	Truck	0.31 %
	7	Other	0.77 %
	0	None	51.18 %
	1	Head (Self)	28.61 %

Attribute	Code	Description	Percentage
Relationship to Head of House	2	Wife/Husband	11.96 %
	3	Son/Daughter	45 %
	4	Son/Daughter in law	4.35 %
	5	Grandchild/Great grand child	7.07 %
	6	Parent	0.63 %
	7	Other relative	2.24 %
	8	Domestic employee	0.02 %
	9	Boarder	0.02 %
	10	Nonrelative	0.04 %
	11	Clergy	0.07 %
	12	Visitor	0 %
	13	Other	0.01 %

3.4 Data extraction & initial preparation

Table 3.2 indicates the types of data that were extracted from the Home Visit Survey (HVS) 2013 database.

Table 3-2: Extracted data

2013 HVS database	Extracted data attributes/characteristics
2013 Trip	Origin, Origin Type, Departure Time, Trip Purpose, Destination, Destination Type, Arrival Time
2013 Household	Household Monthly Income
2013 Household Additional	Auto Ownership
2013 Member	HHM code, Member ID, Age, Gender, Relation to Head of Household, Education Status, Social Status, Transport Mode to School, Transport Mode to Work, Occupation

4 ACTIVITY PATTERNS

This section includes the methodology adopted for activity pattern development and discussion of the obtained results.

4.1 Activity pattern development

Based on the characteristics of the available travel data, it was identified that the most suitable method for activity pattern representation was the usage of only space and time dimensions.

The coding used for spatial representation is indicated in table 4.1 which is based on the origin and destination of the trip.

Table 4-1: Spatial representation codes

Origin/Destination Type	Description	Assigned Code
1	Home	H
2	Workplace	W
3	School/Education institute	S
4	Other	O

The coding used for temporal representation is indicated in table 4.2 which is based on the departure time period of the trip.

Table 4-2: Temporal representation codes

Time Period	Description	Assigned Code
0:00- 5:59	EARLY OFF PEAK	1
6:00 - 9:59	AM PEAK	2
10:00 - 14:59	MIDDAY	3
15:00 - 18:59	PM PEAK	4
19:00 - 23:59	LATE OFF PEAK	5

For example, consider the following travel data of an individual. A person leaves home at 6:15am to go to workplace. He departs from workplace at 17:00 to return home.

So, based on the above coding systems his trip to work can be represented as “H2W” and his trip from work can be represented as “W4H”. By combining the trips the individual’s activity pattern can be derived as “H2W4H”.

The dataset contained 1106 unique activity patterns.

4.2 Activity pattern adjustments

4.2.1 Data cleaning

Data relating to incorrect activity patterns (which were assumed as data with errors) were removed. The reasons for classifying these patterns as incorrect patterns are as follows.

- The pattern consisting of only 1 trip (i.e. H2W)
- The patterns starting location not being Home (i.e. O2W4O)
- Pattern consisting of incorrect travel data (i.e. H2S1H - Wrong departure times)

2661 out of 78953 members were identified as members with incorrect activity patterns.

4.2.2 Tour completeness

The completeness of each tour was determined by comparing the similarity of the starting and ending origin types.

E.g.

- “H2W4H” is a complete tour as both the starting and ending origin types (H) are the same
- “H2O2W” is an incomplete tour as starting (i.e. “H”) and ending (i.e. “W”) origin types aren’t similar

51 members were identified as individuals with incomplete patterns

Pattern rejection in 4.2.1 and 4.2.2 was due to considerations made regarding daily pattern modelling such as individual is expected to start his/her day at home and end his/her day at home.

4.3 Tour purpose

All members were assigned a tour purpose based on trip purpose as shown in table 4.3. In cases of multiple tours most prominent purpose was assigned. Work, Educational & other were the three considered tour purposes.

Table 4-3: Tour purpose

Trip purpose	Assigned tour purpose
To work	Work
To school	Educational
Shopping	Other
Business	Other
Private matters	Other
To home	-
Others	Other

For the extracted complete tours, the tour purpose distribution was calculated, and the results are shown in figure 4.1.

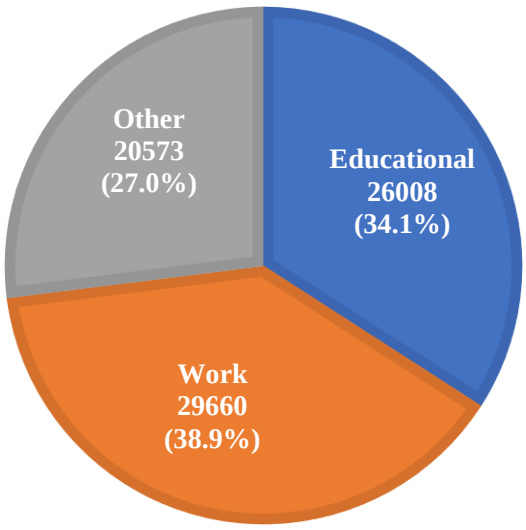


Figure 4-1: Tour purpose distribution

Based on the derived distribution most member's tour purpose can be identified as work tours which is followed by educational and other purposes. The distribution is in

line with age distribution of the dataset with the highest percentage of expected working age group's (i.e. 20-60years) influence and the next highest percentage of school age group's (i.e. 0-20years) influence both being reflected with tour purpose distributions of work and educational purposes respectively.

4.4 Activity pattern results

Activity patterns with more than 1% representation is shown in table 4.4.

Table 4-4: Highest represented activity patterns

Pattern	In Sample	Weighted number	Percentage*	Purpose
H2S3H	22281	1,006,676.27	29.31	Educational
H2W4H	16322	746,872.21	21.75	Work
H2O3H	5105	205,263.27	5.98	Other
H2W5H	4552	195,932.82	5.70	Work
H3O3H	3779	156,536.78	4.56	Other
H2O4H	3340	139,699.48	4.07	Other
H2W3H	2026	96,093.21	2.80	Work
H1W4H	1645	72,643.68	2.12	Work
H2O2H3O3H	1590	67,265.99	1.96	Other
H2O2H	1438	57,535.11	1.68	Other
H2S4H	1070	50,351.12	1.47	Educational
H4O4H	1193	47,673.60	1.39	Other
H3O4H	991	41,486.99	1.21	Other

*Percentage calculated based on weighted number

Details of the remaining patterns are shown in Appendix – I.

The highest represented pattern is an educational purpose pattern. But based on tour purpose distribution work purpose patterns (38.9%) were more than educational purpose patterns (34.1%). This apparent discrepancy can be explained when unique activity patterns related to each tour purpose group is understood. The highest frequent pattern of "H2S3H" is where the member leaves home in the am peak to school/education institute and returns home during the midday time period. Majority

of school students travel schedule will have this unique activity pattern. But in the case of work patterns the departure time from home and arrival time back at home can vary based on factors such as occupation, work category (i.e. full time or part time).It is reflected with several different work patterns such as “H2W4H”, “H2W5H”, “H1W4H” etc. Another reason is that most workers will have other purposes (i.e. shopping, banking) also attached to their work trip and hence the activity pattern will change from “HWH” form to “HWOH” form and similar variations. Hence work purpose tours, though having the highest frequency based on tour purpose, will have comparatively higher number of activity pattern variations when compared to education purpose patterns. Therefore, when unique activity patterns are considered the less varying education purpose pattern will have a higher frequency.

The obtained results also show that work patterns and other purpose patterns varies significantly from individual to individual when compared to education purpose patterns. This behavior must be considered when deciding to group members based on their activity pattern.

4.5 Activity pattern grouping

For each tour purpose (i.e. work, educational, other) similar patterns were grouped in the following method.

4.5.1 Work patterns

All activity patterns with work purpose were grouped based on combination of following factors.

1. No. of work tours (1 tour, 1 tour + subtours, 2+ tours)
2. No. of diversions (0 stops, 1 stop, 2+ stops)
3. No. of non-work tours (0, 1, 2+)
4. Time categorization:
    - For 1 work tour – Full Time Peak (FT_Peak)
      Full Time Early (FT_Early)
      Full Time Late (FT_Late)
      Part Time Early (PT_Early)
      Part Time Late (PT_Late)

- For 1 work tour + subtours – Full Time Peak (FT_Peak)
  All Other
- For 2+ work tours – All

In terms of number of work tours "1 tour + subtours" is where the individual will have a secondary tour (i.e. go out for lunch) attached to the main work tour and the activity patterns will take "HWOWH" and variations of its form. "2+tours" is where the individual will have two work tours (i.e. come home midday and go back to work) and the activity patterns will take "HWHWH" and variations of its form.

Diversions is where the individual will have other locations (i.e. shop, bank) attached to the work tour and the patterns will take "HWOH" and variations based on the number of stop locations.

Non work tours are when an individual will have other tours additionally to the work tour (i.e. go out for dinner after returning home from work) and the activity pattern will take "HWHOH" and variations of its form.

Time categorization is based on the time the individual departs from home and arrives back at home and how each time category is defined is shown in figure 4.2. For 1 work tour a higher level of detail is given to time categories and with the addition of subtours and work tours the time categories were simplified.

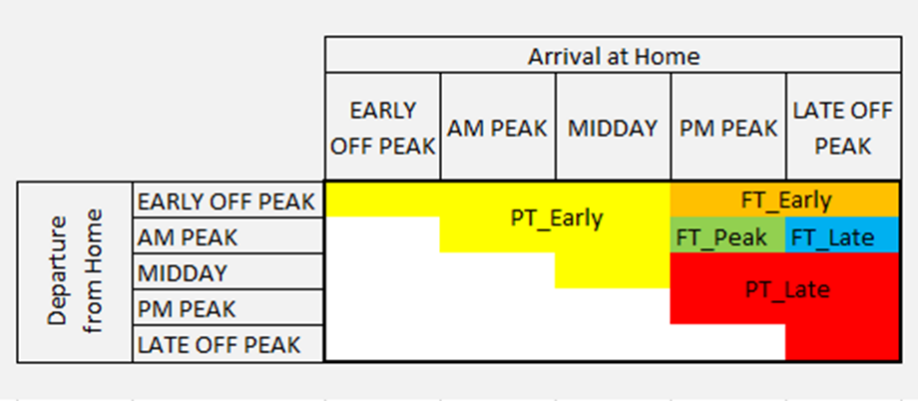


Figure 4-2: Work pattern time categorization

Figure 4.3 indicates the initially identified work pattern groups.

	Diversions	0 Stops			1 Stop			2+ Stops		
	Non Work Tours	0	1	2+	0	1	2+	0	1	2+
1 Tour	FT_Peak	22 (54.88%)	-	-	-	-	-	-	-	-
	FT_Early	20 (7.70%)	-	-	-	-	-	-	-	-
	FT_Late	21 (15.31%)	-	-	-	-	-	-	-	-
	PT_Early	23 (9.60%)	-	-	-	-	-	-	-	-
	PT_Late	24 (1.87%)	-	-	-	-	-	-	-	-
1Tour+ sub tours	FT_Peak	-	-	-	25 (1.74%)	-	-	27 (0.67%)	-	-
	All Other	-	-	-	26 (1.31%)	-	-	28 (0.47%)	-	-
2+ Tours	All	29 (2.20%)	-	-	30 (0.19%)	31 (2.29%)	-	32 (0.53%)	33 (0.59%)	34 (0.47%)
			Representative groups							

Figure 4-3: Identified work pattern groups

Table 4.5 shows the frequencies for initially identified 15 work pattern groups. Each pattern group is identified based on "[No. of work tours] @ [Time category] @ [No. of diversions] @ [No. of non-work tours]" code.

Table 4-5: Initially identified work pattern groups

Pattern Group		**Amount**	**%**
1WT@FT_Early@0 Stops@0	20	2289	7.7
1WT@FT_Late@0 Stops@0	21	4552	15.3
1WT@FT_Peak@0 Stops@0	22	16322	55.0
1WT@PT_Early@0 Stops@0	23	2843	9.6
1WT@PT_Late@0 Stops@0	24	555	1.9
1WT+Sub@FT_Peak@1 Stop@0	25	517	1.7
1WT+Sub@All Other@1 Stop@0	26	390	1.3
1WT+Sub@FT_Peak@2+ Stops@0	27	198	0.7
1WT+Sub@All Other@2+ Stops@0	28	139	0.5
WT2+@All@0 Stops@0	29	641	2.2
WT2+@All@1 Stop@0	30	59	0.2
WT2+@All@1 Stop@1	31	682	2.3
WT2+@All@2+ Stops@0	32	157	0.5
WT2+@All@2+ Stops@1	33	176	0.6
WT2+@All@2+ Stops@2+	34	140	0.5
		29660	

These groups were combined to create 5 groups as shown in Table 4.6 for simplicity and to increase the significance of the groups. The highlighted groups in table 4.5 shows the considered main work pattern group for each cluster.

Table 4-6: Work pattern groups

Pattern	Combined Groups	Representative Group	%
1 Work Tour Full time one /no peak	20,21	20	23.1
1 Work Tour Full time both peak	22	22	55.0
1 Work Tour Part time	23,24	23	11.5
1 work Tour + Subtours	25,26,27,28	25	4.2
2+ Work tours	29-34	29	6.3

The simplified results show the following characteristics of individuals with work tour purpose.

- Majority of the members have an activity schedule of both to and from work occurring during morning and evening peak which is consistent with the expected behavior of workers in urban areas
- A significant number of workers try to avoid both the peak times or at least one of the peak times in their work travels
- A significant proportion of the part time workers
- Members with sub tours, non-work tours and multiple work tours are comparatively low

4.5.2 Education patterns

All activity patterns with education purpose were grouped based on combination of following factors.

1. No. of education tours (1 tour, 1 tour + subtours, 2+ tours)
2. No. of diversions (0 stops, 1 stop, 2+ stops)

3. No. of non-Education tours (0, 1, 2+)
4. Time categorization:

- For 1 tour – Full Time Early (FT_Early)
  Full Time Late (FT_Late)
  Day_Time
  Evening
- For 1 tour + subtours - Full Time Late (FT_Late)
  All Other
- For 2+ tours - All

Education patterns consists of educational tours of school students, university students, vocational and professional degree students etc. The number of educational tours categorization is similar to that of number of work tours in the work pattern groups. For example a student who goes to school and comes back home will constitute "1 tour" whereas a student who goes to school and comes back and later go to a tuition class and come back will constitute "2+ tours".

Definitions of diversions & non education tours categories are similar to that of contemporary work pattern categories.

Time categorization is based on the time the individual departs from home and arrives back at home and how each time category is defined is shown in figure 4.4. For 1 education tour a higher level of detail is given to time categories and with the addition of subtours and education tours the time categories were simplified.

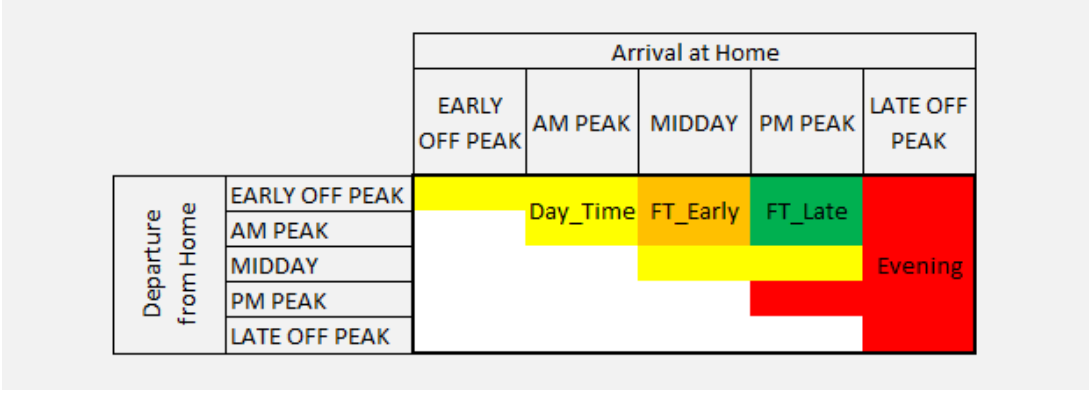


Figure 4-4: Educational pattern time categorization

Initially identified education patterns are shown in figure 4.5.

	Diversions	0 Stops			1 Stop			2+ Stops		
	Non School Tours	0	1	2+	0	1	2+	0	1	2+
1 Tour	FT_Early	1 (88.3%)	-	-	-	-	-	-	-	-
	FT_Late	2 (4.52%)	-	-	-	-	-	-	-	-
	Day_Time	3 (0.29%)	-	-	-	-	-	-	-	-
	Evening	4 (0.24%)	-	-	-	-	-	-	-	-
1 Tour + sub tours	FT_Late	-	-	-	5 (0.11%)	-	-	6 (0.02%)	-	-
	All Other	-	-	-	7 (2.18%)	-	-	8 (0.29%)	-	-
2+ Tours	All	9 (0.07%)	10 (0.003%)	-	-	11 (3.74%)	-	-	12 (0.10%)	13 (0.08%)
			Representative groups							

Figure 4-5: Identified education pattern groups

Table 4.7 shows the frequencies for initially identified 13 education pattern groups. Each pattern group is identified based on "[No. of education tours] @ [Time category] @ [No. of diversions] @ [No. of non-education tours]" code.

Table 4-7: Initially identified education patterns

Pattern Group		**Amount**	**%**
1ST@FT_Early@0 Stops@0	1	22976	88.3
1ST@FT_Late@0 Stops@0	2	1177	4.5
1ST@Day_Time@0 Stops@0	3	75	0.3
1ST@Evening@0 Stops@0	4	63	0.2
1ST+Sub@FT_Late@1 Stop@0	5	28	0.1
1ST+Sub@FT_Late@2+ Stops@0	6	6	0
1ST+Sub@All Other@1 Stop@0	7	567	2.2
1ST+Sub@All Other@2+ Stops@0	8	76	0.3
ST2+@All@0 Stops@0	9	19	0.1
ST2+@All@0 Stops@1	10	1	0
ST2+@All@1 Stop@1	11	972	3.7
ST2+@All@2+ Stops@1	12	27	0.1
ST2+@All@2+ Stops@2+	13	21	0.1
		26008	

These groups were combined to create 4 groups as shown in Table 4.8 for simplicity and to increase the significance of the groups. The highlighted groups in table 4.7 shows the considered main education pattern group for each cluster.

Table 4-8: Education pattern groups

Pattern	Combined Groups	Representative Group	%
1 Education Tour with return before PM peak	1&3	1	88.7
1 Education Tour with return during/after PM peak	2&4	2	4.8
1 Education Tour + Subtour	7,5,6,8	7	2.6
2+ Education tours	11,12,13	11	3.9

The simplified results show the following characteristics of individuals with education tour purpose.

- Majority of the members have an activity schedule of returning from school/education institute before PM peak which is consistent with the expected schedule of school children
- The members returning from school/education institute after PM peak of 4.8% can be attributed to students who do extracurricular activities
- Members with multiple education tours can be attributed to students who go to tuition classes

4.5.3 Other patterns

All activity patterns that were identified as other purpose were grouped based on combination of following factors.

1. No. of tours (1 tour, 2 tours, 3+ tours)
2. Purpose: Shopping (Sh)
   Religious (R)
   Personal (P)

Business (B)

Leisure (L)

Other (O)

3. Time categorization:
    - For 1 tour – Peak
      Off peak
    - For 2 tours – All
    - For 3+ tours – All)

Definitions of number of tours categories are similar to that of contemporary work pattern and education pattern categories.

The purpose categorization was identified using origin/destination type as in table 4.9.

Table 4-9: Purpose category

Origin/Destination type		**Assigned Purpose**
1	Residence, dormitory	Home
2	Government, public office	Personal
3	Business office, private company	Personal
4	Educational facility	Personal
5	Religious facility	Religious
6	Medical facility	Personal
7	Accommodation, entertainment facility	Leisure
8	Restaurant	Shopping
9	Retail, Traditional market	Shopping
10	Supermarket	Shopping
11	Shopping mall, shopping plaza	Shopping
12	Grocery market	Shopping
13	Factory	Personal
14	Warehouse, storage facility	Business
15	Transport, communication facility	Personal
16	Supply, disposal facility	Business
17	Recreational, sport facility	Leisure

Origin/Destination type		Assigned Purpose
18	Park, natural environmental area etc.	Leisure
19	Agricultural, forestry and fishery areas	Business
20	Construction site	Business
21	Other	Other

Time categorization is based on the time the individual departs from home and arrives back at home. For 1 tour a higher level of detail is given to time categories with peak time category is where the either the individual's departure or return tour occurs in AM/PM peak. For multiple tours detailed time categorization was ignored for simplify the process.

Initially identified other patterns are shown in figure 4.5.

	Purpose	Social	Religious	Personal	Leisure	Other	Business
1 Tour	Peak	41 (16.33%)	40 (4.39%)	43 (26.88%)	44 (1.09%)	45 (3.76%)	42 (10.53%)
	OffPeak	47 (9.16%)	46 (1.02%)	49 (9.66%)	50 (0.19%)	51 (1.11%)	48 (0.44%)
2 Tours	All	53 (1.87%)	52 (0.28%)	55 (10.40%)	56 (0.02%)	57 (0.35%)	54 (0.33%)
3+ Tours	All	59 (0.18%)	58 (0.06%)	61 (1.76%)	62 (0.02%)	63 (0.06%)	60 (0.05%)

Representative groups

Figure 4-6: Identified other pattern groups

Table 4.10 shows the frequencies for initially identified 24 other pattern groups. Each pattern group is identified based on "[No. of tours] @ [Time category] @ [Purpose]" code.

Table 4-10: Initially identified other pattern groups

Pattern Group		Amount	%
1T@Peak@R	40	903	4.4
1T@Peak@Sh	41	3361	16.3
1T@Peak@B	42	2168	10.5
1T@Peak@P	43	5534	26.9
1T@Peak@L	44	225	1.1

Pattern Group		Amount	%
1T@Peak@O	45	773	3.8
1T@OffPeak@R	46	210	1
1T@OffPeak@Sh	47	1886	9.2
1T@OffPeak@B	48	90	0.4
1T@OffPeak@P	49	1988	9.7
1T@OffPeak@L	50	39	0.2
1T@OffPeak@O	51	229	1.1
2T@All@R	52	58	0.3
2T@All@Sh	53	385	1.9
2T@All@B	54	68	0.3
2T@All@P	55	2141	10.4
2T@All@L	56	5	0
2T@All@O	57	71	0.3
3T+@All@R	58	13	0.1
3T+@All@Sh	59	37	0.2
3T+@All@B	60	11	0.1
3T+@All@P	61	362	1.8
3T+@All@L	62	4	0
3T+@All@O	63	12	0.1
		20573	

These groups were combined to create 8 groups as shown in Table 4.11 for simplicity and to increase the significance of the groups. The highlighted groups in table 4.10 shows the considered main other pattern group for each cluster.

Table 4-11: Other pattern groups

Pattern	Combined Groups	Representative Group	%
Single Tour – R	40,46	40	5.4
Single Tour peak – Sh	41	41	16.3
Single Tour – B	42,48	42	11.0

Pattern	Combined Groups	Representative Group	%
Single Tour peak – P	43	43	26.9
Single Tour - L & O	44,45,50,51	45	6.2
Single Tour Off peak – Sh	47	47	9.2
Single Tour Off peak – P	49	49	9.7
Multiple Tours	52-63	55	15.4

The simplified results show the following characteristics of individuals with other tour purpose.

- Most other purpose tours are single tours with 85% and multiple tours only accounting for 15%
- The other tour purpose with highest frequency is personal tours followed by shopping and business tours
- Members with religious and leisure purpose tours are comparatively lower
- Most personal and shopping tours occur during peak times

4.6 Activity pattern distribution in groups

For each identified activity pattern choice group, the included activity patterns were identified. The activity pattern distribution in each choice group was calculated based on the weighted number of individuals of each activity pattern.

The main activity pattern for each activity pattern choice group is shown in table 4.12.

Table 4-12: Main activity patterns

Pattern Group	Subgroup	Main Pattern
Work	1 Work Tour Full time both peak (22)	H2W4H
	1 Work Tour Full time one /no peak (20)	H2W5H
	1 Work Tour Part time (23)	H2W3H
	2+ Work tours (29)	H2W3H3W4H
	1 work Tour + Subtours (25)	H2O2W4H

Pattern Group	Subgroup	Main Pattern
Education	1 School Tour with return AM (1)	H2S3H
	1 School Tour with return PM (2)	H2S4H
	2+ School tours (11)	H2S3H4O4H
	1 School Tour + Subtour (7)	H2S3O4H
Other	Single Tour peak - P (43)	H2O3H@P
	Single Tour peak - Sh (41)	H2O3H@Sh
	Multiple Tours (55)	H2O2H3O3H@P
	Single Tour - B (42)	H2O4H@B
	Single Tour Off peak - P (49)	H3O3H@P
	Single Tour off-peak - Sh (47)	H3O3H@Sh
	Single Tour - L & O (45)	H2O3H@O
	Single Tour - R (40)	H2O3H@R

The complete activity pattern distribution for each activity pattern choice group is included in Appendix – II.

4.7 Summary

A total of 1106 No. of unique activity patterns were identified which were distributed among groups and subgroups.

Table 4-13: Activity pattern summary

Pattern Group	No. of subgroups
Work	5
Education	4
Other	8

5 ACTIVITY PATTERN CHOICE MODEL

This section includes the methodology adopted for activity pattern choice model development and discussion of the obtained results.

5.1 Choice model structure

Initially a multilevel nested structure shown in figure 5.1 was considered. But the data didn't fit. This was also reflected by the probability of selecting choices with low frequency was very low with the derived choice models being more biased towards choices with high frequencies.

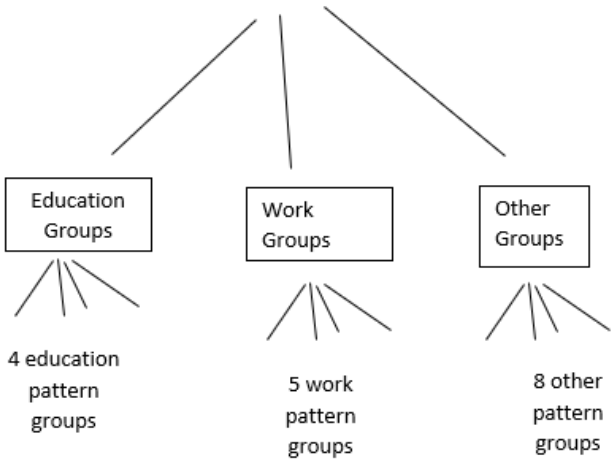


Figure 5-1: Initial choice model

To overcome the issues the choice model structure in figure 5.2 was considered. Each level was considered as a single level structure and each level was estimated separately. The structure has 2 choices at each level. The utility for one choice (the lowest frequency choice) was considered as 0 and the other choice was estimated relative to it.

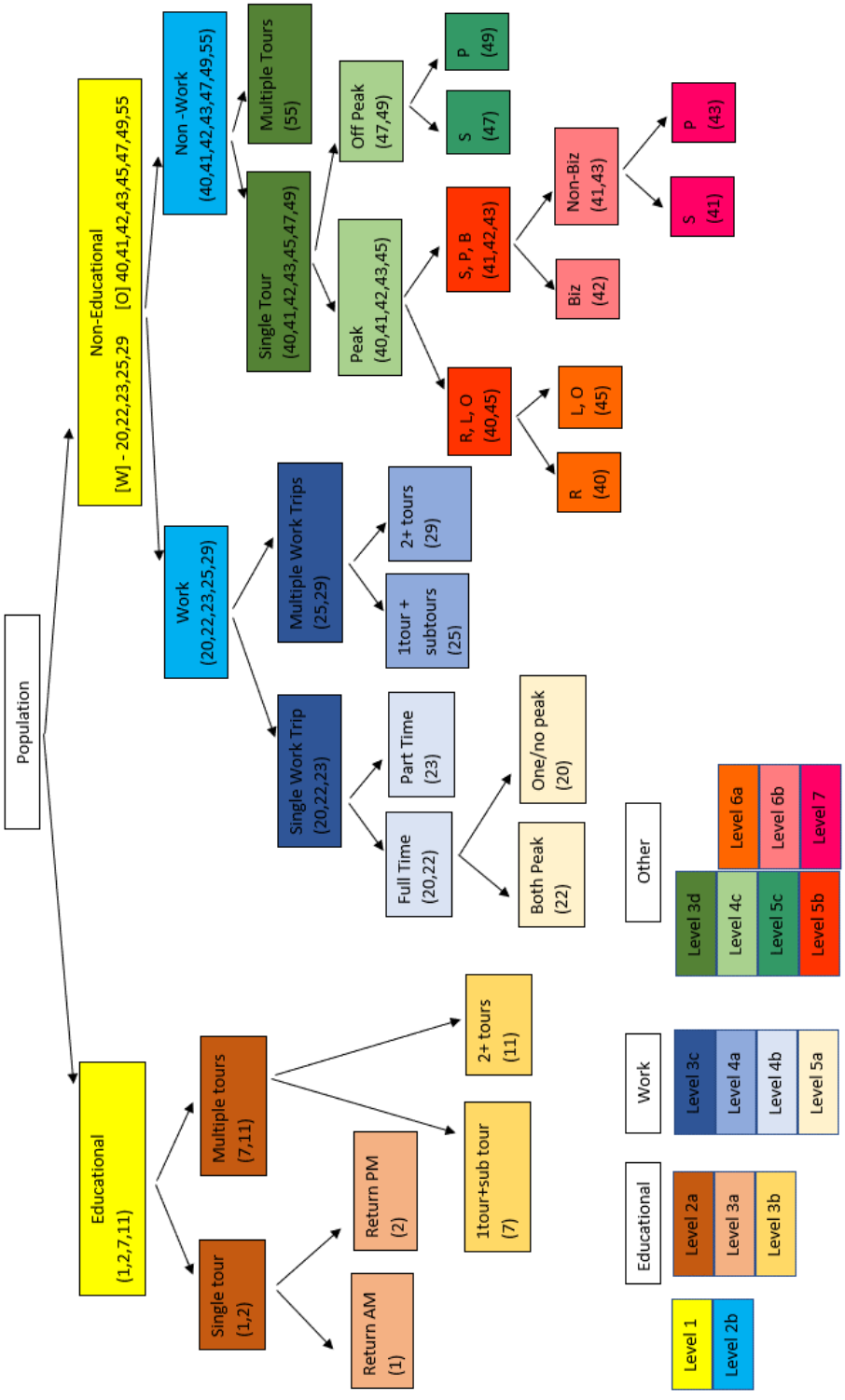


Figure 5-2: Choice model structure

5.2 Choice model estimation

The following socio-economic characteristics were considered to develop the choice model.

- Age
- Gender
- Relative household membership
- Household Income group
- Social status
- Education status
- Auto ownership
- Mode to school/travel mode
- Occupation

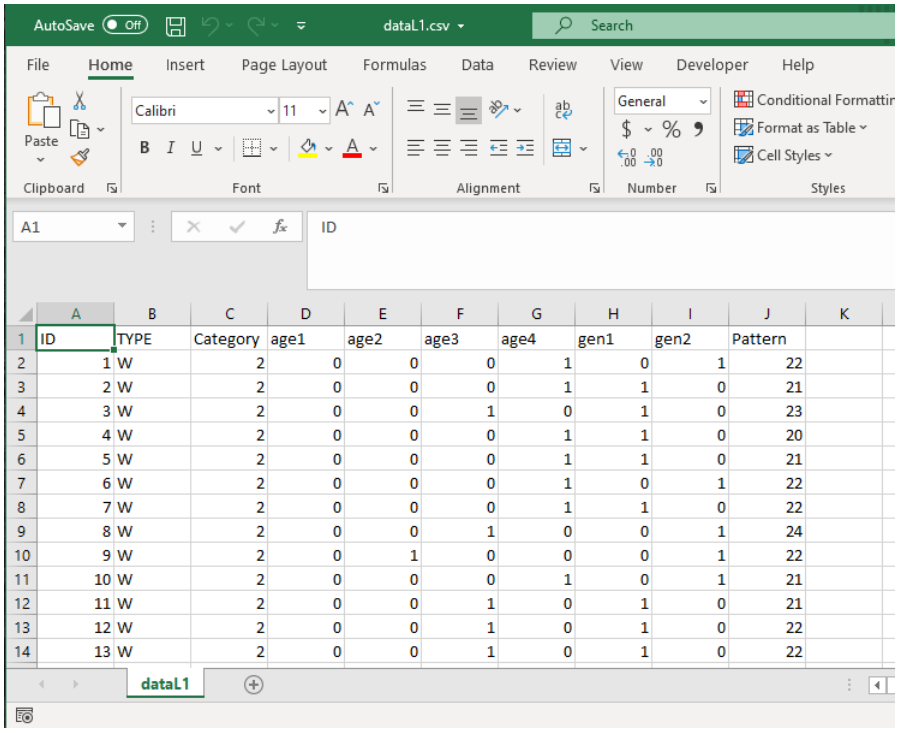
All these characteristics were converted to categorical data and for each type coefficient of one category was considered as 0 to calculate other characteristics relatively.

For estimation of parameters of the choice model “Apollo” module in R programing language was used (Hess & Palma, 2019a; Hess & Palma, 2019b).

Running the choice model in Apollo module requires the following.

- Creation of data file in .CSV format for each choice model based on the considered two choices (Figure 5.3).
- The code related to the choice model. It includes the input settings, parameter definition & initial values, choices, choice models and output settings (Figure 5.4 & figure 5.5).

The codes written for Level 1 is included in Appendix – III as a sample.



	A	B	C	D	E	F	G	H	I	J
1	ID	TYPE	Category	age1	age2	age3	age4	gen1	gen2	Pattern
2	1	W	2	0	0	0	1	0	1	22
3	2	W	2	0	0	0	1	1	0	21
4	3	W	2	0	0	1	0	1	0	23
5	4	W	2	0	0	0	1	1	0	20
6	5	W	2	0	0	0	1	1	0	21
7	6	W	2	0	0	0	1	0	1	22
8	7	W	2	0	0	0	1	1	0	22
9	8	W	2	0	0	1	0	0	1	24
10	9	W	2	0	1	0	0	0	1	22
11	10	W	2	0	0	0	1	0	1	21
12	11	W	2	0	0	1	0	1	0	21
13	12	W	2	0	0	1	0	1	0	22
14	13	W	2	0	0	1	0	1	0	22

Figure 5-3: Data file

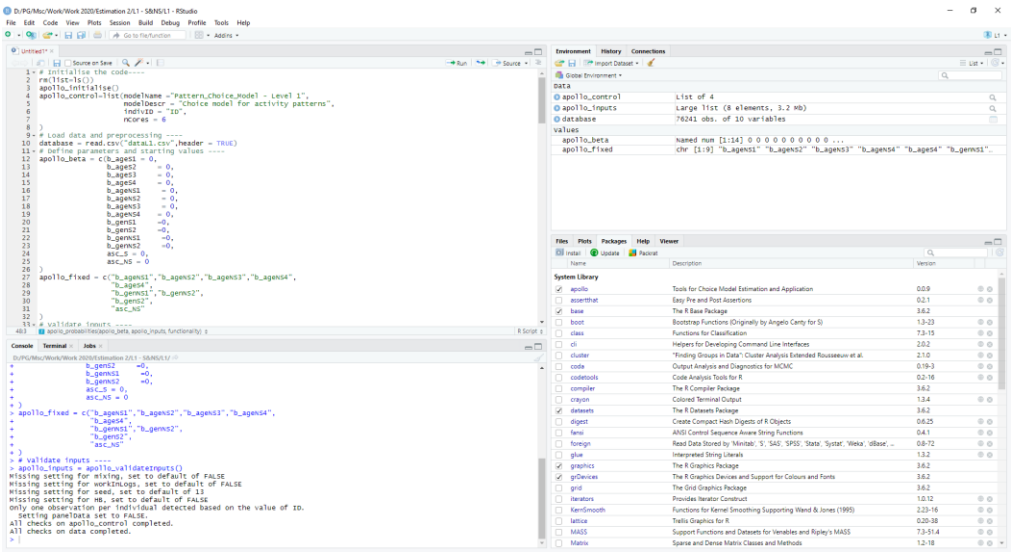


Figure 5-4: Model run in Apollo module

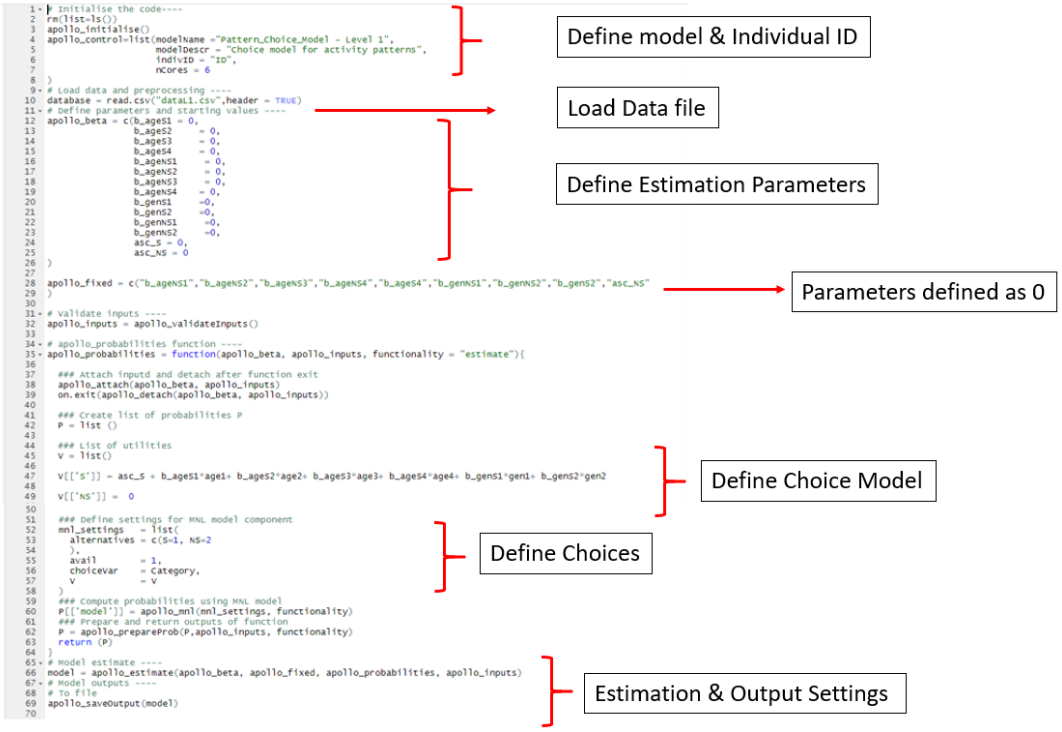


Figure 5-5: Choice model code

5.3 Choice model results

5.3.1 Level 1

At this level u1 & u20 are calculated. u1 represents all educational patterns and u20 represents all work and other patterns (figure 5.6).

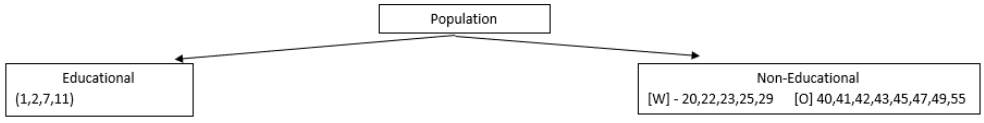


Figure 5-6: Level 1

At this level u20 is set to 0 and based on the estimated parameters the choice model for u1 is shown below.

U1 = 13.3051 * ageS1 + 10.2225 * ageS2 + 5.756 * ageS3 - 0.2636 * genS1 - 8.1764

U20 = 0

Table 5-1: Level 1 results

Parameter		Estimate	Std. err.	t-ratio (0)
Age				
<10	b_ageS1	13.3051	0.354	37.6
10 to 20	b_ageS2	10.2225	0.334	30.6
20 to 30	b_ageS3	5.7560	0.335	17.2
30+*	b_ageS4	0	NA	NA
Gender				
Male	b_genS1	- 0.2636	0.038	- 6.9
Female*	b_genS2	0	NA	NA
Constant	asc_S	-8.1764	0.334	- 24.5

*parameter set to 0

$\rho^2(0)$: 0.8102

The high $\rho^2(0)$ value indicates that the model has a good fit. With all parameters having a t-ratio greater than 1.96 all the estimated parameters are significant.

Based on the results the highest contributor towards education patterns is age being below 10 years. An individual with age below 30 years has a high likelihood of having an education pattern. With the increase of age group, the likelihood gradually reduces. Both these choice model behaviours are consistent with actual social behaviour. Male gender attribute having a negative value may be due to the high male working population. But its impact is significantly lower compared to age attribute.

5.3.2 Level 2b

At this level u20 & u40 are calculated. u20 represents all work patterns and u40 represents all other patterns (figure 5.7).

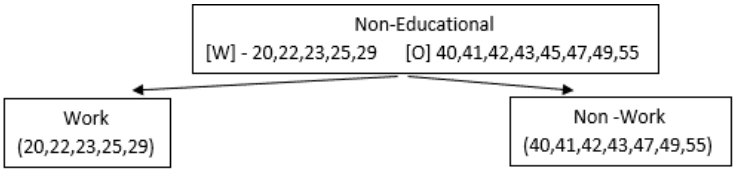


Figure 5-7: Level 2b

At this level u40 is set to 0 and based on the estimated parameters the choice model for u20 is shown below.

U20 = - 1.4953 * ageW3 - 1.9254 * ageW5 - 1.2395 * genW1 + 14.9303 * ssW1 + 12.9081 * ssW2 - 10.4374

U40 = 0

Table 5-2: Level 2b results

Parameter		**Estimate**	**Std. err.**	**t-ratio (0)**
Age				
<20*	b_ageW1	0	NA	NA
20 to 60	b_ageW3	-1.4953	0.125	-11.9
60+	b_ageW5	-1.9254	0.136	-14.2
Gender				
Male	b_genW1	-1.2395	0.041	-30.1
Female*	b_genW2	0	NA	NA
Social Status				
Working (Full Time)	b_ssW1	14.9303	3.426	4.4
Working (Part Time)	b_ssW2	12.9081	3.426	3.8
Other*	b_ssW17	0	NA	NA
Constant	asc_W	-10.4374	3.427	-3.0

*parameter set to 0

$\rho^2(0)$: 0.5635

The $\rho^2(0)$ value indicated that the model has a good fit. With all parameters having a t-ratio greater than 1.96 all the estimated parameters are significant.

Based on the results the highest contributor towards work patterns is social status being working full time. Social status of working full time or part time increases the likelihood for working patterns whereas gender and age attributes contributes towards likelihood of other patterns. Based on comparison of age attribute estimates age greater than 60 years comparatively increase the likelihood for other patterns. Part time work

status slightly increases the likelihood for other patterns compared to full time work patterns.

5.3.3 Level 2a

At this level u1 & u7 are calculated. u1 represents single educational tours and u7 represents multiple educational tours (figure 5.8).

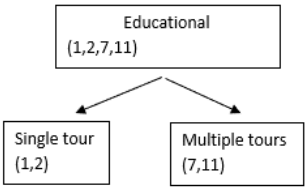


Figure 5-8: Level 2a

At this level u7 is set to 0 and based on the estimated parameters the choice model for u1 is shown below.

U1 = -0.9541 * ss13 -1.2756 * ss14 - 1.6416 * ss15 + 0.9549 * hhi11 + 0.5751 * hhi12 -1.3095 * m11 - 0.5447 * m12 - 0.3082 * m13 -1.6944 * m15 + 1.1333
U7 = 0

Table 5-3: Level 2a results

Parameter		**Estimate**	**Std. err.**	**t-ratio (0)**
Social Status				
Kindergarten, Student (grade 1-8)	b_ss13	-0.9541	0.209353	-4.6
Student (grade 9-11)	b_ss14	-1.27555	0.212831	-6.0
Student (A/L)	b_ss15	-1.64158	0.221306	-7.4
Other Students*	b_ss16	0	NA	NA
Household Income				
< Rs.40,000	b_hhi11	0.954853	0.147835	6.5
Rs.40,000 - Rs.79,999	b_hhi12	0.575087	0.158116	3.6
Rs.80,000 - Rs.199,999*	b_hhi14	0	NA	NA

Parameter		Estimate	Std. err.	t-ratio (0)
Transport Mode				
Private	b_m11	-1.30949	0.102488	-12.8
Public	b_m12	-0.54474	0.094664	-5.8
Hired	b_m13	-0.30815	0.086921	-3.5
walk/cycle*	b_m14	0	NA	NA
other	b_m15	-1.69435	0.357042	-4.7
Constant	asc_P1	1.133271	0.247007	4.6

*parameter set to 0

$\rho^2(0)$: 0.0895

The $\rho^2(0)$ value is low. This may be due to available attributes being insufficient to distinguish between the two choices. The above attributes were selected after several estimation runs with these attributes giving the best fit model the available dataset.

Based on the results the highest contributor towards single educational tours is the alternative specific constant and this is an extension of the attributes being insufficient to distinguish between the two choices. Household income increases the likelihood for single educational tours whereas social status and transport mode attributes contributes towards likelihood of multiple educational tours. Based on comparison of estimates for social status of school children, increase in grade coincides with increase in likelihood for multiple education tours which captures the effect of tuition classes.

5.3.4 Level 3a

At this level u1 & u2 are calculated. u1 represents single educational tour with AM return and u2 represents single educational tour with PM return (figure 5.9).

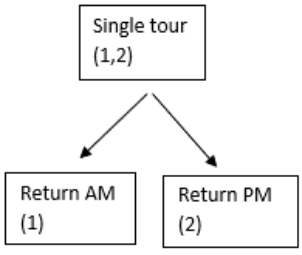


Figure 5-9: Level 3a

At this level u2 is set to 0 and based on the estimated parameters the choice model for u1 is shown below.

U1 = 5.196 * ss13 + 4.4059 * ss14 -0.5683 * ss15 -0.3769 * m11 -0.6275 * m12 -0.5669

U2 = 0

Table 5-4: Level 3a results

Parameter		Estimate	Std. err.	t-ratio (0)
Social Status				
Kindergarten, Student (grade 1-10)	b_ss13	5.19597	0.137	37.9
Student (O/L, A/L)	b_ss14	4.40592	0.139	31.7
Student (UG/PG)	b_ss15	-0.5683	0.155	-3.7
Other Students*	b_ss16	0	NA	NA
Transport Mode				
Private	b_m11	-0.3769	0.157	-2.4
Public	b_m12	-0.6275	0.106	-5.9
walk/cycle*	b_m13	0	NA	NA
Constant	asc_P1	-0.5669	0.140	-4.1

*parameter set to 0

$\rho^2(0)$: 0.8609

The high $\rho^2(0)$ value indicates that the model has a good fit.

Based on the results the highest contributor towards single educational tour with AM return is being a student below grade 10. Social status of school students increases the likelihood for single educational tour with AM return whereas social status of UG/PG student and transport mode attributes contributes towards likelihood of single educational tour with PM return.

5.3.5 Level 3b

At this level u7 & u11 are calculated. u7 represents single educational tours & sub tours and u11 represents more than 2 educational tours (figure 5.10).

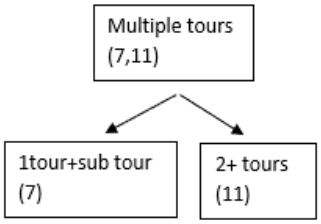


Figure 5-10: Level 3b

At this level u7 is set to 0 and based on the estimated parameters the choice model for u11 is shown below.

U11 = - 0.9234 * ss113 -1.347 * ss114 -2.1303 * m111 -1.2401 * m112 -0.6017 * m113 - 1.0384 * m115 + 1.6414

U7 = 0

Table 5-5: Level 3b results

Parameter		**Estimate**	**Std. err.**	**t-ratio (0)**
Social Status				
Student (A/L)	b_ss113	-0.9234	0.151	-6.1
Student (UG/PG)	b_ss114	-1.347	0.484	-2.8
Other Students*	b_ss115	0	NA	NA
Transport Mode				
Private	b_m111	-2.1303	0.158	-13.5
Public	b_m112	-1.2401	0.161	-7.7
Hired	b_m113	-0.6017	0.168	-3.6
walk/cycle*	b_m114	0	NA	NA
other	b_m115	-1.0384	0.419	-2.5
Constant	asc_P11	1.64142	0.122	13.5

*parameter set to 0

$\rho^2(0)$: 0.153

The $\rho^2(0)$ value is low. This may be due to available attributes being insufficient to distinguish between the slightly different two choices.

Based on the results the only contributor towards more than 2 educational tours is alternative specific constant and this is an extension of the attributes being insufficient to distinguish between the two choices. All attributes of social status and transport mode increases the likelihood for single educational tours and subtours. Compared to transport mode of walk/cycle, usage of private or public transport mode will increase the likelihood for single tour with subtour.

5.3.6 Level 3c

At this level u20 & u29 are calculated. U20 represents single work tours and u29 represents multiple work tours (figure 5.11).

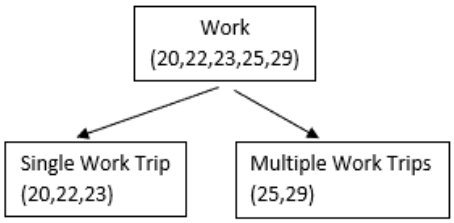


Figure 5-11: Level 3c

At this level u29 is set to 0 and based on the estimated parameters the choice model for u20 is shown below.

U20 = 0.34077 * age203f -0.798 * age204m -0.3173 * age204f -0.2906 * age205m + 0.5158 * ss201 -0.8117 * ao201 -0.9306 * ao202 -0.6403 * ao203 -0.3497 * tm201 + 1.3905 * tm202 -0.457 * oc202 + 0.4290 * oc203 + 0.0587 * oc204 + 0.6928 * c_W20 + 0.6928

U29 = 0

Table 5-6: Level 3c results

Parameter		Estimate	Std. err.	t-ratio (0)
Age & Gender				
20 to 30 -male*	b_age203m	0	NA	NA
20 to 30 -female	b_age203f	0.34077	0.148	2.3
30 to 60 -male	b_age204m	-0.798	0.073	-10.9
30 to 60 -female	b_age204f	-0.3173	0.099	-3.2
60 + -male	b_age205m	-0.2906	0.144	-2.0
Social Status				
Working (Full Time)	b_ss201	0.51575	0.081	6.3
Working (Part Time) *	b_ss202	0	NA	NA
Auto Ownership				
None*	b_ao200	0	NA	NA
MC	b_ao201	-0.8117	0.074	-11.0
3W	b_ao202	-0.9306	0.097	-9.6
Car/Van/Jeep/Pickup	b_ao203	-0.6403	0.172	-3.7
Transport Mode				
Private	b_tm201	-0.3497	0.080	-4.4
Public	b_tm202	1.39049	0.077	18.2
bicycle/walking*	b_tm203	0	NA	NA
Occupation				
Office/Institution-based workers (i.e. Engineer, Doctor, Manager, clerk etc.)*	b_oc201	0	NA	NA
Professor, Lecturer, Teacher (Education sector workers)	b_oc202	-0.457	0.129	-3.5
Policeman, Fire fighters, Security guards, Armed force	b_oc203	0.42896	0.158	2.7
Farmers, Fishermen, Street vendor, Driver, Labourers	b_oc204	0.05869	0.058	1.0

Parameter		Estimate	Std. err.	t-ratio (0)
Constant	asc_W20	0.69278	0.110	6.3

*parameter set to 0

$\rho^2(0)$: 0.2141

The $\rho^2(0)$ value is low. This may be due to available attributes being insufficient to distinguish between the different two choices.

Based on the results the highest contributor towards single work tours is use of public transport mode. This is an expected behaviour as public transport users will try to minimize travel compared to individuals with private transport. Auto ownership increases the likelihood for multiple work tours. Estimated values of occupation attribute indicates that all occupations except education sector workers will have higher likelihood of u20 (single work tour) choice whereas street vendors, fisherman etc. will have higher likelihood of u29 (multiple work tour) choice. Significant deviation from this categorization occurs for professor, lecturer, teacher occupations and this may be due to specific characteristics of these professions such as impact of flexible work hours, consultancy work for professors and lecturers and impact of institution-based tuition classes for teachers.

5.3.7 Level 4a

At this level u25 & u29 are calculated. U25 represents single work tour & sub tours and u29 represents more than 2 work tours (figure 5.12).

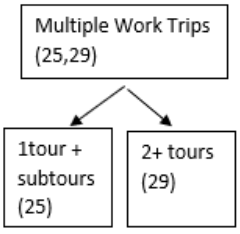


Figure 5-12: Level 4a

At this level u25 is set to 0 and based on the estimated parameters the choice model for u29 is shown below.

U29 = -0.8583 * age293f -0.428 * age294m -0.9902 * age294f -1.3972 * age295f -0.4084 * ss291 -0.4988 * ao291 -0.5918 * tm292 + 0.30748 * oc292 + 0.66987 * oc294 + 1.40517

U25 = 0

Table 5-7: Level 4a results

Parameter		Estimate	Std. err.	t-ratio (0)
Age & Gender				
20 to 30 -male*	b_age293m	0	NA	NA
20 to 30 -female	b_age293f	-0.8583	0.258	-3.3
30 to 60 -male	b_age294m	-0.428	0.112	-3.8
30 to 60 -female	b_age294f	-0.9902	0.156	-6.3
60 + -female	b_age295f	-1.3972	0.565	-2.5
Social Status				
Working (Full Time)	b_ss291	-0.4084	0.118	-3.5
Working (Part Time)*	b_ss292	0	NA	NA
Auto Ownership				
None*	b_ao290	0	NA	NA
MC/3W	b_ao291	-0.4988	0.096	-5.2
Transport Mode				
Private*	b_tm291	0	NA	NA
Public	b_tm292	-0.5918	0.118	-5.0
Occupation				
Office/Institution-based workers (i.e. Engineer, Doctor, Manager, clerk etc.)*	b_oc291	0	NA	NA

Parameter		Estimate	Std. err.	t-ratio (0)
Professor, Lecturer, Teacher (Education sector workers)	b_oc292	0.30748	0.174	1.8
Farmers, Fishermen, Street vendor, Driver, Labourers	b_oc294	0.66987	0.084	8.0
Constant	asc_W29	1.40517	0.165	8.5

*parameter set to 0

$\rho^2(0)$: 0.0804

The $\rho^2(0)$ value is low. This may be due to available attributes being insufficient to distinguish between the different two choices.

Based on the results the highest contributor towards more than 2 work tours is alternative specific constant and this is an extension of the attributes being insufficient to distinguish between the two choices. All attributes of occupation increase the likelihood for more than 2 work tours with street vendors, fisherman etc. having a comparatively higher contribution. In all age categories females are more likely to prefer subtours compared to males.

5.3.8 Level 4b

At this level u20 & u23 are calculated. U20 represents single work tour (full time) and u23 represents single work tour (part time) (figure 5.13).

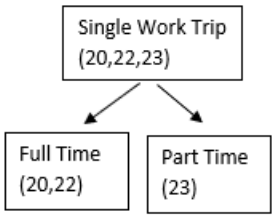


Figure 5-13: Level 4b

At this level u23 is set to 0 and based on the estimated parameters the choice model for u20 is shown below.

U20 = -0.399 * age203f -0.1864 * age204m -0.7396 * age204f -0.3862 * age205m -1.1788 * age205f + 0.992 * ss201 -0.3194 * ao201 -0.4228 * ao202 -0.5415 * ao203 + 0.5565 * tm201 + 0.716 * tm202 -4.275 * oc202 -0.4799 * oc204 + 0.2364

U23 = 0

Table 5-8: Level 4b results

Parameter		Estimate	Std. err.	t-ratio (0)
Age & Gender				
20 to 30 -male*	b_age203m	0	NA	NA
20 to 30 -female	b_age203f	-0.399	0.109	-3.7
30 to 60 -male	b_age204m	-0.1864	0.074	-2.5
30 to 60 -female	b_age204f	-0.7396	0.085	-8.7
60 + -male	b_age205m	-0.3862	0.136	-2.8
60 + -female	b_age205f	-1.1788	0.254	-4.6
Social Status				
Working (Full Time)	b_ss201	0.99201	0.072	13.8
Working (Part Time)*	b_ss202	0	NA	NA
Auto Ownership				
None*	b_ao200	0	NA	NA
MC	b_ao201	-0.3194	0.066	-4.8
3W	b_ao202	-0.4228	0.103	-4.1
Car/Van/Jeep/Pickup	b_ao203	-0.5415	0.201	-2.7
Transport Mode				
Private	b_tm201	0.5565	0.087	6.4
Public	b_tm202	0.71598	0.066	10.9
bicycle/walking*	b_tm203	0	NA	NA
Occupation				
Office/Institution-based workers (i.e. Engineer, Doctor, Manager, clerk etc.)*	b_oc201	0	NA	NA

Parameter		Estimate	Std. err.	t-ratio (0)
Professor, Lecturer, Teacher (Education sector workers)	b_oc202	-4.275	0.153	-28.0
Farmers, Fishermen, Street vendor, Driver, Labourers	b_oc204	-0.4799	0.056	-8.5
Constant	asc_W20	0.23644	0.103	2.3

*parameter set to 0

$\rho^2(0)$: 0.2762

The $\rho^2(0)$ value is low. This may be due to available attributes being insufficient to distinguish between the different two choices.

Based on the results the highest contributor towards single work tour (full time) is social status attribute of full time work. Based on the dataset occupations of Professor, Lecturer, Teacher attribute has a higher contribution to single work tour (part time) compared to other occupations. Auto ownership of cars/vans increases likelihood for single work tour (part time) compared to other types. Use of public transport mode increases the likelihood for single work tour (full time) compared to private modes.

5.3.9 Level 5a

At this level u20 & u22 are calculated. u22 represents single work tour (full time) with both outbound & return during peak times and u20 represents single work tour (full time) with both outbound & return during off peak or only one out of the two during peak (figure 5.14).

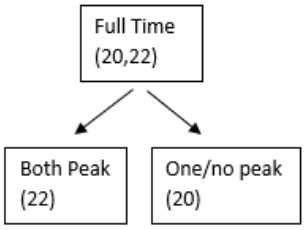


Figure 5-14: Level 5a

At this level u20 is set to 0 and based on the estimated parameters the choice model for u22 is shown below.

U22 = -0.9338 * gen221 + 0.3386 * ss221 + 0.2596 * es222 + 1.1353 * es223 + 0.1346 * tm222 + 0.1187 * tm223 + 0.1245 * oc221 -0.4289 * oc223 -0.1232 * oc224 + 0.616

U20 = 0

Table 5-9: Level 5a results

Parameter		Estimate	Std. err.	t-ratio (0)
Gender				
Male	b_gen221	-0.9338	0.040	-23.3
Female*	b_gen222	0	NA	NA
Social Status				
Working (Full Time)	b_ss221	0.33862	0.051	6.6
Working (Part Time) *	b_ss222	0	NA	NA
Educational Status				
Up to A/L*	b_es221	0	NA	NA
Voc. Training, Trade school/Pro Qual	b_es222	0.25964	0.086	3.0
Degree	b_es223	1.13526	0.072	15.8
Transport Mode				
Private*	b_tm221	0	NA	NA
Public	b_tm222	0.1346	0.038	3.5
bicycle/walking	b_tm223	0.11872	0.050	2.4
Occupation				
Office/Institution-based workers (i.e. Engineer, Doctor, Manager, clerk etc.)	b_oc221	0.12446	0.063	2.0

Parameter		Estimate	Std. err.	t-ratio (0)
Professor, Lecturer, Teacher (Education sector workers)*	b_oc222	0	NA	NA
Policeman, Fire fighters, Security guards, Armed force	b_oc223	-0.4289	0.096	-4.4
Farmers, Fishermen, Street vendor, Driver, Labourers	b_oc224	-0.1232	0.064	-1.9
Constant	asc_W22	0.61596	0.087	7.1

*parameter set to 0

$\rho^2(0)$: 0.0841

The $\rho^2(0)$ value is low. This may be due to available attributes being insufficient to distinguish between the marginally different two choices.

Based on the results the highest contributor towards single work tour (full time) with both outbound & return during peak times (U22) is educational status attribute of degree qualification. Based on transport mode public transport users have a higher likelihood for work trips in peak times compared to private mode users. Occupation attribute of office/institute based workers have a higher likelihood for work trips during peak times compared to other occupations as expected.

5.3.10 Level 3d

At this level u40 & u55 are calculated. u40 represents single other purpose tour and u55 represents multiple other purpose tours (figure 5.15).

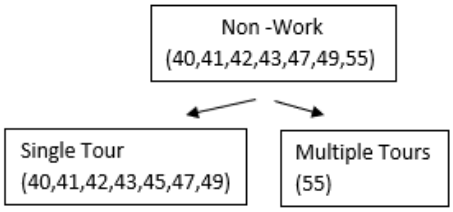


Figure 5-15: Level 3d

At this level u55 is set to 0 and based on the estimated parameters the choice model for u40 is shown below.

U40 = -0.5606 * age402f -0.5792 * age404m -0.2151 * age404f + 1.33454 * age405f + 1.76989 * ss403 -0.6824 * ss4014 + 0.24033 * ss4015 + 0.6476 * ss4016 + 0.24076 * hhi402 + 0.67998 * hhi403 -0.9572 * ao401 -1.1447 * ao402 -1.7815 * ao403 + 1.29137

U55 = 0

Table 5-10: Level 3d results

Parameter		**Estimate**	**Std. err.**	**t-ratio (0)**
Age & Gender				
<30-male*	b_age402m	0	NA	NA
<30-female	b_age402f	-0.5606	0.126	-4.5
30 to 60-male	b_age404m	-0.5792	0.086	-6.7
30 to 60-female	b_age404f	-0.2151	0.113	-1.9
60 +-female	b_age405f	1.33454	0.157	8.5
Social Status				
Working*	b_ss401	0	NA	NA
Student	b_ss403	1.76989	0.253	7.0
Housewife	b_ss4014	-0.6824	0.097	-7.0
Retired	b_ss4015	0.24033	0.098	2.5
Unemployed	b_ss4016	0.6476	0.114	5.7
Household Income				
< Rs.40,000*	b_hhi401	0	NA	NA
Rs.40,000 - Rs.79,999	b_hhi402	0.24076	0.064	3.8
> Rs.80,000	b_hhi403	0.67998	0.115	5.9

Parameter		Estimate	Std. err.	t-ratio (0)
Auto Ownership				
None*	b_ao400	0	NA	NA
MC	b_ao401	-0.9572	0.054	-17.7
3W	b_ao402	-1.1447	0.087	-13.1
Car/Van/Jeep/Pickup	b_ao403	-1.7815	0.191	-9.3
Constant	asc_O40	1.29137	0.086	15.1

*parameter set to 0

$\rho^2(0)$: 0.1302

The $\rho^2(0)$ value is low. This may be due to available attributes being insufficient to distinguish between the two choices.

Based on the results the highest contributor towards single other purpose tour is social status attribute of student. Over 60 year females have a higher likelihood for single other purpose tours whereas below 60 years females a more likely for multiple other purpose tours. Auto ownership increase the likelihood for multiple other purpose trips with ownership of car/van having a comparatively higher contribution.

5.3.11 Level 4c

At this level u40 & u49 are calculated. u40 represents single other purpose tour (peak) and u55 represents single other purpose tour (off peak) (figure 5.16).

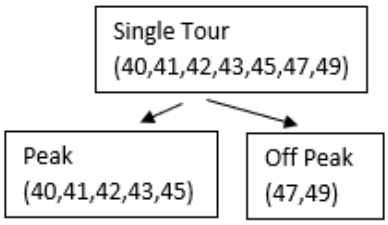


Figure 5-16: Level 4c

At this level u49 is set to 0 and based on the estimated parameters the choice model for u40 is shown below.

U40 = 0.9583 * ss403 -0.4916 * ss4014 -0.293 * ss4015 -0.2184 * ss4016 -0.2766 * gen402 + 0.0785 * hhi402 + 0.2919 * hhi403 -0.3049 * ao401 -0.366 * ao402 -0.4309 * ao403 + 0.8401 * oc402 + 0.7478 * oc404 + 0.7859

U49 = 0

Table 5-11: Level 4c results

Parameter		Estimate	Std. err.	t-ratio (0)
Social Status				
Working*	b_ss401	0	NA	NA
Student	b_ss403	0.95834	0.154	6.2
Housewife	b_ss4014	-0.4916	0.079	-6.2
Retired	b_ss4015	-0.293	0.075	-3.9
Unemployed	b_ss4016	-0.2184	0.087	-2.5
Gender				
Male*	b_gen401	0	NA	NA
Female	b_gen402	-0.2766	0.065	-4.3
Household Income				
< Rs.40,000*	b_hhi401	0	NA	NA
Rs.40,000 - Rs.79,999	b_hhi402	0.07846	0.056	1.4
> Rs.80,000	b_hhi403	0.29193	0.098	3.0
Auto Ownership				
None*	b_ao400	0	NA	NA
MC	b_ao401	-0.3049	0.047	-6.5
3W	b_ao402	-0.366	0.080	-4.6
Car/Van/Jeep/Pickup	b_ao403	-0.4309	0.182	-2.4
Occupation				

Parameter		Estimate	Std. err.	t-ratio (0)
Office/Institution-based workers (i.e. Engineer, Doctor, Manager, clerk etc.)*	b_oc401	0	NA	NA
Professor, Lecturer, Teacher (Education sector workers)	b_oc402	0.84012	0.382	2.2
Farmers, Fishermen, Street vendor, Driver, Labourers	b_oc404	0.74778	0.081	9.3
Constant	asc_O40	0.78592	0.062	12.7

*parameter set to 0

$\rho^2(0)$: 0.0819

The $\rho^2(0)$ value is low. This may be due to available attributes being insufficient to distinguish between the marginally different two choices.

Based on the results the highest contributor towards single other purpose tour (peak) is social status of student. Increase in household income increases the likelihood for single other purpose tour (peak) whereas auto ownership increase the likelihood of single other purpose tour (off peak).

5.3.12 Level 5c

At this level u47 & u49 are calculated. u47 represents single other purpose tour (off peak & shopping) and u49 represents single other purpose tour (off peak & personal) (figure 5.17).

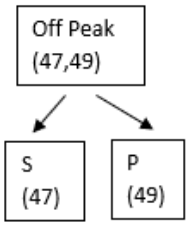


Figure 5-17: Level 5c

At this level u47 is set to 0 and based on the estimated parameters the choice model for u49 is shown below.

U49 = 1.52633 * ss493 -0.2969 * ss4916 -0.1786 * hhi492 + 0.32311 * ao491 + 0.28786 * ao492 -0.0552

U47 = 0

Table 5-12: Level 5c results

Parameter		Estimate	Std. err.	t-ratio (0)
Social Status				
Working *	b_ss491	0	NA	NA
Student	b_ss493	1.52633	0.348	4.4
Unemployed	b_ss4916	-0.2969	0.110	-2.7
Household Income				
< Rs.40,000*	b_hhi491	0	NA	NA
Rs.40,000 - Rs.79,999	b_hhi492	-0.1786	0.081	-2.2
Auto Ownership				
None*	b_ao490	0	NA	NA
MC	b_ao491	0.32311	0.069	4.7
3W	b_ao492	0.28786	0.115	2.5
Constant	asc_O49	-0.0552	0.049	-1.1

*parameter set to 0

$\rho^2(0)$: 0.0124

The $\rho^2(0)$ value is low. This may be due to available attributes being insufficient to distinguish between the marginally different two choices.

Based on the results the highest contributor towards single other purpose tour (off peak & personal) is social status attribute of student. Attribute of household income increases the likelihood for single other purpose tour (off peak & shopping).

5.3.13 Level 5b

At this level u40 & u43 are calculated. u40 represents single other purpose tour (peak & religious, leisure, other) and u43 represents single other purpose tour (peak & shopping, personal, business) (figure 5.18).

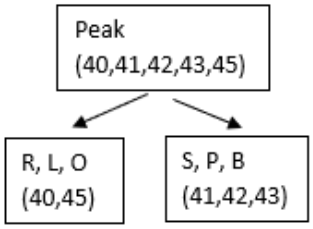


Figure 5-18: Level 5b

At this level u40 is set to 0 and based on the estimated parameters the choice model for u43 is shown below.

U43 = -0.2843 * ss4314 -0.1962 * ss4315 -0.5479 * ss4316 + 0.14051 * hhi432 + 0.28163 * hhi433 -0.1032 * ao431 -0.4451 * oc432 + 0.6910 * oc434 + 0.4455

U40 = 0

Table 5-13: Level 5b results

Parameter		**Estimate**	**Std. err.**	**t-ratio (0)**
Social Status				
Working *	b_ss431	0	NA	NA
Housewife	b_ss4314	-0.2843	0.074	-3.8
Retired	b_ss4315	-0.1962	0.088	-2.2
Unemployed	b_ss4316	-0.5479	0.099	-5.5

Parameter		Estimate	Std. err.	t-ratio (0)
Household Income				
< Rs.40,000*	b_hhi431	0	NA	NA
Rs.40,000 - Rs.79,999	b_hhi432	0.14051	0.070	2.0
> Rs.80,000	b_hhi433	0.28163	0.123	2.3
Auto Ownership				
None*	b_ao430	0	NA	NA
MC	b_ao431	-0.1032	0.058	-1.8
Occupation				
Office/Institution-based workers (i.e. Engineer, Doctor, Manager, clerk etc.)*	b_oc431	0	NA	NA
Professor, Lecturer, Teacher (Education sector workers)	b_oc432	-0.4451	0.354	-1.3
Farmers, Fishermen, Street vendor, Driver, Labourers	b_oc434	0.69104	0.088	7.9
Constant	asc_O43	0.44549	0.064	7.0

*parameter set to 0

$\rho^2(0)$: 0.0556

The $\rho^2(0)$ value is low. This may be due to available attributes being insufficient to distinguish between the marginally different two choices.

Based on the results the highest contributor towards single other purpose tour (peak & shopping, personal, business) is occupation of education sector workers. Increase in household income increases the likelihood for single other purpose tour (peak & shopping, personal, business). Social status of unemployed increase the likelihood for single other purpose tour (peak & religious, leisure, other).

5.3.14 Level 6a

At this level u40 & u45 are calculated. u40 represents single other purpose tour (peak & religious) and u45 represents single other purpose tour (peak & Leisure, Other) (figure 5.19).

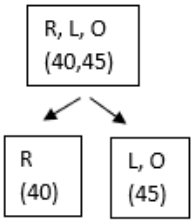


Figure 5-19: Level 6a

At this level u40 is set to 0 and based on the estimated parameters the choice model for u45 is shown below.

U45 = -1.0423 * age452f -0.9391 * age454f -0.4984 * age455m -1.4439 * age455f -0.2946 * ss453 -0.6153 * ss4514 -0.8776 * ss4515 -9.7334 * rhh455 + 1.1926

U40 = 0

Table 5-14: Level 6a results

Parameter		**Estimate**	**Std. err.**	**t-ratio (0)**
Age & Gender				
<30-male*	b_age452m	0	NA	NA
<30-female	b_age452f	-1.0423	0.167	-6.3
30 to 60-female	b_age454f	-0.9391	0.154	-6.1
60 + -male	b_age455m	-0.4984	0.175	-2.8
60 + -female	b_age455f	-1.4439	0.167	-8.6
Social Status				
Working *	b_ss451	0	NA	NA
Student	b_ss453	-0.2946	0.237	-1.2

Parameter		Estimate	Std. err.	t-ratio (0)
Housewife	b_ss4514	-0.6153	0.138	-4.5
Retired	b_ss4515	-0.8776	0.153	-5.7
Relation to HoH				
Head (Self)*	b_rhh451	0	NA	NA
clergy	b_rhh455	-9.7334	36.957	-0.3
Constant	asc_O45	1.19257	0.085	14.0

*parameter set to 0

$\rho^2(0)$: 0.1007

The $\rho^2(0)$ value is low. This may be due to available attributes being insufficient to distinguish between the two choices.

Based on the results the highest contributor towards single other purpose tour (peak & Leisure, Other) is the alternative specific constant and this is an extension of the attributes being insufficient to distinguish between the two choices. Across all age groups females have a high likelihood for single other purpose tour (peak & religious) compared to males. As expected, Relation to head of house attribute of clergy increases the likelihood for single other purpose tour (peak & religious).

5.3.15 Level 6b

At this level u42 & u43 are calculated. u42 represents single other purpose tour (peak & business) and u43 represents single other purpose tour (peak & shopping, personal) (figure 5.20).

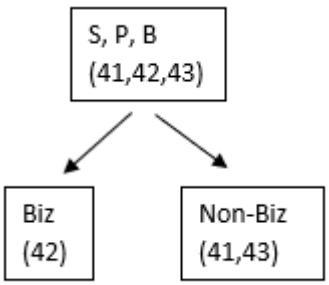


Figure 5-20: Level 6b

At this level u42 is set to 0 and based on the estimated parameters the choice model for u43 is shown below.

U43 = 2.1801 * age432f + 1.8151 * age434f + 0.5549 * age435m + 1.9581 * age435f + 3.6894 * ss433 + 1.6355 * ss4314 + 2.1724 * ss4315 + 2.016 * ss4316 + 0.2400 * hhi432 + 0.7091 * ao431 + 0.6004 * ao432 + 0.6101 * ao433 -1.626 * oc434 -0.2738

U42 = 0

Table 5-15: Level 6b results

Parameter		Estimate	Std. err.	t-ratio (0)
Age & Gender				
<30-male*	b_age432m	0	NA	NA
<30-female	b_age432f	2.18014	0.337	6.5
30 to 60-female	b_age434f	1.81512	0.146	12.4
60 + -male	b_age435m	0.5549	0.110	5.0
60 + -female	b_age435f	1.95806	0.255	7.7
Social Status				
Working *	b_ss431	0	NA	NA
Student	b_ss433	3.68936	0.713	5.2
Housewife	b_ss4314	1.63552	0.219	7.5
Retired	b_ss4315	2.17241	0.203	10.7
Unemployed	b_ss4316	2.01598	0.219	9.2
Household Income				
< Rs.40,000*	b_hhi431	0	NA	NA
Rs.40,000 - Rs.79,999	b_hhi432	0.24004	0.091	2.6
Auto Ownership				
None*	b_ao430	0	NA	NA
MC	b_ao431	0.70907	0.069	10.3

Parameter		Estimate	Std. err.	t-ratio (0)
3W	b_ao432	0.60044	0.125	4.8
Car/Van/Jeep/Pickup	b_ao433	0.61005	0.240	2.5
Occupation				
Office/Institution-based workers (i.e. Engineer, Doctor, Manager, clerk etc.)*	b_oc431	0	NA	NA
Farmers, Fishermen, Street vendor, Driver, Labourers	b_oc434	-1.626	0.071	-22.8
Constant	asc_O43	-0.2738	0.557	-0.5

*parameter set to 0

$\rho^2(0)$: 0.5765

The $\rho^2(0)$ value indicates the model has a good fit.

Based on the results the highest contributor towards single other purpose tour (peak & shopping, personal) is social status attribute student. All attributes of social status contribute heavily to the choice of single other purpose tour (peak & shopping, personal). Across all age groups females have a high likelihood for single other purpose tour (peak & shopping, personal) compared to males.

5.3.16 Level 7

At this level u41 & u43 are calculated. u41 represents single other purpose tour (peak & shopping) and u43 represents single other purpose tour (peak & personal) (figure 5.21).

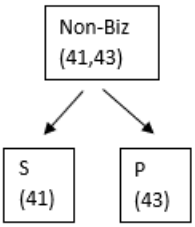


Figure 5-21: Level 7

At this level u41 is set to 0 and based on the estimated parameters the choice model for u43 is shown below.

U43 = -0.185 * age434m -0.3275 * age434f -0.2364 * age435m + 2.4475 * ss433 + 0.3045 * ss4314 + 0.3744 * ss4315 + 0.3500 * ss4316 + 0.1981 * hhi433 + 0.3618 * ao432 + 0.4639 * ao433 + 0.6200 * oc432 + 0.3201 * oc434 + 0.2006

U41 = 0

Table 5-16: Level 7 results

Parameter		Estimate	Std. err.	t-ratio (0)
Age & Gender				
<30-male*	b_age432m	0	NA	NA
30 to 60-male	b_age434m	-0.185	0.075	-2.5
30 to 60-female	b_age434f	-0.3275	0.067	-4.9
60 + -male	b_age435m	-0.2364	0.094	-2.5
Social Status				
Working *	b_ss431	0	NA	NA
Student	b_ss433	2.44748	0.205	11.9
Housewife	b_ss4314	0.30452	0.083	3.7
Retired	b_ss4315	0.3744	0.087	4.3
Unemployed	b_ss4316	0.35001	0.093	3.8
Household Income				
< Rs.40,000*	b_hhi431	0	NA	NA
>Rs.80,000	b_hhi433	0.19813	0.112	1.8
Auto Ownership				
None*	b_ao430	0	NA	NA
3W	b_ao432	0.36182	0.084	4.3
Car/Van/Jeep/Pickup	b_ao433	0.46391	0.187	2.5
Occupation				

Parameter		Estimate	Std. err.	t-ratio (0)
Office/Institution-based workers (i.e. Engineer, Doctor, Manager, clerk etc.)*	b_oc431	0	NA	NA
Professor, Lecturer, Teacher (Education sector workers)	b_oc432	0.62004	0.289	2.1
Farmers, Fishermen, Street vendor, Driver, Labourers	b_oc434	0.32012	0.080	4.0
Constant	asc_O43	0.20059	0.074	2.7

*parameter set to 0

$\rho^2(0)$: 0.0619

The $\rho^2(0)$ value is low. This may be due to available attributes being insufficient to distinguish between the two choices.

Based on the results the highest contributor towards single other purpose tour (peak & personal) is social status attribute student. Household income and auto ownership increases the likelihood for single other purpose tour (peak & personal). Based on age and gender attributes females of ages 30 to 60 years have a comparatively higher likelihood for single other purpose tour (peak & shopping).

5.4 Summary and model application

Choice models were developed for the identified 17 pattern groups in chapter 4. For most of the choice models at higher levels the $\rho^2(0)$ value indicated a good fit. But for choice models at the lower level the $\rho^2(0)$ value was low due to one choice being relatively highly represented in the dataset compared to the other choice and also the available socio economic characteristics weren't sufficient to distinguish between the two choices. This was mostly observed in the other purpose pattern groups choice models.

The estimated choice models also indicated several social behaviour effects. For example, Level 1 indicated the effect of high male working population and Level 2a indicated the effect of tuition classes.

The developed choice model can be used to assign an individual an activity pattern based on the individual's socio economic characteristics. At level 1 the individual's socio economic characteristics will be used to calculate the two utilities (U1 & U20) to check whether the pattern will be educational or not. By using the logit equation, the probability of choosing each choice will be calculated. The choice with the highest probability will be the individual's choice group at Level 1. Techniques such as Monte Carlo simulation can be used to incorporate random effect where the selection of the choice will be based on multiple runs using the random number generation and the calculated probabilities. After a choice is made at Level 1 the process will continue for the relevant subsequent levels till a choice is made at the root level of the choice model structure. This will assign one of the 17 choice model groups for the individual. The activity pattern for the individual can be assigned based on the activity pattern distribution (Section 4.6) for the selected subgroup using methods such as Monte Carlo technique.

For the developed choice model structure to be used for practical modelling it has to be calibrated/validated using aggregate choice quantities that are known. Hence the developed choice models will be adjusted using calibration constants so that observed choices are matched by the choices derived using the choice models. This is beyond the scope of the research.

6 CONCLUSIONS AND RECOMMENDATIONS

Sri Lanka in the near future will move towards activity based modelling and activity pattern formulation is an important step in it. The research tries to address this issue by developing an activity pattern choice model for individuals in Western Province based on Home Visit Survey data.

The first objective of the research was to identify suitable activity patterns. Based on HVS data activity patterns for each member was developed with spatial representation(i.e. Home, Work, Education & Other) and temporal representation (5 time periods).3 main categories (i.e. Education, Work & other) were clearly identified and each member with an activity pattern was assigned a category based on the most prominent trip in the pattern. These 3 categories were further categorized based on number of purpose & non purpose tours, diversions and time category in the case of educational & work patterns and number of tours, purpose and time category for other pattern category.17 subgroups were identified which consisted of 5 work pattern groups, 4 educational pattern groups and 8 other pattern groups.

The second objective was to develop an activity pattern choice model. A mathematical model was developed based on socio economic data to assign an activity pattern group to an individual. This is required in activity based modelling where a person is simulated and the available data from population synthesis step of the model will be each individuals socio economic data. The developed choice model is a multi-level structure. But estimation was done by considering each level as a single level structure with each level estimated separately. Each level consisted of 2 choices and one choice was estimated relative to the other. Estimation for the 7 level choice model structure was carried out using “Apollo” module in R programming language.

The estimated choice model at highest level distinguishes between education and work patterns and has high $\rho^2(0)$ value and hence the data fits well. The upper levels of Education and work patterns also display similar behaviour. At lower levels of the choice model structure and mainly the patterns related to other pattern groups displays fuzziness in the estimated results with a low $\rho^2(0)$ value. This can be attributed to the limitation of the dataset to 4 activity types (i.e. Home, Work, Education, Other). The

well represented work and education pattern groups have a higher accuracy and the highly varying and fuzzy other pattern groups have a lower accuracy. Hence the choice model structure accuracy is high at higher levels and low at the lower levels.

6.1 Positive aspects of the adopted research method

The Home Visit Survey database (with its limitations highlighted in section 6.2) provided a dataset that was reliable (due to its extensive use in transport modelling) and representative of the Western Province population. It ensured saving a massive amount of time and resources that would have been required for data collection.

The method adopted to cluster pattern choice groups based on trip & tour characteristics and time dimension was simple (compared to other clustering algorithms) but effective.

The developed choice model structure of stop/repeat model type (with 2 choices at each level) ensured better representation of choices with low frequencies compared to a multileveled nested structure.

The software used for estimation (Apollo module of R programming language) was open source, highly customizable and provided options for memory optimization and hence is an excellent solution for future logit estimation purposes.

6.2 Limitations of the adopted research method and suggestions

The Home Visit Survey dataset had the following limitations.

1. The trip purposes were only limited to work, education and other purposes. Hence the initial codes for activity patterns had to be limited to home, work, school/education institute and other. In order to expand other purposes, other purpose patterns were grouped into 6 purposes based on destinations of other purpose trips in a subsequent step. But it resulted in comparatively low representation for religious and leisure purposes.
2. The data set only consisted of departure and arrival times of activities. Hence the representation of time dimension had to be restricted to categorized time periods. But time representation in activity based models would be better with time slice interval representation. And also, an important activity pattern of

staying at home all day was not represented due to its unavailability in the dataset.

3. The dataset was for 2012-2013 time period. Hence its validity in current year can be questioned. But with no massive economical, social and technological advancement having taken place in Sri Lanka during the remaining time period it is a fair assumption that activity patterns of individuals may have not changed drastically. But a more recent dataset would have been preferred.

The above limitations can be minimized with the use of time use survey dataset. The comparatively detailed time use survey data will provide details such as time dimension at a more finer level and also the activity categories will be more. The research was initially planned to be carried out using time use survey -2018 dataset. But it was unavailable during the research time period and hence it was carried out using the best available data source of HVS dataset.

The estimated choice models will provide inconsistent results of activity purposes regarding some individuals. For example, an individual in school going age category will still have a probability of having a non educational pattern. In order to correct it and refine the model for practical use it has to be calibrated using calibration constants. But it is beyond the scope of the research.

6.3 Recommendations for future work

- The developed models estimated choice models for other pattern have a low accuracy and a better fitting model can be developed if the data related to other group patterns be further divided and the socio economic data related to these aspects be made available
- The scope of the research is restricted to the estimation aspect of activity pattern choice model development. The developed pattern choice model can be further developed by calibrating the model based on known aggregate choice quantities and henceforth be used for practical modelling in activity based models
- HVS dataset which was used for the research is a less detailed dataset and the activity patterns are restricted to activities linked with individual's travels. Use

of comparatively detailed time use dataset as the source for activity pattern formulation will provide a more detailed and useful activity pattern generating choice model that may be able to incorporate concepts of work time shifts, work from home etc. which the choice model developed in this research may not fully capture.

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Appendix – I: Activity Patterns

Pattern	In Sample	Weighted number	%
H2S3H	22281	1,006,676.27	29.31
H2W4H	16322	746,872.21	21.75
H2O3H	5105	205,263.27	5.98
H2W5H	4552	195,932.82	5.70
H3O3H	3779	156,536.78	4.56
H2O4H	3340	139,699.48	4.07
H2W3H	2026	96,093.21	2.80
H1W4H	1645	72,643.68	2.12
H2O2H3O3H	1590	67,265.99	1.96
H2O2H	1438	57,535.11	1.68
H2S4H	1070	50,351.12	1.47
H4O4H	1193	47,673.60	1.39
H3O4H	991	41,486.99	1.21
H1S3H	695	33,132.06	0.96
H1W5H	644	28,863.01	0.84
H1W3H	644	27,093.53	0.79
H2S3H4O4H	493	21,394.31	0.62
H2O5H	505	21,238.29	0.62
H4O5H	483	19,409.59	0.57
H2O2W4H	386	18,704.90	0.54

Pattern	In Sample	Weighted number	%
H3W5H	330	15,204.19	0.44
H2S3O4H	288	13,293.45	0.39
H2S3H3O4H	268	11,923.59	0.35
H1O3H	279	11,603.80	0.34
H2W3H3W4H	181	7,583.01	0.22
H3W4H	160	7,345.10	0.21
H1O4H	181	7,276.19	0.21
H2O3O3H	160	6,757.96	0.20
H2S3H4O5H	142	6,319.63	0.18
H2O2S3H	139	6,134.84	0.18
H2W3H3W5H	148	6,100.07	0.18
H2W4H5O5H	119	6,068.21	0.18
H5O5H	145	6,060.42	0.18
H2W3H4W5H	145	5,939.61	0.17
H2O2W4O4H	98	5,893.58	0.17
H2O2W5H	118	5,642.63	0.16
H1S4H	107	4,973.61	0.14
H3O5H	122	4,832.50	0.14
H1O2H	115	4,755.44	0.14
H3O3O3H	105	4,252.44	0.12
H2O2H2W4H	95	4,209.45	0.12
H2W4O4H	80	4,178.34	0.12

Pattern	In Sample	Weighted number	%
H2O2H4O4H	97	4,019.72	0.12
H2O3H3O4H	97	3,954.14	0.12
H2O3H4O4H	93	3,937.35	0.11
H3O3H4O4H	88	3,571.11	0.10
H2S3O3H	73	3,294.78	0.10
H2O2O3H	77	3,245.85	0.09
H2W4H4O5H	63	2,968.15	0.09
H2O2H3O3H3O3H	67	2,749.40	0.08
H3S4H	64	2,681.25	0.08
H3O3O4H	57	2,658.31	0.08
H2O2O2W4H	50	2,511.25	0.07
H1O5H	52	2,390.37	0.07
H2W2H	55	2,355.15	0.07
H4W5H	55	2,321.15	0.07
H2W4O5H	45	2,291.96	0.07
H2W3H4O4H	46	2,250.72	0.07
H2O2W3O3H	43	2,234.40	0.07
H2O2S3O3H	41	2,175.56	0.06
H2O3H3O3H	47	2,089.91	0.06
H2O2O4H	50	2,073.04	0.06
H2O2H2W5H	45	2,041.14	0.06
H2S5H	40	2,031.75	0.06

Pattern	In Sample	Weighted number	%
H3W3H	57	2,006.58	0.06
H2O2O2H	43	1,917.70	0.06
H2W3O4H	36	1,886.17	0.05
H1W2H	49	1,846.66	0.05
H2O2H3O3H4O4H	42	1,805.45	0.05
H2O2H3O4H	37	1,732.59	0.05
H2O2W3O3H3W5H	41	1,705.55	0.05
H2O4O4H	40	1,666.59	0.05
H2O2W3O3H3W4H	34	1,631.26	0.05
H2O2O3O3H	36	1,574.28	0.05
H2O2O2H3O3O3H	40	1,571.23	0.05
H2W4H4O4H	34	1,531.46	0.04
H2S1H	36	1,464.65	0.04
H2O2W	28	1,426.91	0.04
H2W3H4W4H	31	1,374.80	0.04
H2O3H4O5H	33	1,284.72	0.04
H2O2W3H	28	1,272.17	0.04
H3O4O4H	24	1,219.87	0.04
H2O2H4O5H	30	1,194.15	0.03
H2S3O	25	1,177.66	0.03
W2H4W	28	1,147.04	0.03
H3O3H3O3H	28	1,141.98	0.03

Pattern	In Sample	Weighted number	%
H1S3O4H	27	1,139.71	0.03
H2O3O4H	28	1,132.98	0.03
H3O3H4O5H	26	1,128.01	0.03
H2O3O3O3H	25	1,119.66	0.03
H2W3O3H	21	1,115.89	0.03
H2O2H2O4H	29	1,110.12	0.03
H2O4H5O5H	27	1,093.13	0.03
H2O2H2O2H3O3H	26	1,086.52	0.03
H2S3H5O5H	24	1,060.95	0.03
H2O2H3O3O3H	25	1,034.08	0.03
H2S3O5H	22	1,019.87	0.03
H2O2W3O3H4W5H	23	1,008.19	0.03
H1O1H	23	1,003.05	0.03
H2O2O2W5H	21	1,001.02	0.03
H4O4H4O4H	24	999.79	0.03
H2O2H3O3H3O4H	23	988.46	0.03
H1W3H4W5H	22	941.92	0.03
H2W3H4O5H	19	932.21	0.03
H2O2H2W3O3H3W5H	23	919.54	0.03
H3O3H3O4H	21	897.75	0.03
O2S3O	21	895.38	0.03
H2S4O4H	19	860.54	0.03

Pattern	In Sample	Weighted number	%
H1S3H4O4H	14	835.24	0.02
H2O2H2W3O3H3W4H	20	830.07	0.02
H2O2H2O3H	22	829.29	0.02
H3O4H4O4H	18	828.57	0.02
H2O2O2W4O4H	13	825.82	0.02
H2W3H3O4H	17	815.53	0.02
H1W3H4O4H	15	796.23	0.02
H2O2H2O3H3O3H	19	774.27	0.02
H2O2O2H3O3H	19	766.88	0.02
H2O4H4O5H	17	745.82	0.02
O2W4O	18	742.09	0.02
H3O3H5O5H	17	706.62	0.02
H2O2H2O2H	19	700.55	0.02
H2W3O3W4H	16	697.40	0.02
H4O4O5H	15	688.91	0.02
H2W5O5H	13	684.37	0.02
H2O2H2O2H3O3H3O3H	18	682.55	0.02
H1O2H3O3H	14	676.80	0.02
W3H1W	15	675.28	0.02
H3W1H	16	662.25	0.02
H2W3O3W5H	12	554.77	0.02
H2W4H4W5H	12	550.51	0.02

Pattern	In Sample	Weighted number	%
O2S4O	11	541.11	0.02
H4W1H	13	540.31	0.02
H4O4H5O5H	9	511.23	0.01
H4O4H4O5H	11	510.09	0.01
H1O1H3W4H	7	506.68	0.01
H2W5H5O5H	13	503.68	0.01
H2O2H2O5H	11	494.44	0.01
H3O3O3O3H	12	490.54	0.01
H2O2H3O3H5O5H	12	484.30	0.01
H2O2H2W3H4W5H	10	468.71	0.01
H2W2H3W3H	11	466.56	0.01
H2W2O3W4H	12	460.26	0.01
H1O2W4H	11	444.91	0.01
H2O2H2W3O3H	10	444.07	0.01
H4W4H	10	442.59	0.01
H2O2H2O3O3H3O4H	6	437.95	0.01
H2O3H5O5H	9	432.06	0.01
H3S3H	8	426.61	0.01
H4O4O4H	10	426.57	0.01
H2O2H3W4H	9	421.56	0.01
H2O2W4O5H	8	412.72	0.01
H2O2H5O5H	10	409.45	0.01

Pattern	In Sample	Weighted number	%
H2O4O5H	9	404.42	0.01
H1O2H4O4H	9	401.83	0.01
H1O1H2W4H	10	399.85	0.01
H2S3H3S4H	8	396.11	0.01
H1W4H5O5H	9	393.01	0.01
H2O2O5H	11	383.92	0.01
H2S3H4S4H	10	383.37	0.01
H2S3H4O4H4O5H	6	382.31	0.01
H2O2H2W3O3H4W5H	11	380.32	0.01
H1W3H3O3H	12	379.95	0.01
H2W2O4H	9	368.88	0.01
H2W3O3H3W4H	5	364.90	0.01
H1S3O5H	7	363.57	0.01
H2O2H2O3O3H	8	356.44	0.01
H4S5H	6	350.65	0.01
H2W4O	9	345.88	0.01
O1W4O	3	343.87	0.01
H3W4H4O4H	6	342.47	0.01
H2O2O2H3O3H3O3H	9	342.34	0.01
W1H4W	8	329.81	0.01
H2O4H4O4H	8	329.53	0.01
H2W3O3H3W5H	8	327.41	0.01

Pattern	In Sample	Weighted number	%
H2O2W3O3H4W4H	8	325.88	0.01
H4O5O5H	9	323.55	0.01
H2O2O	7	321.74	0.01
H1O2O3H	8	320.26	0.01
H2W1H	8	318.73	0.01
H1W4O4H	7	316.86	0.01
H1O2W5H	8	316.67	0.01
W2H5W	8	314.94	0.01
H2W3H3O3H	7	314.63	0.01
H2O2H3O3H4O5H	10	312.85	0.01
H2O2H3O3H3W5H	7	312.34	0.01
H1O2H2W4H	7	310.21	0.01
H2O2W5O5H	6	307.27	0.01
H1W3H4O5H	9	306.83	0.01
H1O2H2O3H	9	306.81	0.01
H2O2W3H3W5H	6	297.60	0.01
H1O2H3O3H4O4H	8	292.22	0.01
H3O3O3O4O4H	4	288.96	0.01
H4S4H	7	287.05	0.01
H3O3O4O4H	7	285.54	0.01
H1W3H3W5H	7	280.39	0.01
O2W5O	6	279.55	0.01

Pattern	In Sample	Weighted number	%
H2W2O4W4H	6	278.97	0.01
H2W3O3H4W5H	5	272.00	0.01
H3O3O3O4H	4	271.16	0.01
H2O2H2W3H3W5H	7	269.30	0.01
H3W3H4W5H	8	264.08	0.01
W4H1W	7	263.44	0.01
H2O2S4H	4	262.72	0.01
H1S5H	6	262.46	0.01
H2O2O3H3O3H	6	262.18	0.01
H2O3O3O4H	6	261.66	0.01
H2S3H3O5H	6	258.27	0.01
H2O3O	7	255.64	0.01
H2W2H4W5H	7	254.82	0.01
H3O3H3O3H4O4H	7	251.67	0.01
W2H3W	6	251.19	0.01
H2W3H5O5H	6	245.87	0.01
H2O3O5H	6	244.77	0.01
H2O2W3H4W5H	6	243.32	0.01
H2O3H3O5H	6	243.14	0.01
H2O2H2O2H3O3H4O4H	4	241.07	0.01
H2O2H2W4O4H	5	238.70	0.01
H2W2O3W5H	5	238.09	0.01

Pattern	In Sample	Weighted number	%
H2O3H3W4H	4	234.49	0.01
H2S3O4O5H	3	233.28	0.01
H2O2H2W3H3O3H3W4H	6	233.01	0.01
H2S3H4O4O4H	5	232.29	0.01
H2O2O2O2W4H	5	231.33	0.01
H1O1H5O5H	4	230.53	0.01
H2W3H3W4H4W4H	6	227.90	0.01
H2O2O3H4O5H	4	224.54	0.01
H3S5H	4	222.80	0.01
H2O2O2O3H	6	222.12	0.01
H3O3W4H	5	222.09	0.01
H4O1H	6	220.29	0.01
H2O2H2O2H2W5H	6	220.25	0.01
H2O2H3O3H4O4H4O4H	6	219.85	0.01
H3O3O3H4O4H	5	214.02	0.01
H2W2H2W3H4W5H	4	212.73	0.01
H2S3H4O4O5H	4	211.73	0.01
H2W2O2W4H	5	210.62	0.01
H1W4H4O5H	6	208.78	0.01
H5W5H	6	208.51	0.01
H2O2O2W3O3H	4	208.45	0.01
H2O2H2W3H3O3H	6	208.20	0.01

Pattern	In Sample	Weighted number	%
H2O2H3O3O4H	5	205.98	0.01
H3O4H5O5H	5	205.61	0.01
H2S3H4O	5	205.33	0.01
H2W3H4W5O5H	3	203.53	0.01
H2O2O2W3O3O3H	5	202.10	0.01
H2O2O2W4O4O4H	3	197.38	0.01
H2S3O4O4H	5	197.11	0.01
H2O2W4O4H5O5H	2	196.78	0.01
H2O2O2W3O3H3W4H	4	195.42	0.01
H3O4H4O5H	5	195.12	0.01
H2O2H2O2H3O3O3H	4	194.62	0.01
W5H1W	6	193.86	0.01
H2O2O2H2W4H	5	191.61	0.01
H1O1H3W4H4O4H	3	189.38	0.01
H2S4O5H	4	188.95	0.01
H3W3H4O4H	4	188.53	0.01
H2O2H3W5H	6	188.43	0.01
H1O3H4O4H	5	183.62	0.01
H2O3H4W4H	3	183.23	0.01
W2H1W	5	182.75	0.01
H3W3H4O5H	3	182.01	0.01
H2O2H3O4O4H	4	180.18	0.01

Pattern	In Sample	Weighted number	%
H2S3H4O4H5O5H	5	180.16	0.01
H1W4H4O4H	4	176.80	0.01
H2W3O4W5H	3	176.57	0.01
H2W3O4O4H	4	175.09	0.01
H2O2O2O4H	4	174.69	0.01
H2O2O2S3H	4	174.08	0.01
H5O1H	5	172.30	0.01
H2S4H4O5H	4	170.77	0.00
H2O2O3O3H3O5H	4	170.61	0.00
H2O2H2W4H5O5H	4	169.06	0.00
H1O2H5O5H	4	167.93	0.00
H2O3O3H4O4H	5	166.42	0.00
H1S3H4O5H	4	165.26	0.00
H1O1H2O2H3O3H	4	164.73	0.00
H2O5W5H	4	164.52	0.00
H2O2H4O4H4O4H	5	164.32	0.00
H3O3H3W4H	2	164.30	0.00
H2O2H2W4H4O4H	4	164.29	0.00
H2W3H3W4O4H	3	164.15	0.00
H2O2W3O3H4O4H	3	163.52	0.00
H2O2O3O3H3O4H	4	161.91	0.00
H2O3W4H	4	161.42	0.00

Pattern	In Sample	Weighted number	%
H2O3H3W5H	4	160.77	0.00
H2W2H3O3H	4	160.51	0.00
H1O1H2W3H	2	160.06	0.00
H2W2O3H	3	157.35	0.00
H2W3H3O3H4O4H	1	156.90	0.00
H2O2O4O4H	4	156.85	0.00
H1O2O4H	4	155.93	0.00
H2O2O2W3O3H3W4O4H4W5H	1	154.94	0.00
H1W1H	4	153.40	0.00
H2W3H3W4H5O5H	4	153.10	0.00
H1O1H3O3H	4	151.37	0.00
H1O2H2O4H	4	149.78	0.00
H2O2O2O2W4O4H	3	149.02	0.00
H2W3O4H5O5H	3	148.82	0.00
H2O2H2W3H3W4H	3	147.04	0.00
H2O2H2O2H4O4H	4	146.44	0.00
H2O2H3O5H	4	146.27	0.00
H1O1H2W5H	3	144.54	0.00
H1S3O4O4H	3	144.42	0.00
H2W4H4O4H5O5H	3	144.02	0.00
H2O4S5H	2	143.98	0.00
H2O2H2O2H2W4H	4	143.24	0.00

Pattern	In Sample	Weighted number	%
H2H4H	3	142.92	0.00
H2O2O2W3H3O3H3W4O4H	1	141.29	0.00
H2S3H3O4O4H	1	141.00	0.00
H2W2O4W5H	4	140.80	0.00
H1W2H2O2H3O3H	2	140.09	0.00
H2O2H3O3H4W5H	4	139.83	0.00
H2O2H3O3H3O4H4O4H	3	138.59	0.00
H2O3O4O4H	4	138.35	0.00
H2O2S3H4O5H	3	138.08	0.00
H1O2W3H	4	137.70	0.00
H1O3H4O5H	4	137.14	0.00
H2O2W3O4H	3	136.38	0.00
H2O2S3O4H	3	136.00	0.00
H2O3H3O3H4O4H	2	135.89	0.00
H2O2O3O4H	4	134.49	0.00
H2W5H5O1H	2	132.78	0.00
H2O3H4O4H4O4H	3	132.44	0.00
H3O3H4O4H4O5H	3	131.23	0.00
H2O2O2H2W3O3O3H3W5H	3	129.84	0.00
H2O2H2O2W4H5O5H	2	128.91	0.00
H3O3O	4	128.23	0.00
O2O4O	3	127.68	0.00

Pattern	In Sample	Weighted number	%
H1W3H4W4H	4	127.45	0.00
H1S2H	2	127.45	0.00
H2O2H4W5H	3	127.33	0.00
H1O2H2W5H	3	127.16	0.00
H3W5O5H	2	126.38	0.00
H2O2H2O2H2W3O3H3W4H	2	126.21	0.00
H2W2H3W3H4W5H	3	126.16	0.00
H2W3O3H4W4O4W4H	1	126.12	0.00
H2W3O3W4H5O5H	2	125.80	0.00
H1W3H3W4H	3	125.78	0.00
H4O4H4O4H4O5H	2	125.41	0.00
H3O3H3O4H4O4H	3	124.20	0.00
W1H3W	3	124.17	0.00
W3H3W	3	124.08	0.00
H1W2O3W5H	2	122.37	0.00
H2W3H3W3H4W4H	3	122.22	0.00
H1O2W3O3H	2	122.03	0.00
H2O3H4O4H4O5H	3	120.87	0.00
H2W2O2W5H	3	120.65	0.00
H2W2H4W4H	4	120.55	0.00
H1O1H2O3H	3	119.92	0.00
H2O2H2O2W4H	3	119.01	0.00

Pattern	In Sample	Weighted number	%
H2O2O4H5O5H	3	118.94	0.00
H2O2H2O2H3W4H	1	118.92	0.00
H2S4H4O4H	3	118.88	0.00
H2O2H2W3H	3	118.84	0.00
H2O2H2O3H3O5H	1	118.59	0.00
H4O4O4O4H	3	118.42	0.00
H3W4H4W5H	4	118.03	0.00
H3O3H3O3H4O5H	2	117.59	0.00
H2S3H3O4H4O5H	4	117.50	0.00
H2O2W4H5O5H	2	117.46	0.00
H2O2O3O3H3W4H	2	117.06	0.00
H3O4O5H	3	115.59	0.00
O2S3H	3	115.21	0.00
H2O2O2H4O4H	2	114.41	0.00
H1W2H2W3H4W5H	2	112.76	0.00
H2O2O2S3O3O3H	1	112.73	0.00
H2O2H2W3H4O4H	2	112.68	0.00
H2O2H3O3O3H4O4H	2	112.31	0.00
H2O2O2S4H	2	111.70	0.00
H2O3O3H3O4H	2	111.50	0.00
H1O1H2O2H4O4H	2	111.46	0.00
H2O2S3H4O4H	3	110.95	0.00

Pattern	In Sample	Weighted number	%
H2S3H4O1H	3	109.44	0.00
H2O2H2O2W5H	3	108.94	0.00
H2W3H3O3H3W4H	2	108.68	0.00
H3O3O5H	2	108.35	0.00
O2O3H	3	108.10	0.00
H3W5H5O5H	2	106.98	0.00
H2O2H2O3H4O5H	3	106.58	0.00
H2O2O2H3O	2	105.91	0.00
H3W3H3W4H	2	104.48	0.00
H3O3H4O4H4O4H	2	104.45	0.00
H1W4O5H	3	104.05	0.00
H3O3O3H4O5H	3	104.01	0.00
H3W3O4H	2	103.64	0.00
H2S2O3H	2	103.60	0.00
H2W3O5W5H	1	103.09	0.00
H1O1H2W3H4O4H	1	103.09	0.00
H2O2H4O4H5O5H	2	102.67	0.00
H3O3O3H5O5H	2	102.43	0.00
H1O1O2H	2	102.29	0.00
H2O3O3O5H	3	101.93	0.00
H2O2O2H3O3H4O4H	2	101.13	0.00
H2W2H2O2W3O3H	3	101.01	0.00

Pattern	In Sample	Weighted number	%
H3O3H3O3O3O3W4O4H	1	100.43	0.00
H2S3O3O4H	2	99.66	0.00
H1O1O3H	3	99.65	0.00
H2O2O2W3O3O3H4W5H	3	99.54	0.00
H2W4O4O4H	2	99.45	0.00
H1W3O4H	3	99.38	0.00
H2W2O5H	2	99.20	0.00
H2O2O2W3O3W4O4H	2	99.10	0.00
H2O2W3H3O3O4O4H	1	99.02	0.00
H2O2H2W3H5O5H	2	98.83	0.00
H2O2H3O3H3O3O3H	2	98.67	0.00
H1O1H3O3H4O4H	3	98.23	0.00
H1W2H3W3H	2	98.23	0.00
H3O3O3O3O3H	2	98.09	0.00
H2O2S4O4H	2	97.79	0.00
H1W2H3W4H	2	97.34	0.00
H2W4O4O5H	2	96.65	0.00
H2O2H2W3O3H4W4H	2	96.27	0.00
H3O4O5O5H	2	94.45	0.00
H2O3O3O3O3H	1	94.22	0.00
H2O3W4O4H	2	94.00	0.00
H2O3H3O4H4O5H	2	93.24	0.00

Pattern	In Sample	Weighted number	%
H2O2H3O3H4W1H	2	93.18	0.00
H2O2O2O3O3H	2	92.72	0.00
H2W3H3O5H	2	92.72	0.00
H2S3O3S3H	1	92.31	0.00
H2O3H3O4O4H	2	92.28	0.00
O1W5H1O	1	91.53	0.00
H1O2H2O2W4H	2	91.08	0.00
H2O2W4H4O4O5H	1	91.02	0.00
H2O2O4O5H	1	90.82	0.00
H1W1O3W4H	3	90.65	0.00
H2W2O5W5H	2	90.47	0.00
H2O2H2O3O3H4O4H	2	90.32	0.00
H2O5O5H	2	90.20	0.00
H2W4O5O5H	1	89.54	0.00
H1O1H2O3H4O4H	2	88.42	0.00
H2O2O2O3O3O3H	2	88.40	0.00
W1H5W	2	87.77	0.00
H2O2H2O3H4O4H	2	87.44	0.00
H2W3H4O4H4W5H	1	87.18	0.00
H2O2O2S3O3H	2	86.89	0.00
H2O2W3O3W5H	2	86.75	0.00
H2O2O2O2W3O3O3H	1	85.80	0.00

Pattern	In Sample	Weighted number	%
H1O2H2W3H	3	85.37	0.00
H2O2H2O2H2W3O3H	2	85.35	0.00
H1O2H2O5H	2	84.36	0.00
H2O2O3O3O3H	2	84.13	0.00
H2W3H3W3O4H	1	84.01	0.00
H1W2H3W5H	2	83.95	0.00
H2O2H2O2W4O4H	2	83.51	0.00
H1O1H2W4O4H	2	83.18	0.00
H2O2W4H4O4H	2	83.06	0.00
H2O2O2W3O3H3W5H	2	82.42	0.00
H2S3H5O5O	1	81.26	0.00
H1W1O5H	1	80.80	0.00
H2S3O4H4O4H	1	80.71	0.00
H1S3H3O4H	2	80.51	0.00
H2W3O3W4H4O5H	2	80.47	0.00
H2W3H4O4H4W4O4H	1	80.46	0.00
H3O3H5O1H	1	80.35	0.00
H2O2O2H2W3O3O3H3W4H	2	80.13	0.00
H2O2H2O3H3W5H	1	80.02	0.00
H3W3O4W4H	1	79.42	0.00
H1O1H2O2H	2	79.25	0.00
H2O2W4O5O5H	1	79.09	0.00

Pattern	In Sample	Weighted number	%
H2O2H2O3H3W3H4W5H	1	78.91	0.00
H1O1W5H	2	78.62	0.00
H2O3H3O4H4O4H	2	78.41	0.00
H2W2H3O4H4W4H4O4H5O5H	1	78.16	0.00
H2W2O2W3O3W4H	2	78.05	0.00
H2W4H4W4H	2	77.86	0.00
H1O3O4H	2	77.66	0.00
H2O2H2O2W3O3H3W5H	2	77.64	0.00
H2O2O2H2W5H	2	77.62	0.00
H2W4H5W5H	2	77.55	0.00
H2S3O4H4O5H	2	77.47	0.00
H2O2W4O4O4H	2	76.93	0.00
H2W2H3W5H	2	76.76	0.00
H2O3O3H4O5O5H	1	76.70	0.00
H2O2H4O4O4H	2	76.52	0.00
H3O3H3W5H	2	76.52	0.00
H1W3O3H	2	76.41	0.00
H3W5H5O5O5H	1	76.12	0.00
H2O2O2W3O3H4O4H	1	76.00	0.00
H2O2O2H2O3H3O3O3H	2	75.86	0.00
H1O4O4H	2	75.80	0.00
H1O2O3O3O4H	1	75.63	0.00

Pattern	In Sample	Weighted number	%
H2O2O3O3H3O3O4H	1	75.63	0.00
H2O2O2W3O3O3W4H	1	75.44	0.00
H3O3H3O5H	2	75.39	0.00
H2O2O2H2O2H3O3H3O3H4O4H	1	75.13	0.00
H1O2O3O3H	1	75.13	0.00
H2W2O2W3H	2	75.03	0.00
H2O2H3W3O3H4W5H	1	74.78	0.00
W4H5W	1	74.74	0.00
H2O2H3O1H	3	74.73	0.00
H2O2S3O5H	2	74.44	0.00
H2O2W4H4O5H	2	74.33	0.00
H2O2O3W4H	2	73.84	0.00
H1W2H3O3H4O5H	1	72.96	0.00
H2O2O2H3O3H3O4H	2	72.68	0.00
H2W4H5O5O5H	2	72.50	0.00
H2O2O2S3O3O4H	1	72.50	0.00
H2O2W3H3W4H	2	72.43	0.00
H2O2H2W5O5H	1	72.12	0.00
H2O2H2O2H3O3O3O3H3O3H3O3H4O4H	1	72.12	0.00
H2O2H2O2O3H3O3H3O3O4H4O4H	1	72.12	0.00
H2W3H3W4H4O4H	2	71.93	0.00
H2O2O2W3H	2	71.72	0.00

Pattern	In Sample	Weighted number	%
H2W3H3W3H	2	71.66	0.00
H2O2O3O3H4O4H	2	71.48	0.00
H2W3H4O4O4H	1	71.33	0.00
H1O1H2O3H3O4H	2	71.24	0.00
H2O1H	2	71.10	0.00
H2O2H2O2H3O3H4W5H	1	70.94	0.00
H1O1W4O5H	2	70.91	0.00
H3O3H4O	2	70.55	0.00
H2W2O3H3O3H3O3H3O4H	1	70.47	0.00
H1O3O	2	70.42	0.00
H2O2O2H2O4H	2	69.95	0.00
H2W2O3W3H	2	69.85	0.00
H2O2O2H3W4H	1	69.85	0.00
H1O1W4H	2	69.73	0.00
H2O3H3O3H3O4H	2	69.69	0.00
H2O3H3O4H5O5H	2	69.68	0.00
H2W5O5O5H	1	69.66	0.00
H2O2H2W3O3W3H	1	69.66	0.00
H1O2O2H3W3O3W4H	1	69.47	0.00
H1O3H3O5H	2	69.46	0.00
H3W3O3H	2	68.89	0.00
H2O2H2W4H4O5H	2	68.88	0.00

Pattern	In Sample	Weighted number	%
H1O2H2O2H3O3H	2	68.76	0.00
H2O5O5O5H	2	68.60	0.00
O3W5O	1	68.37	0.00
H2W2H2W3H	2	68.33	0.00
H1O1H2W4H5O5H	2	68.05	0.00
H2O2W4O4H4W5H	2	67.72	0.00
H2W2O3O3H	1	67.65	0.00
H2W3O3W3H4W5H	1	67.65	0.00
H2S3O3O4O4H	2	67.64	0.00
H2S4H5O5H	2	67.58	0.00
H2O2H3O3H3O5H	2	67.31	0.00
H2O2W3O3H4O4W4O4H	1	67.26	0.00
H3O4O4O4H	1	67.09	0.00
H1W3H3W3O4H	1	66.85	0.00
H1W2H2O2H3O3H4W5H	1	66.85	0.00
H2O2H3O3H3O3H4O4H	2	66.70	0.00
H2O2H2O2H3O3O3H3O3H3O3W4O4H	1	66.22	0.00
H2O3H4W5H	2	66.14	0.00
H2O5H5O5H	2	66.14	0.00
H2W3O3W3H3O3H4O4H4O4H	1	66.10	0.00
H3O3H4O5O5H	2	66.06	0.00
H3W3H4W4H	2	65.96	0.00

Pattern	In Sample	Weighted number	%
H2O2H2O2H2O2H3O3H	2	65.81	0.00
H2W4H4O4W4O4H4W5H	1	65.76	0.00
H2O2O2O2O2H	1	65.59	0.00
H2O2O2O2S3H	1	65.59	0.00
H2O2O3H3O4H	1	65.36	0.00
H2W2O2O2O3O4H	1	65.33	0.00
H2W3O3O3H3W4H	1	65.33	0.00
H2O2O2O2H2W4H	1	65.33	0.00
H2W3H3O3O3H	1	65.22	0.00
H2O3O3O3O4H	1	64.83	0.00
H4O4O4H5O5H	2	64.83	0.00
H1O3H3O4H4O4H	1	64.78	0.00
W3H3W4H1W	1	64.78	0.00
H2O2W4H4O5O5H5O5H	1	64.67	0.00
H1O1H1W4H5O5H	1	63.96	0.00
H3O3H4O4O4H	1	63.80	0.00
H2W2H2O2H3O3H	2	63.69	0.00
H2O2W3H4O4H	1	63.52	0.00
H2O2O2W4O5H	1	62.75	0.00
H2O2O2W3O3W5O5H	1	62.75	0.00
H2S3H4O4O4H4O4H	1	62.35	0.00
H1O2H2O2H2W3H4W5H	1	62.02	0.00

Pattern	In Sample	Weighted number	%
H2O2H3O3O4H4O4O4H	1	61.95	0.00
H2O2W2O3O3O3H	1	61.85	0.00
H2W3O3O3O3W4O5H	1	61.82	0.00
H2W3O3O3W4H	1	61.82	0.00
H2W3O3O3W4O5H	1	61.82	0.00
H1W3O3W3H4W5H	1	61.58	0.00
H3W3O4H4O5H	1	61.56	0.00
H2O2H2O4H4O4H	2	61.55	0.00
H3O3H4W4H5O5H	1	61.46	0.00
H1O1H2O2H2O3H3O5H	1	61.21	0.00
H1O3H3O3H	2	61.21	0.00
H2O2H3O3H3O3H5O5H	1	61.12	0.00
H2O2H2O3O3O3H	1	60.79	0.00
H2O2O3O5H	1	60.40	0.00
H2W3H3O4H4O4H	1	60.20	0.00
H2O2O2O2W3O3O3O4H	1	60.19	0.00
H2O3O3O4O4H	2	59.96	0.00
H2O2H3O3H3O3O4H	1	59.82	0.00
H2O3O3W4O4W4O5O5H	1	59.82	0.00
H2W3O3O3O3W4O4W4H	1	59.82	0.00
H2O3S3H	1	59.29	0.00
H2O2O2O3W4H5O5H	1	59.29	0.00

Pattern	In Sample	Weighted number	%
H2W3O4W4H	2	59.28	0.00
H2O2H2W4H4W5H	2	58.93	0.00
H2O3H4O4O4H	1	58.80	0.00
H2O2H2W3H4W4H	1	58.80	0.00
H2O2O3H3O5H	1	58.80	0.00
H1S3H4O4O5H	1	58.71	0.00
H1O1H2O4O4H	1	58.69	0.00
H1O1H2O5H	1	58.69	0.00
H2O2H2O3H3O4H5O5H	1	58.69	0.00
H1O1H1W5H	1	58.69	0.00
H4O5H5O5H	2	58.57	0.00
H1W2O4W4H	1	58.51	0.00
H2W2H3W3H4O5H	1	58.51	0.00
H2O2H2W3O3O3O3H	1	58.23	0.00
O2H5O	2	58.20	0.00
H2W3O5H	1	58.13	0.00
H2S3H3O3H	1	57.91	0.00
H2O2W3O3H4W4H4O4O5H	1	57.89	0.00
W2H4O4W	1	57.76	0.00
H3O3O3H4O4O4H	1	57.59	0.00
H1S3O3H	1	57.52	0.00
H1O1H4O4H	1	57.37	0.00

Pattern	In Sample	Weighted number	%
H2O2H4O4O4H4W	1	57.22	0.00
H1O3H4O4O4O4H	1	57.17	0.00
H2O2H2O4O4H	1	57.17	0.00
H2W2H2O3H4W4H	1	57.03	0.00
H1W4H5O5O5H	1	57.03	0.00
H2O3H4O5O5H	1	57.03	0.00
H2O2W3O3W3O3H4W4H	1	57.02	0.00
H2O2H2O2O3H4O4H	1	56.97	0.00
O3W4O	1	56.82	0.00
H2W2O3O4H	1	56.70	0.00
H2O5W4H	1	56.68	0.00
H1O1H3W1H	1	56.21	0.00
H1O3O3H	1	56.03	0.00
H2O2S3O3O4H	1	55.84	0.00
H2S3H3O4O4O4O4H	1	55.82	0.00
H2W3H3W3H3W4H	1	55.81	0.00
H1O1H2W3H3W4H	1	55.81	0.00
H2O3W5H	1	55.58	0.00
H2O2H2O2W3O3H	1	55.23	0.00
H2O2O2O2W4O4O4O4H	1	55.00	0.00
H2O2O2S4O4O4H	1	55.00	0.00
H2O2O2H2W3O3H4W5H	1	55.00	0.00

Pattern	In Sample	Weighted number	%
H2O2O2W3O3O3H3W4H	1	54.56	0.00
H5S1H	1	54.00	0.00
H2O2W2O3W3O4W4H	1	53.86	0.00
H3O3W3H	1	53.86	0.00
H2H3H3H4H	1	53.82	0.00
H2O2H2O2H2O3H3O3H3O4H5O5H	1	53.43	0.00
H1O1H2S3H3O4H	1	53.43	0.00
O2S3O4O4O	1	53.37	0.00
H1O2H2W3H4W5H	1	53.32	0.00
H3O3H3O3O3O3O4O4O4O5H	1	53.25	0.00
H2O3W3O4H	1	53.02	0.00
H1O1H2O2W4H	1	52.50	0.00
O2O3O3O	1	52.39	0.00
H2O3O3O3O3O4H	1	52.21	0.00
H2O2W3H3O3H3W3H3O3O3H3W5H	1	52.17	0.00
H3O1H	1	52.17	0.00
H1O2H2O3H4O5H	1	52.13	0.00
H2O2O2W3O3H3O3H3W5H	1	51.97	0.00
H2O2H2O2H3O3H4O5H	1	51.97	0.00
H2O2O2O3O3H4O4H	1	51.97	0.00
H2W3H4W4O5H	1	51.87	0.00
W3H3O3O3H5O5H1W	1	51.76	0.00

Pattern	In Sample	Weighted number	%
O2O3O4O4H	1	51.67	0.00
H2O2S3H3O4H	1	51.63	0.00
H2O2O3H4O4H	1	51.29	0.00
H1O2O2H	2	51.15	0.00
H2W2H2O2O2W3H3O3O3H	1	51.11	0.00
H3O3H3O4O4H	1	51.09	0.00
H2O2H2O2H2W3O3H4W5H	1	51.09	0.00
H2W3H3O4H4O5H	1	51.09	0.00
H2O2O2H3O3H3O3H4O4H	1	51.09	0.00
O2W3H	1	51.09	0.00
H2O3H3O4W4H	1	51.00	0.00
H2W2H2O3H4O4H	1	51.00	0.00
H2W3H3O3H3O3H4O4H5O5H	1	50.49	0.00
H1W2H2O2W2H2W3O3H3W4H4O4W4O4H4W5H	1	50.49	0.00
H2O3H3O3H4O4H4O4H	1	50.49	0.00
H2O4O4H5O5H	1	50.49	0.00
H2S3H3O3O4H	1	50.49	0.00
H2O2H2O2H3O5H	1	50.49	0.00
H3O3H4O5H5O5H	1	50.49	0.00
H2W2O2W3H3W5H	1	50.49	0.00
H2O2O2H3O3O3H5O5H	1	50.31	0.00
H2O2H2W3H4O4H4W4O4H	1	50.30	0.00

Pattern	In Sample	Weighted number	%
H1O1H2O2H2W3O3H	1	50.30	0.00
H1W2O2O3W4O4W5H	1	50.06	0.00
H1W2H3W3H4W4H	1	49.21	0.00
H3O3O3O3O4O4H	1	49.15	0.00
H2W2H2O2W3O3H3O3W4O4H4W5H	1	48.95	0.00
H1W3H4O4H4W5H	1	48.95	0.00
H2O2H3W3H	1	48.67	0.00
H2W3H3O3W5H	1	48.67	0.00
H1W2H2W3H	2	48.66	0.00
H1O2H2O3H3O3H	1	48.32	0.00
H2O2H4O5H5O5H	1	48.17	0.00
H2O2H2W3O3H5O5H	1	48.00	0.00
H2O2H2O3H3O4H	1	48.00	0.00
H1O1H2O2H2O2H3O3H4O4H4O4H4O4H5O5H	1	47.84	0.00
H1O2H3O3O4H	1	47.84	0.00
H2O2W2O3W3H	1	47.84	0.00
H3O3O4O5H	1	47.67	0.00
H2O3O3O3W4O4W5H5O1H	1	47.67	0.00
H2O2H3O4H5O5H5O5H	1	47.41	0.00
H2W4O4O4H5O5H	1	47.41	0.00
H2O2H3O3H4W4H	1	47.33	0.00
H2O2H2O2H2O2O3O3H3O4H	1	47.33	0.00

Pattern	In Sample	Weighted number	%
H5O5O5H	1	47.28	0.00
H2O2W3O3H3W4O4W4O4W5H	1	47.04	0.00
H2O2O3O3O4O4H	1	47.04	0.00
H2O2O2H2W3O3H3W5H	1	47.04	0.00
H2H3H	1	46.84	0.00
H2O2H2O2H3O3H3O3O3O4H	1	46.84	0.00
H3O3O4H5O5H	1	46.78	0.00
H2O2O2W3O3H4O5H	1	46.05	0.00
H2W2O3W3H3W4H	1	46.04	0.00
H2O2H2O2H4W1H	1	46.04	0.00
H2W3H3O3O3W4H	1	45.86	0.00
H2O2O2H3O3O3H4O4H4O4H	1	45.76	0.00
H3O3O3O3H4O4H	1	45.40	0.00
H2O2W2H	1	45.35	0.00
H2W2O4H5O5H	1	45.34	0.00
H2O3S4H	1	45.29	0.00
H2O2H3O3H3W4H	1	45.13	0.00
H2O2H3O4O5O5H	1	45.08	0.00
H2O2H3O3H3O3H3O3H4O4H4W5H	1	45.08	0.00
H2W3H4O4H5O5H	1	44.92	0.00
H2O2O2H2W3H3W5H	1	44.85	0.00
H5W3H	1	44.85	0.00

Pattern	In Sample	Weighted number	%
H1W2O2O2W3H	1	44.84	0.00
H2O2H2W3O3H3O3H3W4H	1	44.78	0.00
H2O2H2W3H3O3H3W5H	1	44.75	0.00
H1O1H3W5H	1	44.75	0.00
H2W3H3O4O4H5O5H	1	44.75	0.00
H2O2O2O2H4O4H	1	44.75	0.00
H1O1H3O3H5O5H	1	44.75	0.00
H2W4H4W	1	44.75	0.00
H1O3W5H	1	44.63	0.00
H2O2H2O2O5H	1	44.49	0.00
O2W3O	1	44.40	0.00
H2W2H2O3H	1	44.34	0.00
H2O3O3H4O5H	1	44.34	0.00
H2O2H2O2H3O3O3H4O4H	1	44.34	0.00
H2O2O2W3H4W5H	1	44.21	0.00
H2O2O3O3H3O3H	1	44.17	0.00
H3O3O3H4O4O4O4H	1	44.11	0.00
H3S4O	2	44.05	0.00
H2O3O3O3O4O4O5H	1	43.90	0.00
H1O1H1S4H5O5H	1	43.77	0.00
H1O1H1S4H	1	43.77	0.00
H3O3O3O3W4O4W5H	1	43.66	0.00

Pattern	In Sample	Weighted number	%
H2O2O3O3O4H	1	43.66	0.00
H2O2W3H3O3O3O4H	1	43.65	0.00
H2O2W1H	1	43.65	0.00
H2W3O3H4O4H	1	43.65	0.00
H3W4O5H	1	43.48	0.00
H2O2H4W4H	1	43.37	0.00
H1W1O2W4H	1	43.37	0.00
H2W1H5O5H	1	43.17	0.00
H2O2W2O3W4O4H	1	43.12	0.00
H1O2H2W4H5O5H	1	43.12	0.00
H2O2H2O5H5O5H5O5H	1	43.09	0.00
H2O2H2W	1	43.03	0.00
H2S3H3O4H5O5H	1	42.92	0.00
H1W3O4W4H	1	42.88	0.00
H1O2H3O5H	1	42.85	0.00
H1O2W4O4H	1	42.83	0.00
H3O3H3O3O4H	1	42.76	0.00
H2W2H4O4H	1	42.71	0.00
H2O2S3O3H4O5H	1	42.71	0.00
H2O2O2H3O3H4O5H	1	42.71	0.00
H2O2H2O2H2O3H4O4H5O5H	1	42.67	0.00
H2W2H2O2H2W3H3O3H3W5H	1	42.60	0.00

Pattern	In Sample	Weighted number	%
H2S2H3S4H	1	42.50	0.00
H1W2O2W5H	1	42.46	0.00
H2O2O2H2W3H3O3H	1	42.35	0.00
O2S3O4O	1	42.35	0.00
H2O2H3W4H4O4H	1	42.27	0.00
H2O2W2O2W4H	1	42.23	0.00
H1O1H2W4H4W5H	1	42.23	0.00
H1W3O3H4W5H	1	42.22	0.00
H2O2O2O3O3O5H	1	42.22	0.00
H2W4H4O5H5O5H	1	41.88	0.00
H1O1O1H	1	41.88	0.00
W3H5W	2	41.80	0.00
H3W3O3H3W5H	1	41.72	0.00
O2S3O3S4O	1	41.65	0.00
H1O1H3O4H	1	41.65	0.00
H1O2H2O3H3O4H	1	41.60	0.00
H2O2H2O3O3O4H	1	41.55	0.00
H2O2H2O2W3O3H3O3H3W5H	1	41.47	0.00
H1O2H4O5H	1	41.46	0.00
H2W3H3W4H4O4H5O5H	1	41.43	0.00
H2O2O2O3H3O3H	1	41.33	0.00
H2O3H4O4H5O5H	1	41.23	0.00

Pattern	In Sample	Weighted number	%
H2O2O2W3H4O4H	1	41.22	0.00
H2O2O2W3O3H4W5H	1	41.17	0.00
H2O2W3O3H3W3H4W5H	1	40.87	0.00
H1W3O3W4H	1	40.87	0.00
H3O3W4O5H	1	40.52	0.00
H1O3O4O4H	1	40.48	0.00
H3O4H5O1H	1	40.48	0.00
H2O2O2H3O3O3H3O3H	1	40.46	0.00
H2W2H2O2H2W5H	1	40.12	0.00
H1W3O5H	1	40.12	0.00
H2O2H2O3O3H4O5H	1	40.12	0.00
H2O2W2O3W4H	1	40.03	0.00
H1O2H3O4H4O5H	1	39.96	0.00
H2O2O2O2H3O3H	1	39.93	0.00
H1O1H2O2H2W3O3H3W4H4W5H	1	39.88	0.00
H2O2H2O2W3O3H5O5H	1	39.88	0.00
H2W4H4O4W5O5H	1	39.77	0.00
H1W2O2H	1	39.63	0.00
H2O3H4O4W5H	1	39.47	0.00
H2O2H2O2O2H	1	39.41	0.00
H2O2H2O2O4H4O5H	1	39.38	0.00
H2O2H3O3O3H4O5H	1	39.38	0.00

Pattern	In Sample	Weighted number	%
H1O2O2W3O3H4O4H	1	39.38	0.00
H2O2O2O2H3O3O3O3H	1	39.33	0.00
H2W4H5O3H	1	39.32	0.00
H2O2O5O5H	1	39.26	0.00
H2O2H2O2H2W3O3H3O3H	1	39.22	0.00
H2W2O2W3H3W4H	1	39.21	0.00
H2O2W3H4O5H	1	39.10	0.00
H2W3H3W5O5H	1	39.10	0.00
H1W4H5W5H	1	39.10	0.00
O2O4H	1	39.04	0.00
H2S3O3O3H	1	38.72	0.00
H1W2H3O3H4O4H	1	38.52	0.00
H2O2W3O3O3H	1	38.50	0.00
H2O2H2O2H3O3H3O4O4H	1	38.42	0.00
H2O2H2O2H2O2H3O3H3O3H4O4H	1	38.35	0.00
W2H2O2H4W	1	38.35	0.00
H2W3H3O3H4W5H	1	38.35	0.00
H2O2W5H5O5H	1	38.35	0.00
H2O2W2O2W3O3H	1	38.31	0.00
H2O2H2O2O2O2W3O3H3W5O5H	1	38.30	0.00
H2O2H3O3H3O5H5O1H	1	38.16	0.00
H2W2H3O3W4H	1	37.96	0.00

Pattern	In Sample	Weighted number	%
H2O3H3O4H4W4H	1	37.96	0.00
H2W3H3W4H4O5H	1	37.96	0.00
H2O2W3H3O4H	1	37.96	0.00
H1W1H2W3H4W5H	1	37.87	0.00
H2S2H	1	37.85	0.00
H3W3H3O3H	1	37.82	0.00
H3W4H4O5H	1	37.72	0.00
H2O2O2H2O2H3O3O3O3H4O4H4O4H4O4H	1	37.72	0.00
H2S4O4O4H	1	37.62	0.00
H1O1H2O2H3O3H5O5H	1	37.60	0.00
H1O2H2O3O3O3H	1	37.60	0.00
H2W3O3W3O4O4W5H	1	37.44	0.00
H2O2O2H3O3O4O4H	1	37.21	0.00
H2S3H4O5O	1	37.14	0.00
H2O3W3H	1	37.09	0.00
H1O2H2O2H3O3H3O5H	1	37.09	0.00
H1O1H3O3H4O4H4O5H	1	36.94	0.00
H2O2O2H4O4O5H	1	36.92	0.00
H2O2O3H3O4O4H	1	36.87	0.00
H2O2H2O2O3O3H	1	36.87	0.00
H2O3H3S3H	1	36.87	0.00
H2O2H2O2O2H2O3O3H3O4H4O4O4H4O5H5O5H	1	36.87	0.00

Pattern	In Sample	Weighted number	%
H2O2H2O2H2O3O3H3O4H	1	36.87	0.00
H2O2H3O	1	36.87	0.00
H2O2H2O2W4H4O5H	1	36.74	0.00
H2O2W2O3W4H4O5H	1	36.74	0.00
H2W4H4O4O5H	1	36.74	0.00
H2O2W3O3H4O4W4O4H4W5H	1	36.74	0.00
H2O3H4O5H5O5H	1	36.72	0.00
H1O2H2O2O2H2W3H	1	36.71	0.00
H3O3H3O3O3H	1	36.71	0.00
H2O2H4O4H4O5H	1	36.71	0.00
H2O2W3O3W4O4W5O5H	1	36.66	0.00
H1W2H3O4H	1	36.64	0.00
H2O3O4H5O5H	1	36.62	0.00
H2O3H3O3H3O3H4O4H4O5H	1	36.62	0.00
H2S3O4H5O5H	1	36.52	0.00
H1O1O5H	1	36.49	0.00
H1O2O2H3O4H	1	36.49	0.00
H2W3H4O4H4O5H	1	36.49	0.00
H2O4O4O4H	1	36.49	0.00
O4H1O	1	36.49	0.00
O2O2H3O3H	1	36.49	0.00
H2O2O2W4H4W5H	1	36.43	0.00

Pattern	In Sample	Weighted number	%
O2H2O3H3O	1	36.43	0.00
H2O2O2H2W3H3O3O3H	1	36.43	0.00
H2O2W3O3W3H4W5H	1	36.43	0.00
H1W1O2W3H3W4H	1	36.38	0.00
H3O3W5H	1	36.29	0.00
H2O3W4O5H	1	36.21	0.00
H2W2O2W	1	36.21	0.00
H2O3O3W4H	1	36.20	0.00
H2W2O3W4H4W5H	1	36.20	0.00
H2W4O5W5H	1	36.20	0.00
H2O2H2O2H2W3O3H4O4H4O5H	1	36.19	0.00
H2O4H5O1H	1	36.19	0.00
H2O2H2O2H2O3H	1	36.04	0.00
H2O2O2H2W3O3H	1	36.04	0.00
H2O2O2O2W3H3W5H	1	35.71	0.00
H1O1H2W4H4O4H	1	35.71	0.00
H1W1O5W5H	1	35.30	0.00
H5H3H	1	35.29	0.00
H2O2O2H2O3O3H3O5H	1	35.24	0.00
H2S3O5S5H	1	35.24	0.00
H2S4H4O5O5H	1	35.24	0.00
H2W3H3W5H5O5H	1	35.02	0.00

Pattern	In Sample	Weighted number	%
H2S3H3O3O3H	1	34.97	0.00
H2O2H2S4H	1	34.88	0.00
H2O2H2O2H2W3O4H4O4H4O5O5H	1	34.88	0.00
H2O2H2O3H3O4H4O5H	1	34.88	0.00
H2O2H3O3H3O4H4O5H	1	34.88	0.00
H2O2H2O2W2O5H	1	34.88	0.00
H2O3O3H5O5H	1	34.75	0.00
H2O2H3O3O3H3O4H4O5H	1	34.70	0.00
H1O2H4O4H5O5H	1	34.70	0.00
H2O3H3O3H3O5H	1	34.70	0.00
H1O2O3O4O5H	1	34.70	0.00
H1O3H4O4H4O4H	1	34.70	0.00
H2O2H2O2W3O3H3W4H	1	34.69	0.00
H3O1O3H	1	34.60	0.00
H1O2H2O2H	1	34.60	0.00
H2O2O2W5O5H	1	34.54	0.00
H1O2H2W4H4O5H	1	34.54	0.00
H2W2H2W4H	1	34.54	0.00
H3O4H4O5O5H	1	34.54	0.00
H3O4H5O	1	34.54	0.00
H1W3O3H5O5H	1	34.54	0.00
H1W2O2W3H4W5H	1	34.54	0.00

Pattern	In Sample	Weighted number	%
H2O2W3O3W4H	1	34.54	0.00
H2O2O2O3O3H3O3H	1	34.50	0.00
H2W3H4W5H5W1H	1	34.25	0.00
H1W2H2O2W3O3H3W3O3H3W5H	1	34.25	0.00
H2O2H3O3O3H4O4H5O5H	1	34.25	0.00
H3O3O3H3O3H4O4H	1	34.15	0.00
H2O2H3O3H3W1H	1	34.02	0.00
H2W2H2O2O2W5H	1	33.99	0.00
H2O3H3O3H3O3H	1	33.78	0.00
H2O2H2O4H5O5H	1	33.78	0.00
H1O2O2H3O3H3O3H	1	33.78	0.00
H1W3H4O4H5O5H	1	33.78	0.00
H2O2H2W4O5H	1	33.78	0.00
H2O2O2O2H3O3H3O3O3H	1	33.71	0.00
H4O4H4W	1	33.71	0.00
H2W3O3H3W3H4W4O4H	1	33.68	0.00
H2O2H2W5H5W5H	1	33.67	0.00
H2O2H4O4O5H	1	33.66	0.00
H2W2H2W3H3W5H	1	33.64	0.00
H2W3H3W4H5W5H	1	33.54	0.00
H2O2H2O2O2H2O3H3O3H3O3H	1	33.54	0.00
H2O2O2W3O4H	1	33.50	0.00

Pattern	In Sample	Weighted number	%
H2W3O4H4O5O5O5H	1	33.50	0.00
W2H2O2H4O4H5W	1	33.41	0.00
H1W2H2W5H	1	33.39	0.00
H2O2H2O3H3O3H4O4H4O4H	1	33.38	0.00
H2W2O3O3W4O5H	1	33.38	0.00
H1O2O3H4O4H	1	33.38	0.00
H2O2H2O2O4H	1	33.19	0.00
H2O2H2O2H2W1H	1	33.19	0.00
H2O2H2O2H2O2H3O3H3O4H	1	33.18	0.00
H1S2O3O4S5H	1	33.14	0.00
H2O2W3H3W5O5H	1	33.12	0.00
H2O3O3O3H3O3H	1	33.00	0.00
H1O1H2O2H2W5H	1	33.00	0.00
H2O2W3O3H3O3O3H3W4H4W5H	1	33.00	0.00
H2W2H2O2W3O3H3W5H	1	33.00	0.00
H2W2H2O3W5H	1	32.91	0.00
H2O2H2O2W3O3H3W3O3H3W5H	1	32.90	0.00
H2O2H2W3O4H4W5H	1	32.88	0.00
H1O2H2O2O2H2O2H	1	32.88	0.00
H1W1O2O3W3H	1	32.80	0.00
H2O2O3H5O5H	1	32.75	0.00
H2O2O2H2O3H3O3H	1	32.42	0.00

Pattern	In Sample	Weighted number	%
H2O2O2H4O5H	1	32.42	0.00
H3O3O3H4O4O5H	1	32.42	0.00
H3S4H4O5H	1	32.42	0.00
H2O2H3O3H4O4H4O4H5O5H	1	32.41	0.00
H2W2H5O5H	1	32.41	0.00
H2O2H2W3H3O3H3O3H	1	32.20	0.00
H2O2H2O2H2O2H2W4H	1	32.20	0.00
H1O1H2O4H	1	31.88	0.00
H2W3H3O3H3O3H	1	31.84	0.00
H2O2H2W3O3H4O4W4O4H	1	31.84	0.00
H2O2H3W3H3O3H4O5H	1	31.84	0.00
H2O2H1O1H	1	31.82	0.00
H2W2H3O4H	1	31.81	0.00
H1W1O2W3H	1	31.81	0.00
H2O2W2O4H	1	31.81	0.00
H2O2H2O2H2O3O3H3O3H3W5H	1	31.75	0.00
H2W3H3O3H3W5H	1	31.73	0.00
H2O2O2W3O3O3H4W4H	1	31.64	0.00
H4S5O5H	1	31.64	0.00
O3O3H	1	31.56	0.00
H3O4O4H4O5H	1	31.56	0.00
H1W3H3O4H	1	31.55	0.00

Pattern	In Sample	Weighted number	%
H2O2H3O3H3O3H4O4O4H4O4H	1	31.55	0.00
H1O3O3O4H	1	31.55	0.00
H2H5H	1	31.51	0.00
H2W2H2O4H	1	31.35	0.00
H2O2H2O2H2O3O3H4O5H	1	31.35	0.00
H2W3O3W4H5O5O5H	1	31.35	0.00
H1O4H5O5H	1	31.28	0.00
H2O2H3O3H4O4H5O5H	1	31.20	0.00
H1O2H2O3O3H4O4H	1	31.10	0.00
H2W3H4O4W5H	1	31.10	0.00
H2O2H2O2H2W3H3W4H	1	31.10	0.00
H2O2H2O2W3H4O4H	1	31.10	0.00
H2O2H3O3H3O3H3O4H	1	31.10	0.00
H4O4W5H	1	31.10	0.00
H4O4H4O5O5H	1	31.10	0.00
H2W4O4O4W5H	1	31.10	0.00
H2W3O3W3O3W4H	1	31.05	0.00
H2O4S3H	1	31.03	0.00
H2O2H2O2O2W4O4H	1	31.02	0.00
H4O4H5O1H	1	30.97	0.00
H3O3O3O5O5H	1	30.97	0.00
H3S4H5O5H	1	30.88	0.00

Pattern	In Sample	Weighted number	%
H2W3O3H4O4H4O4H	1	30.88	0.00
H2O2H2O3H3O3H3O4H	1	30.84	0.00
H3O4H4O4O4H5O5H	1	30.76	0.00
H1W3O4O4H	1	30.76	0.00
H2O2O3O3H5O5H	1	30.76	0.00
H2O2H2O2H2W3H3O3H	1	30.76	0.00
H2W2H2O2W3O3H4W4H4O4W5H	1	30.76	0.00
H2O2H2O2H3W3O3H3W5H	1	30.76	0.00
H1O2H3W5H	1	30.76	0.00
H2W2H2W3H3W4H	1	30.57	0.00
H2W3O3O3W3H	1	30.56	0.00
H1W2H3O3H3W5H	1	30.27	0.00
H1O1W4O4H	1	30.25	0.00
H2O3H3O4O5H5O5H	1	30.17	0.00
H2O2H2W3H3O3O4H	1	30.09	0.00
H2O3O4O5H	1	30.09	0.00
W4H4W	1	30.09	0.00
H1O3O5H	1	30.08	0.00
H3O3O4O4O4O4H	1	29.95	0.00
H2W3O3O3H4O4O5H	1	29.71	0.00
H1O1H2O2H2O3H3O3H3O3H3O3H4O4H	1	29.71	0.00
H2O2O2O5H	1	29.61	0.00

Pattern	In Sample	Weighted number	%
H5O5O5O5O5O5H	1	29.51	0.00
H3O3H4O4H5O5H	1	29.51	0.00
H1S3H5O5H	1	29.51	0.00
H1O2W	1	29.48	0.00
H2W2O3W3O3H	1	29.23	0.00
H2W3H3W3H4W5H	1	29.23	0.00
H2W3H3W3H3W5H	1	29.23	0.00
H2O3H3O3H4O5H	1	29.06	0.00
H2O2H2O2H3O3H3O3H3O3H4O4H	1	28.95	0.00
H2S3H4H	1	28.88	0.00
H2W3O3W3H3W5H	1	28.29	0.00
H2S2O4O4H	1	28.29	0.00
H2W3O3W4O4W4H5O5H	1	28.29	0.00
H2O2H2W3O3W5H5O5H	1	28.29	0.00
H2O2W2H2W3O3H3O3H4W5H	1	28.10	0.00
H3W4O4H	1	28.10	0.00
H1O1W3H	1	28.04	0.00
H3O3O3H3O3H	1	27.91	0.00
H2O2W3H3O3O4H	1	27.74	0.00
H2O2H2W3O3O3H3W4H	1	27.57	0.00
H2W2O2H3O3H4W4H	1	27.57	0.00
H2W2H2O2H2W4H4O5O5H	1	27.57	0.00

Pattern	In Sample	Weighted number	%
H1O2H3O4H	1	27.57	0.00
H2O2W3H3O4W5H5O5H	1	27.57	0.00
H1W2H4O4H	1	27.48	0.00
H2O2O3O3H4W5H5O5H	1	27.35	0.00
H2W3H3O3H4W4H	1	27.01	0.00
H2O2H2O2H2H4H4O4H	1	26.91	0.00
H1O2H3O1H	1	26.88	0.00
H2O2O3O4O5O5H	1	26.26	0.00
H2O2H2O2H3O3H3O3H3O3H	1	26.20	0.00
H1W2H3O3H	1	26.18	0.00
H2W3O3W3H4W4H	1	26.18	0.00
H2O2O4O4H5O5H	1	26.18	0.00
H1O3H3O4H	1	26.18	0.00
H1O1H4O5H	1	26.13	0.00
H1W2H4W4H	1	25.90	0.00
H1O4H4O4H	1	25.88	0.00
H1O2H2O3H4O4H	1	25.78	0.00
H2O2H2O2H5O5H	1	25.11	0.00
H2O2H2O3O3H3O5H	1	25.05	0.00
H5O5H1O1H	1	24.91	0.00
H2O2H3O3H4O1H	1	24.82	0.00
H2W2O2H2O3W5H	1	24.55	0.00

Pattern	In Sample	Weighted number	%
H2O2H2O2H2O2H3O3O3O3O3O3O3H4O4H4O4H	1	24.47	0.00
H1W5H5W	1	24.47	0.00
H2O2O2W3O3H3O3H4W5H	1	24.43	0.00
H1O2H2O2H3O3H3O3H4O5H	1	24.29	0.00
H1W4H4O4O5H	1	23.63	0.00
H4O4H4O4H5O5H	1	23.49	0.00
H2O3H3O3H4O	1	22.92	0.00
H1O1H2O2H5O5H	1	22.87	0.00
H1O1H2W3H3W5H	1	22.70	0.00
H2O4O	1	22.70	0.00
H1W3H5O5H	1	22.49	0.00
W3H4O4H5O5H1W	1	22.49	0.00
H2O2H4O5O5H	1	21.63	0.00
H2O2O2H2W3H3O3O3H4W5H	1	20.90	0.00
H2O2H2O2W3O3H3O3H4W5H	1	20.90	0.00
H2O2H2O2H2O3H3O4H4O4O4H	1	20.90	0.00
H2O4H4O4H5O5H	1	20.90	0.00
H2O2H3O5W	1	20.90	0.00
H4O4H4O4H5W	1	20.90	0.00
H1O2H2S3H4O4H	1	20.77	0.00
H2S3H3O4H4O4H	1	20.77	0.00
H3W3H4W1H	1	18.58	0.00

Pattern	In Sample	Weighted number	%
H3H3W	1	18.58	0.00
H1W2O2O3W5H	1	18.58	0.00
H2W2H2W3O3H4O5H	1	18.58	0.00
H2W2O2O2W4O5O5H	1	18.40	0.00
H2O2H4O4H4O5H5O5H	1	18.40	0.00
H2O2H3W3H3O3H	1	18.40	0.00
H3W3O3H3W3H	1	18.40	0.00
H2O2H3O3H3O3H3O4H4O4H	1	18.38	0.00

Appendix – II: Activity Pattern Distribution in Groups

Work Pattern Groups

Pattern Group	Pattern	%
1 Work Tour Full time both peak (22)	H2W4H	100.00
1 Work Tour Full time one /no peak (20)	H2W5H	65.87
	H1W4H	24.42
	H1W5H	9.70
1 Work Tour Part time (23)	H2W3H	61.92
	H1W3H	17.46
	H3W5H	9.80
	H3W4H	4.73
	H2W2H	1.52
	H4W5H	1.50
	H3W3H	1.29
	H1W2H	1.19
	H4W4H	0.29
	H2W1H	0.21
	H1W1H	0.10
2+ Work tours (29)	H2W3H3W4H	9.22
	H2W3H3W5H	7.41
	H2W4H5O5H	7.37
	H2W3H4W5H	7.22
	H2O2H2W4H	5.12
	H2W4H4O5H	3.61
	H2W3H4O4H	2.74
	H2O2H2W5H	2.48
	H2O2W3O3H3W5H	2.07
	H2O2W3O3H3W4H	1.98
	H2W4H4O4H	1.86
	H2W3H4W4H	1.67
	H2O2W3O3H4W5H	1.23
	H1W3H4W5H	1.14
	H2W3H4O5H	1.13
	H2O2H2W3O3H3W5H	1.12
	H2O2H2W3O3H3W4H	1.01
	H2W3H3O4H	0.99

Pattern Group	Pattern	%
	H1W3H4O4H	0.97
	H2W4H4W5H	0.67
	H1O1H3W4H	0.62
	H2W5H5O5H	0.61
	H2O2H2W3H4W5H	0.57
	H2W2H3W3H	0.57
	H2O2H2W3O3H	0.54
	H2O2H3W4H	0.51
	H1O1H2W4H	0.49
	H1W4H5O5H	0.48
	H2O2H2W3O3H4W5H	0.46
	H1W3H3O3H	0.46
	H2W3O3H3W4H	0.44
	H3W4H4O4H	0.42
	H2W3O3H3W5H	0.40
	H2O2W3O3H4W4H	0.40
	H2W3H3O3H	0.38
	H2O2H3O3H3W5H	0.38
	H1O2H2W4H	0.38
	H1W3H4O5H	0.37
	H2O2W3H3W5H	0.36
	H1W3H3W5H	0.34
	H2W3O3H4W5H	0.33
	H2O2H2W3H3W5H	0.33
	H3W3H4W5H	0.32
	H2W2H4W5H	0.31
	H2W3H5O5H	0.30
	H2O2W3H4W5H	0.30
	H2O2H2W4O4H	0.29
	H2O3H3W4H	0.28
	H2O2H2W3H3O3H3W4H	0.28
	H2W3H3W4H4W4H	0.28
	H2O2H2O2H2W5H	0.27
	H2W2H2W3H4W5H	0.26
	H1W4H4O5H	0.25
	H2O2H2W3H3O3H	0.25
	H2W3H4W5O5H	0.25
	H2O2W4O4H5O5H	0.24
	H2O2O2W3O3H3W4H	0.24

Pattern Group	Pattern	%
	H2O2O2H2W4H	0.23
	H1O1H3W4H4O4H	0.23
	H3W3H4O4H	0.23
	H2O2H3W5H	0.23
	H2O3H4W4H	0.22
	H3W3H4O5H	0.22
	H1W4H4O4H	0.21
	H2O2H2W4H5O5H	0.21
	H3O3H3W4H	0.20
	H2O2H2W4H4O4H	0.20
	H2W3H3W4O4H	0.20
	H2O2W3O3H4O4H	0.20
	H2O3H3W5H	0.20
	H2W2H3O3H	0.20
	H1O1H2W3H	0.19
	H2W3H3O3H4O4H	0.19
	H2O2O2W3O3H3W4O4H4W5H	0.19
	H2W3H3W4H5O5H	0.19
	H2W3O4H5O5H	0.18
	H2O2H2W3H3W4H	0.18
	H1O1H2W5H	0.18
	H2W4H4O4H5O5H	0.18
	H2O2H2O2H2W4H	0.17
	H2O2O2W3H3O3H3W4O4H	0.17
	H1W2H2O2H3O3H	0.17
	H2O2H3O3H4W5H	0.17
	H2W5H5O1H	0.16
	H2O2O2H2W3O3O3H3W5H	0.16
	H2O2H2O2W4H5O5H	0.16
	H1W3H4W4H	0.15
	H2O2H4W5H	0.15
	H1O2H2W5H	0.15
	H2O2H2O2H2W3O3H3W4H	0.15
	H2W2H3W3H4W5H	0.15
	H2W3O3H4W4O4W4H	0.15
	H2W3O3W4H5O5H	0.15
	H1W3H3W4H	0.15
	H2W3H3W3H4W4H	0.15
	H2W2H4W4H	0.15

Pattern Group	Pattern	%
	H2O2H2O2W4H	0.14
	H2O2H2O2H3W4H	0.14
	H2O2H2W3H	0.14
	H3W4H4W5H	0.14
	H2O2W4H5O5H	0.14
	H2O2O3O3H3W4H	0.14
	H1W2H2W3H4W5H	0.14
	H2O2H2W3H4O4H	0.14
	H2O2H2O2W5H	0.13
	H2W3H3O3H3W4H	0.13
	H3W5H5O5H	0.13
	H3W3H3W4H	0.13
	H1O1H2W3H4O4H	0.13
	H2W2H2O2W3O3H	0.12
	H3O3H3O3O3O3W4O4H	0.12
	H2O2O2W3O3O3H4W5H	0.12
	H2O2W3H3O3O4O4H	0.12
	H2O2H2W3H5O5H	0.12
	H1W2H3W3H	0.12
	H1W2H3W4H	0.12
	H2O2H2W3O3H4W4H	0.12
	H2O2H3O3H4W1H	0.11
	H2W3H3O5H	0.11
	H1O2H2O2W4H	0.11
	H2O2W4H4O4O5H	0.11
	H2W3H4O4H4W5H	0.11
	H1O2H2W3H	0.10
	H2O2H2O2H2W3O3H	0.10
	H2W3H3W3O4H	0.10
	H1W2H3W5H	0.10
	H2O2H2O2W4O4H	0.10
	H1O1H2W4O4H	0.10
	H2O2W4H4O4H	0.10
	H2O2O2W3O3H3W5H	0.10
	H2W3O3W4H4O5H	0.10
	H2W3H4O4H4W4O4H	0.10
	H2O2O2H2W3O3O3H3W4H	0.10
	H2O2H2O3H3W5H	0.10
	H2O2H2O3H3W3H4W5H	0.10

Pattern Group	Pattern	%
	H2W2H3O4H4W4H4O4H5O5H	0.09
	H2W4H4W4H	0.09
	H2O2H2O2W3O3H3W5H	0.09
	H2O2O2H2W5H	0.09
	H2W4H5W5H	0.09
	H2W2H3W5H	0.09
	H3O3H3W5H	0.09
	H3W5H5O5O5H	0.09
	H2O2O2W3O3H4O4H	0.09
	H2O2H3W3O3H4W5H	0.09
	H2O2W4H4O5H	0.09
	H1W2H3O3H4O5H	0.09
	H2W4H5O5O5H	0.09
	H2O2W3H3W4H	0.09
	H2O2H2W5O5H	0.09
	H2W3H3W4H4O4H	0.09
	H2W3H3W3H	0.09
	H2W3H4O4O4H	0.09
	H2O2H2O2H3O3H4W5H	0.09
	H2W2O3H3O3H3O3H3O4H	0.09
	H2O2O2H3W4H	0.08
	H2O2H2W3O3W3H	0.08
	H1O2O2H3W3O3W4H	0.08
	H2O2H2W4H4O5H	0.08
	H2W2H2W3H	0.08
	H1O1H2W4H5O5H	0.08
	H2O2W4O4H4W5H	0.08
	H2W3O3W3H4W5H	0.08
	H2O2W3O3H4O4W4O4H	0.08
	H1W3H3W3O4H	0.08
	H1W2H2O2H3O3H4W5H	0.08
	H2O2H2O2H3O3O3H3O3H3O3W4O4H	0.08
	H2O3H4W5H	0.08
	H2W3O3W3H3O3H4O4H4O4H	0.08
	H3W3H4W4H	0.08
	H2W4H4O4W4O4H4W5H	0.08
	H2W3O3O3H3W4H	0.08
	H2O2O2O2H2W4H	0.08

Pattern Group	Pattern	%
	H2W3H3O3O3H	0.08
	H2O2W4H4O5O5H5O5H	0.08
	H1O1H1W4H5O5H	0.08
	H2W2H2O2H3O3H	0.08
	H2O2W3H4O4H	0.08
	H1O2H2O2H2W3H4W5H	0.08
	H1W3O3W3H4W5H	0.07
	H3W3O4H4O5H	0.07
	H3O3H4W4H5O5H	0.07
	H2W3H3O4H4O4H	0.07
	H2O2O2O3W4H5O5H	0.07
	H2O2H2W4H4W5H	0.07
	H2O2H2W3H4W4H	0.07
	H1O1H1W5H	0.07
	H2W2H3W3H4O5H	0.07
	H2O2H2W3O3O3O3H	0.07
	H2O2W3O3H4W4H4O4O5H	0.07
	H2W2H2O3H4W4H	0.07
	H1W4H5O5O5H	0.07
	H2O2W3O3W3O3H4W4H	0.07
	H1O1H3W1H	0.07
	H2W3H3W3H3W4H	0.07
	H1O1H2W3H3W4H	0.07
	H2O2H2O2W3O3H	0.07
	H2O2O2H2W3O3H4W5H	0.07
	H2O2O2W3O3O3H3W4H	0.07
	H1O2H2W3H4W5H	0.06
	H1O1H2O2W4H	0.06
	H2O2W3H3O3H3W3H3O3O3H3W5H	0.06
	H2O2O2W3O3H3O3H3W5H	0.06
	H2W3H4W4O5H	0.06
	H2W2H2O2O2W3H3O3O3H	0.06
	H2O2H2O2H2W3O3H4W5H	0.06
	H2W3H3O4H4O5H	0.06
	H2O3H3O4W4H	0.06
	H2W2H2O3H4O4H	0.06
	H2W3H3O3H3O3H4O4H5O5H	0.06
	H1W2H2O2W2H2W3O3H3W4H4O4W4O4H4W5H	0.06

Pattern Group	Pattern	%
	H2W2O2W3H3W5H	0.06
	H2O2H2W3H4O4H4W4O4H	0.06
	H1O1H2O2H2W3O3H	0.06
	H1W2H3W3H4W4H	0.06
	H2W2H2O2W3O3H3O3W4O4H4W5H	0.06
	H1W3H4O4H4W5H	0.06
	H2O2H3W3H	0.06
	H2W3H3O3W5H	0.06
	H1W2H2W3H	0.06
	H2O2H2W3O3H5O5H	0.06
	H2O3O3O3W4O4W5H5O1H	0.06
	H2W4O4O4H5O5H	0.06
	H2O2H3O3H4W4H	0.06
	H2O2W3O3H3W4O4W4O4W5H	0.06
	H2O2O2H2W3O3H3W5H	0.06
	H2O2O2W3O3H4O5H	0.06
	H2W2O3W3H3W4H	0.06
	H2O2H2O2H4W1H	0.06
	H2W3H3O3O3W4H	0.06
	H2W2O4H5O5H	0.06
	H2O2H3O3H3W4H	0.05
	H2O2H3O3H3O3H3O3H4O4H4W5H	0.05
	H2W3H4O4H5O5H	0.05
	H2O2O2H2W3H3W5H	0.05
	H2O2H2W3O3H3O3H3W4H	0.05
	H2O2H2W3H3O3H3W5H	0.05
	H1O1H3W5H	0.05
	H2W3H3O4O4H5O5H	0.05
	H2W2H2O3H	0.05
	H2O2O2W3H4W5H	0.05
	H2O2W3H3O3O3O4H	0.05
	H2W3O3H4O4H	0.05
	H2O2H4W4H	0.05
	H2W1H5O5H	0.05
	H1O2H2W4H5O5H	0.05
	H2W2H4O4H	0.05
	H2W2H2O2H2W3H3O3H3W5H	0.05
	H2O2O2H2W3H3O3H	0.05
	H2O2H3W4H4O4H	0.05

Pattern Group	Pattern	%
	H1O1H2W4H4W5H	0.05
	H1W3O3H4W5H	0.05
	H2W4H4O5H5O5H	0.05
	H3W3O3H3W5H	0.05
	H2O2H2O2W3O3H3O3H3W5H	0.05
	H2W3H3W4H4O4H5O5H	0.05
	H2O2O2W3H4O4H	0.05
	H2O2O2W3O3H4W5H	0.05
	H2O2W3O3H3W3H4W5H	0.05
	H2W2H2O2H2W5H	0.05
	H1O1H2O2H2W3O3H3W4H4W5H	0.05
	H2O2H2O2W3O3H5O5H	0.05
	H2W4H4O4W5O5H	0.05
	H2O3H4O4W5H	0.05
	H1O2O2W3O3H4O4H	0.05
	H2W4H5O3H	0.05
	H2O2H2O2H2W3O3H3O3H	0.05
	H2W2O2W3H3W4H	0.05
	H2O2W3H4O5H	0.05
	H2W3H3W5O5H	0.05
	H1W4H5W5H	0.05
	H1W2H3O3H4O4H	0.05
	H2W3H3O3H4W5H	0.05
	H2O2W5H5O5H	0.05
	H2O2H2O2O2O2W3O3H3W5O5H	0.05
	H2W2H3O3W4H	0.05
	H2O3H3O4H4W4H	0.05
	H2W3H3W4H4O5H	0.05
	H2O2W3H3O4H	0.05
	H1W1H2W3H4W5H	0.05
	H3W3H3O3H	0.05
	H3W4H4O5H	0.05
	H2O2H2O2W4H4O5H	0.04
	H2O2W2O3W4H4O5H	0.04
	H2W4H4O4O5H	0.04
	H2O2W3O3H4O4W4O4H4W5H	0.04
	H1O2H2O2O2H2W3H	0.04
	H1W2H3O4H	0.04
	H2W3H4O4H4O5H	0.04

Pattern Group	Pattern	%
	H2O2O2W4H4W5H	0.04
	H2O2O2H2W3H3O3O3H	0.04
	H2O2W3O3W3H4W5H	0.04
	H1W1O2W3H3W4H	0.04
	H2W2O3W4H4W5H	0.04
	H2O2H2O2H2W3O3H4O4H4O5H	0.04
	H2O2O2H2W3O3H	0.04
	H2O2O2O2W3H3W5H	0.04
	H1O1H2W4H4O4H	0.04
	H2W3H3W5H5O5H	0.04
	H2O2H2O2H2W3O4H4O4H4O5O5H	0.04
	H2O2H2O2W2O5H	0.04
	H2O2H2O2W3O3H3W4H	0.04
	H1O2H2W4H4O5H	0.04
	H2W2H2W4H	0.04
	H1W3O3H5O5H	0.04
	H1W2O2W3H4W5H	0.04
	H2W3H4W5H5W1H	0.04
	H1W2H2O2W3O3H3W3O3H3W5H	0.04
	H2O2H3O3H3W1H	0.04
	H2W2H2O2O2W5H	0.04
	H1W3H4O4H5O5H	0.04
	H2O2H2W4O5H	0.04
	H2W3O3H3W3H4W4O4H	0.04
	H2O2H2W5H5W5H	0.04
	H2W2H2W3H3W5H	0.04
	H2W3H3W4H5W5H	0.04
	H2W3O4H4O5O5O5H	0.04
	H1W2H2W5H	0.04
	H2O2H2O2H2W1H	0.04
	H2O2W3H3W5O5H	0.04
	H1O1H2O2H2W5H	0.04
	H2O2W3O3H3O3O3H3W4H4W5H	0.04
	H2W2H2O2W3O3H3W5H	0.04
	H2W2H2O3W5H	0.04
	H2O2H2O2W3O3H3W3O3H3W5H	0.04
	H2O2H2W3O4H4W5H	0.04
	H2W2H5O5H	0.04
	H2O2H2W3H3O3H3O3H	0.04

Pattern Group	Pattern	%
	H2O2H2O2H2O2H2W4H	0.04
	H2W3H3O3H3O3H	0.04
	H2O2H2W3O3H4O4W4O4H	0.04
	H2O2H3W3H3O3H4O5H	0.04
	H2W2H3O4H	0.04
	H2O2H2O2H2O3O3H3O3H3W5H	0.04
	H2W3H3O3H3W5H	0.04
	H2O2O2W3O3O3H4W4H	0.04
	H1W3H3O4H	0.04
	H2W2H2O4H	0.04
	H2W3O3W4H5O5O5H	0.04
	H2W3H4O4W5H	0.04
	H2O2H2O2H2W3H3W4H	0.04
	H2O2H2O2W3H4O4H	0.04
	H2O2H2O2O2W4O4H	0.04
	H2W3O3H4O4H4O4H	0.04
	H2O2H2O2H2W3H3O3H	0.04
	H2W2H2O2W3O3H4W4H4O4W5H	0.04
	H2O2H2O2H3W3O3H3W5H	0.04
	H1O2H3W5H	0.04
	H2W2H2W3H3W4H	0.04
	H1W2H3O3H3W5H	0.04
	H2O2H2W3H3O3O4H	0.04
	H2W3O3O3H4O4O5H	0.04
	H2W3H3W3H4W5H	0.04
	H2W3H3W3H3W5H	0.04
	H2W3O3W3H3W5H	0.03
	H2W3O3W4O4W4H5O5H	0.03
	H2O2H2W3O3W5H5O5H	0.03
	H2O2W2H2W3O3H3O3H4W5H	0.03
	H2O2W3H3O3O4H	0.03
	H2O2H2W3O3O3H3W4H	0.03
	H2W2O2H3O3H4W4H	0.03
	H2W2H2O2H2W4H4O5O5H	0.03
	H2O2W3H3O4W5H5O5H	0.03
	H1W2H4O4H	0.03
	H2O2O3O3H4W5H5O5H	0.03
	H2W3H3O3H4W4H	0.03
	H1W2H3O3H	0.03

Pattern Group	Pattern	%
	H2W3O3W3H4W4H	0.03
	H1W2H4W4H	0.03
	H2W2O2H2O3W5H	0.03
	H2O2O2W3O3H3O3H4W5H	0.03
	H1W4H4O4O5H	0.03
	H1O1H2W3H3W5H	0.03
	H1W3H5O5H	0.03
	H2O2O2H2W3H3O3O3H4W5H	0.03
	H2O2H2O2W3O3H3O3H4W5H	0.03
	H3W3H4W1H	0.02
	H2W2H2W3O3H4O5H	0.02
	H2O2H3W3H3O3H	0.02
	H3W3O3H3W3H	0.02
1 work Tour + Subtours (25)	H2O2W4H	30.51
	H2O2W4O4H	9.61
	H2O2W5H	9.20
	H2W4O4H	6.81
	H2O2O2W4H	4.10
	H2W4O5H	3.74
	H2O2W3O3H	3.64
	H2W3O4H	3.08
	H2O2W3H	2.07
	H2W3O3H	1.82
	H2O2O2W5H	1.63
	H2O2O2W4O4H	1.35
	H2W3O3W4H	1.14
	H2W5O5H	1.12
	H2W3O3W5H	0.90
	H2W2O3W4H	0.75
	H1O2W4H	0.73
	H2O2W4O5H	0.67
	H2W2O4H	0.60
	H1W4O4H	0.52
	H1O2W5H	0.52
	H2O2W5O5H	0.50
	H2W2O4W4H	0.45
	H2W2O3W5H	0.39
	H2O2O2O2W4H	0.38

Pattern Group	Pattern	%
	H3O3W4H	0.36
	H2W2O2W4H	0.34
	H2O2O2W3O3H	0.34
	H2O2O2W3O3O3H	0.33
	H2O2O2W4O4O4H	0.32
	H2W3O4W5H	0.29
	H2W3O4O4H	0.29
	H2O5W5H	0.27
	H2O3W4H	0.26
	H2W2O3H	0.26
	H2O2O2O2W4O4H	0.24
	H2W2O4W5H	0.23
	H1O2W3H	0.22
	H2O2W3O4H	0.22
	H3W5O5H	0.21
	H1W2O3W5H	0.20
	H1O2W3O3H	0.20
	H2W2O2W5H	0.20
	H1W4O5H	0.17
	H3W3O4H	0.17
	H2W3O5W5H	0.17
	H2W4O4O4H	0.16
	H1W3O4H	0.16
	H2W2O5H	0.16
	H2O2O2W3O3W4O4H	0.16
	H2W4O4O5H	0.16
	H2O3W4O4H	0.15
	H1W1O3W4H	0.15
	H2W2O5W5H	0.15
	H2W4O5O5H	0.15
	H2O2W3O3W5H	0.14
	H2O2O2O2W3O3O3H	0.14
	H1W1O5H	0.13
	H3W3O4W4H	0.13
	H2O2W4O5O5H	0.13
	H1O1W5H	0.13
	H2W2O2W3O3W4H	0.13
	H2O2W4O4O4H	0.13
	H1W3O3H	0.12

Pattern Group	Pattern	%
	H2O2O2W3O3O3W4H	0.12
	H2W2O2W3H	0.12
	H2O2O3W4H	0.12
	H2O2O2W3H	0.12
	H1O1W4O5H	0.12
	H2W2O3W3H	0.11
	H1O1W4H	0.11
	H2W5O5O5H	0.11
	H3W3O3H	0.11
	H2W2O3O3H	0.11
	H2W2O2O2O3O4H	0.11
	H2O2O2W4O5H	0.10
	H2O2O2W3O3W5O5H	0.10
	H2O2W2O3O3H	0.10
	H2W3O3O3O3W4O5H	0.10
	H2W3O3O3W4H	0.10
	H2W3O3O3W4O5H	0.10
	H2O2O2O2W3O3O3O4H	0.10
	H2O3O3W4O4W4O5O5H	0.10
	H2W3O3O3O3W4O4W4H	0.10
	H2W3O4W4H	0.10
	H1W2O4W4H	0.10
	H2W3O5H	0.09
	H2W2O3O4H	0.09
	H2O5W4H	0.09
	H2O3W5H	0.09
	H2O2O2O2W4O4O4O4H	0.09
	H2O2W2O3W3O4W4H	0.09
	H3O3W3H	0.09
	H2O3W3O4H	0.09
	H1W2O2O3W4O4W5H	0.08
	H2O2W2O3W3H	0.08
	H2O2W2H	0.07
	H1W2O2O2W3H	0.07
	H1O3W5H	0.07
	H3O3O3O3W4O4W5H	0.07
	H2O2W1H	0.07
	H3W4O5H	0.07
	H1W1O2W4H	0.07

Pattern Group	Pattern	%
	H2O2W2O3W4O4H	0.07
	H1W3O4W4H	0.07
	H1O2W4O4H	0.07
	H1W2O2W5H	0.07
	H2O2W2O2W4H	0.07
	H1W3O3W4H	0.07
	H3O3W4O5H	0.07
	H1W3O5H	0.07
	H2O2W2O3W4H	0.07
	H1W2O2H	0.06
	H2O2W3O3O3H	0.06
	H2O2W2O2W3O3H	0.06
	H2W3O3W3O4O4W5H	0.06
	H2O3W3H	0.06
	H2O2W3O3W4O4W5O5H	0.06
	H3O3W5H	0.06
	H2O3W4O5H	0.06
	H2O3O3W4H	0.06
	H2W4O5W5H	0.06
	H1W1O5W5H	0.06
	H2O2O2W5O5H	0.06
	H2O2W3O3W4H	0.06
	H2O2O2W3O4H	0.05
	H2W2O3O3W4O5H	0.05
	H1W1O2O3W3H	0.05
	H1W1O2W3H	0.05
	H2O2W2O4H	0.05
	H4O4W5H	0.05
	H2W4O4O4W5H	0.05
	H2W3O3W3O3W4H	0.05
	H1W3O4O4H	0.05
	H2W3O3O3W3H	0.05
	H1O1W4O4H	0.05
	H2W2O3W3O3H	0.05
	H3W4O4H	0.05
	H1O1W3H	0.05
	H1W2O2O3W5H	0.03
	H2W2O2O2W4O5O5H	0.03

Education Pattern Groups

Pattern Group	Pattern	%
1 School Tour with return AM (1)	H2S3H	96.51
	H1S3H	3.18
	H3S4H	0.26
	H3S3H	0.04
	H1S2H	0.01
	H2S2H	0.00
1 School Tour with return PM (2)	H2S4H	86.10
	H1S4H	8.50
	H2S5H	3.47
	H4S5H	0.60
	H4S4H	0.49
	H1S5H	0.45
	H3S5H	0.38
2+ School tours (11)	H2S3H4O4H	47.49
	H2S3H3O4H	26.47
	H2S3H4O5H	14.03
	H2S3H5O5H	2.35
	H1S3H4O4H	1.85
	H2S3H4O4H4O5H	0.85
	H2S3H3O5H	0.57
	H2S3H4O4O4H	0.52
	H2S3H4O4O5H	0.47
	H2S3H4O4H5O5H	0.40
	H2S4H4O5H	0.38
	H1S3H4O5H	0.37
	H2S3H3O4O4H	0.31
	H2O2S3H4O5H	0.31
	H2S4H4O4H	0.26
	H2S3H3O4H4O5H	0.26
	H2O2S3H4O4H	0.25
	H2S3H4O1H	0.24
	H2S3O4H4O4H	0.18
	H1S3H3O4H	0.18
	H2S3O4H4O5H	0.17
	H2S4H5O5H	0.15
	H2S3H4O4O4H4O4H	0.14
	H1S3H4O4O5H	0.13
	H2S3H3O3H	0.13

Pattern Group	Pattern	%
	H2S3H3O4O4O4H	0.12
	H1O1H2S3H3O4H	0.12
	H2O2S3H3O4H	0.11
	H2S3H3O3O4H	0.11
	H1O1H1S4H5O5H	0.10
	H1O1H1S4H	0.10
	H2S3H3O4H5O5H	0.10
	H2O2S3O3H4O5H	0.09
	H2O3H3S3H	0.08
	H2S3O4H5O5H	0.08
	H2S4H4O5O5H	0.08
	H2S3H3O3O3H	0.08
	H2O2H2S4H	0.08
	H3S4H4O5H	0.07
	H3S4H5O5H	0.07
	H1S3H5O5H	0.07
	H1O2H2S3H4O4H	0.05
	H2S3H3O4H4O4H	0.05
1 School Tour + Subtour (7)	H2S3O4H	42.33
	H2O2S3H	19.53
	H2S3O3H	10.49
	H2O2S3O3H	6.93
	H1S3O4H	3.63
	H2S3O5H	3.25
	H2S4O4H	2.74
	H1S3O5H	1.16
	H2O2S4H	0.84
	H2S3O4O5H	0.74
	H2S3O4O4H	0.63
	H2S4O5H	0.60
	H2O2O2S3H	0.55
	H1S3O4O4H	0.46
	H2O4S5H	0.46
	H2O2S3O4H	0.43
	H2O2O2S3O3O3H	0.36
	H2O2O2S4H	0.36
	H2S2O3H	0.33
	H2S3O3O4H	0.32
	H2O2S4O4H	0.31

Pattern Group	Pattern	%
	H2S3O3S3H	0.29
	H2O2O2S3O3H	0.28
	H2S3H5O5O	0.26
	H2O2S3O5H	0.24
	H2O2O2S3O3O4H	0.23
	H2S3O3O4O4H	0.22
	H2O2O2O2S3H	0.21
	H2O3S3H	0.19
	H1S3O3H	0.18
	H2O2S3O3O4H	0.18
	H2O2O2S4O4O4H	0.18
	H2O3S4H	0.14
	H2S3O3O3H	0.12
	H2S4O4O4H	0.12
	H2S3H4O5O	0.12
	H2S3O5S5H	0.11
	H1S2O3O4S5H	0.11
	H2S3H4O	0.10
	H4S5O5H	0.10
	H2O4S3H	0.10
	H2S2O4O4H	0.09

Other Pattern Groups

Pattern Group	Pattern	%
Single Tour peak - P (43)	H2O3H@P	46.1
	H2O2H@P	13.6
	H2O4H@P	13.5
	H3O4H@P	7.19
	H4O4H@P	6.79
	H2O5H@P	2.92
	H4O5H@P	2.04
	H1O4H@P	1.35
	H2O3O3H@P	1.11
	H1O2H@P	0.94
	H2O2O4H@P	0.76
	H2O2O3O3H@P	0.60
	H2O2O3H@P	0.60

Pattern Group	Pattern	%
	H2O2O2H@P	0.50
	H3O4O4H@P	0.29
	H2O3O4H@P	0.29
	H2O3O3O3H@P	0.18
	H2O2O5H@P	0.16
	H2O4O4H@P	0.11
	H2O2O2O3H@P	0.08
	H2O4O5H@P	0.08
	H2O2O2O4H@P	0.08
	H1O2O4H@P	0.05
	H2O3O4O4H@P	0.04
	H2O3O5H@P	0.04
	H3O4O5O5H@P	0.04
	H2O3O3O4H@P	0.04
	H2O2O2O3O3H@P	0.04
	H2O2O4O5H@P	0.04
	H2O2O2O3O3O3H@P	0.04
	H4O4O4H@P	0.04
	H1O2O3O3H@P	0.03
	H3O4O4O4H@P	0.03
	H2O2O2O2O2H@P	0.03
	H1O2O3H@P	0.03
	H2O3O3O3O4H@P	0.03
	H4O4O5H@P	0.03
	H2O2O3O5H@P	0.03
	H2O3O3O3O3O4H@P	0.02
	H2O2O3O3O4O4H@P	0.02
	H2O3O3O3O4O4O5H@P	0.02
	H2O2O3O3O4H@P	0.02
	H2O2O3O3O3H@P	0.02
	H2O2O2O3O3O5H@P	0.02
	H2O2O5O5H@P	0.02
	H4O4O4O4H@P	0.02
	H1O2O3O4O5H@P	0.02
	H2O3O3O5H@P	0.02
	H2O2O2O5H@P	0.01
	H2O2O3O4O5O5H@P	0.01
	H2O3O3O4O4H@P	0.01
	H2O3H@Sh	44.8

Pattern Group	Pattern	%
Single Tour peak - Sh (41)	H4O4H@Sh	15.2
	H2O2H@Sh	13.0
	H3O4H@Sh	7.60
	H2O4H@Sh	5.89
	H2O3O3H@Sh	2.56
	H2O5H@Sh	2.43
	H4O5H@Sh	1.99
	H2O2O3H@Sh	1.09
	H1O4H@Sh	0.87
	H2O4O4H@Sh	0.87
	H1O2H@Sh	0.76
	H2O2O2H@Sh	0.38
	H3O4O4H@Sh	0.31
	H2O3O3O3H@Sh	0.29
	H2O3O4H@Sh	0.25
	H4O4O5H@Sh	0.25
	H1O2O3H@Sh	0.19
	H4O4O4H@Sh	0.16
	H2O2O4H@Sh	0.16
	H2O4O5H@Sh	0.14
	H2O2O3O3H@Sh	0.12
	H4O5O5H@Sh	0.09
	H3O4O5H@Sh	0.08
	H2O5O5H@Sh	0.07
	H2O2O4O4H@Sh	0.06
	H2O3O3O4H@Sh	0.06
	H1O4O4H@Sh	0.06
	H1O2O3O3O4H@Sh	0.06
	H2O2O3O4H@Sh	0.05
	H1O2O2H@Sh	0.04
	H2O3O5H@Sh	0.03
	H1O2O4H@Sh	0.03
	H2O2O3O3O3H@Sh	0.03
	H2O4O4O4H@Sh	0.03
	H2O5O5O5H@Sh	0.02
	H2O3O4O5H@Sh	0.02
Multiple Tours (55)	H2O2H3O3H@P	48.9
	H2O2H3O3H3O3H@P	1.98
	H2O2H4O4H@P	1.88

Pattern Group	Pattern	%
	H2O3H4O4H@Sh	1.37
	H3O3H4O4H@P	1.21
	H3O3H4O4H@Sh	1.16
	H2O2H3O3H4O4H@P	1.16
	H2O2O2H3O3O3H@P	1.15
	H2O3H3O4H@B	1.06
	H2O3H4O4H@P	0.98
	H2O2H3O3H@Sh	0.97
	H2O2H4O4H@Sh	0.89
	H2O3H3O4H@P	0.79
	H2O3H3O3H@P	0.78
	H2O2H3O4H@P	0.75
	H2O2H3O3H3O4H@P	0.74
	H2O2H2O2H3O3H@P	0.74
	H2O2H2O4H@P	0.72
	H2O2H3O3O3H@P	0.67
	H2O3H3O3H@Sh	0.66
	H3O3H3O3H@P	0.66
	H4O4H4O4H@P	0.65
	H2O2O2H3O3H@P	0.58
	H2O2H3O3H@O	0.56
	H2O3H3O4H@Sh	0.53
	H2O2H2O3H3O3H@P	0.52
	H2O2H2O2H3O3H3O3H@P	0.51
	H2O2H4O5H@P	0.50
	H3O3H4O5H@Sh	0.50
	H2O2H2O2H@P	0.41
	H2O3H4O5H@P	0.39
	H2O2H3O4H@Sh	0.39
	H3O4H4O4H@P	0.38
	H1O2H3O3H@P	0.35
	H2O2H2O3H@P	0.34
	H2O2H2O5H@P	0.34
	H3O3H3O4H@P	0.33
	H3O3H3O4H@Sh	0.32
	H2O3H4O5H@Sh	0.32
	H2O2H4O5H@Sh	0.31
	H2O4H5O5H@P	0.31
	H2O3H3O4H@O	0.31

Pattern Group	Pattern	%
	H2O2H3O3H5O5H@P	0.30
	H2O2H2O3O3H3O4H@P	0.30
	H3O3H5O5H@Sh	0.29
	H2O2H2O3H@Sh	0.28
	H2O4H5O5H@Sh	0.28
	H2O2H2O3O3H@P	0.27
	H2O2O2H3O3H3O3H@P	0.26
	H2O4H4O5H@Sh	0.25
	H3O3H5O5H@P	0.24
	H3O4H4O4H@Sh	0.21
	H2O2H3O3H@R	0.20
	H4O4H5O5H@P	0.20
	H2O2O3H3O3H@P	0.20
	H1O2H3O3H4O4H@P	0.20
	H2O3H4O4H@R	0.19
	H2O3H5O5H@Sh	0.19
	H2O4H4O4H@Sh	0.18
	H4O4H5O5H@Sh	0.18
	H4O4H4O5H@P	0.18
	H2O2H2O2H3O3H4O4H@P	0.18
	H3O3H3O3H@Sh	0.18
	H3O3H4O5H@P	0.18
	H2O4H4O5H@B	0.17
	H1O1H5O5H@P	0.17
	H1O2H4O4H@P	0.17
	H2O2O3H4O5H@Sh	0.17
	H2O3H4O4H@O	0.17
	H2O2H3O3H4O4H4O4H@P	0.17
	H2O2H3O3H4O5H@P	0.16
	H3O3H3O3H4O4H@P	0.16
	H2O2H5O5H@P	0.15
	H3O3H4O5H@R	0.14
	H1O2H3O3H@Sh	0.14
	H2O3H4O4H@B	0.13
	H2O3H5O5H@P	0.13
	H4O4H4O5H@Sh	0.13
	H2O2O3O3H3O5H@P	0.13
	H2O2H3O3O4H@P	0.13
	H3O3H4O4H@O	0.13

Pattern Group	Pattern	%
	H1O1H2O2H3O3H@P	0.12
	H2O2H4O4H4O4H@P	0.12
	H2O2O3O3H3O4H@P	0.12
	H2O2H2O2H3O3O3H@P	0.12
	H2O3H4O4H@L	0.12
	H2O3H3O4H@R	0.11
	H1O1H3O3H@P	0.11
	H3O3O3H4O4H@P	0.11
	H2O2H3O4O4H@Sh	0.11
	H2O3H4O5H@R	0.11
	H2O2H2O2H4O4H@P	0.11
	H2O3H4O5H@B	0.11
	H2O2H3O3H4O4H@Sh	0.10
	H1O2H2O3H@B	0.10
	H2O3H3O3H4O4H@P	0.10
	H2O3H4O4H4O4H@P	0.10
	H4O4H4O4H4O5H@P	0.09
	H2O3H3O3H@O	0.09
	H2O3H4O4H4O5H@R	0.09
	H2O2H3O3H3O4H4O4H@P	0.09
	H2O2H2O3H3O5H@B	0.09
	H1O3H4O4H@Sh	0.09
	H3O3H3O3H4O5H@R	0.09
	H2O3H3O5H@P	0.09
	H2O2H4O5H@R	0.09
	H2O2H4O4H@O	0.09
	H2O2H3O3H3O3H@Sh	0.09
	H2O2H5O5H@O	0.09
	H2O2H4O4H@R	0.08
	H2O2H3O3O3H4O4H@P	0.08
	H2O3O3H3O4H@P	0.08
	H2O4H4O5H@R	0.08
	H2O2H3O5H@P	0.08
	H2O2H3O4H@R	0.08
	H1O2H2O3H@Sh	0.08
	H2O2H2O2H@Sh	0.08
	H2O4H5O5H@R	0.08
	H2O2H3O3O3H@O	0.08
	H1O2H5O5H@Sh	0.08

Pattern Group	Pattern	%
	H2O2H4O4H5O5H@P	0.08
	H3O3H3O4H4O4H@P	0.08
	H2O2O2H3O3H4O4H@P	0.08
	H2O3O3H4O4H@P	0.07
	H2O2H3O3H3O3O3H@P	0.07
	H4O4H4O5H@R	0.07
	H2O2H3O4H@O	0.07
	H2O3H3O5H@Sh	0.07
	H2O2H2O3O3H4O4H@P	0.07
	H2O2O2H4O4H@P	0.07
	H2O2H3O3H5O5H@Sh	0.07
	H3O4H4O5H@R	0.06
	H3O3H4O4H@R	0.06
	H1O2H2O5H@P	0.06
	H3O3H4O4H4O5H@P	0.06
	H2O4H5O5H@B	0.06
	H2O2H3O3H4O4H@B	0.06
	H3O3H5O1H@O	0.06
	H3O3O3H4O5H@P	0.06
	H1O1H2O2H@P	0.06
	H2O2H4O4H@B	0.06
	H2O3O3H4O5O5H@P	0.06
	H2O2O2H2O3H3O3O3H@P	0.06
	H2O2O3O3H3O3O4H@P	0.06
	H3O3H3O5H@P	0.06
	H2O2O4H5O5H@P	0.06
	H2O2O2H2O2H3O3H3O3H4O4H@P	0.06
	H3O4H5O5H@Sh	0.06
	H1O2H2O4H@P	0.06
	H2O2O2H3O3H3O4H@P	0.05
	H2O2H2O2H3O3O3O3H3O3H3O3H4O4H@P	0.05
	H2O2H2O2O3H3O3H3O3O4H4O4H@P	0.05
	H2O4H4O5H@P	0.05
	H1O1H2O3H3O4H@P	0.05
	H2O2O2H2O4H@P	0.05
	H2O3H3O3H3O4H@P	0.05
	H2O3H3O4H5O5H@O	0.05
	H3O3H4O4H@B	0.05
	H2O3O3H4O4H@Sh	0.05

Pattern Group	Pattern	%
	H2O2H3O3H3O5H@P	0.05
	H2O2H3O3H3O3H4O4H@P	0.05
	H2O2H2O4H@Sh	0.05
	H3O3H4O5O5H@P	0.05
	H1O3H4O4H@P	0.05
	H2O2H5O5H@Sh	0.05
	H2O2O3H3O4H@Sh	0.05
	H1O2H5O5H@P	0.05
	H1O3H3O4H4O4H@P	0.05
	H3O3O3H4O4H@Sh	0.05
	H3O3H4O4O4H@Sh	0.05
	H1O3H4O5H@Sh	0.05
	H2O2H3O3O4H4O4O4H@P	0.05
	H1O1H2O2H2O3H3O5H@P	0.05
	H2O2H3O3H3O3H5O5H@P	0.05
	H3O3O3H5O5H@P	0.05
	H2O2H2O3O3O3H@P	0.05
	H1O2H4O4H@Sh	0.05
	H2O2H3O3H3O3O4H@P	0.05
	H2O2H3O1H@P	0.04
	H2O3H4O4O4H@P	0.04
	H2O2O3H3O5H@B	0.04
	H2O2H2O2H3O3H@Sh	0.04
	H1O1H2O4O4H@P	0.04
	H1O1H2O5H@Sh	0.04
	H2O2H2O3H3O4H5O5H@Sh	0.04
	H2O3H3O4O4H@Sh	0.04
	H3O4H5O5H@P	0.04
	H3O3O3H4O4O4H@P	0.04
	H1O1H4O4H@P	0.04
	H3O3H4O4H4O4H@P	0.04
	H1O3H4O4O4O4H@P	0.04
	H2O2H2O4O4H@P	0.04
	H2O3H4O5O5H@P	0.04
	H2O2H2O2O3H4O4H@P	0.04
	H2O3H3O3H@R	0.04
	H1O2H4O4H@R	0.04
	H1O1H2O2H4O4H@O	0.04
	H1O1H2O2H4O4H@P	0.04

Pattern Group	Pattern	%
	H2O2H2O2H@O	0.04
	H2O2H2O4H@O	0.04
	H1O1H3O3H4O4H@R	0.04
	H1O1H2O3H4O4H@Sh	0.04
	H2O2H2O2H2O3H3O3H3O4H5O5H@P	0.04
	H3O3H3O3O3O3O4O4O4O5H@P	0.04
	H2O4H5O5H@L	0.04
	H2O2H2O3H3O3H@B	0.04
	H1O2H2O3H4O5H@L	0.04
	H2O2H2O2H3O3H4O5H@P	0.04
	H2O2O2O3O3H4O4H@B	0.04
	H2O2O3H4O4H@Sh	0.04
	H3O3H3O4O4H@Sh	0.04
	H2O2O2H3O3H3O3H4O4H@P	0.04
	H2O3H3O3H4O4H4O4H@Sh	0.04
	H2O4O4H5O5H@Sh	0.04
	H2O2H2O2H3O5H@Sh	0.04
	H3O3H4O5H5O5H@Sh	0.04
	H4O5H5O5H@Sh	0.04
	H2O2O2H3O3O3H5O5H@P	0.04
	H2O2H3O3H4O4H@O	0.04
	H2O3H3O4H4O5H@Sh	0.04
	H2O2H2O5H@Sh	0.04
	H1O2H2O3H3O3H@B	0.04
	H2O2H4O5H5O5H@P	0.04
	H2O2H2O3H3O4H@L	0.04
	H3O4H4O5H@P	0.04
	H1O1H2O2H2O2H3O3H4O4H4O4H4O4H5O5H@P	0.04
	H1O2H3O3O4H@P	0.04
	H2O2H2O3H4O4H@Sh	0.04
	H2O2H2O2H3O3H@B	0.04
	H2O2H4O4O4H@P	0.04
	H2O2H3O4H5O5H5O5H@O	0.04
	H2O2H2O2H2O2O3O3H3O4H@P	0.04
	H3O3H4O4H4O4H@Sh	0.04
	H3O3H4O4H4O5H@Sh	0.04
	H2O2H2O2H3O3H3O3O3O4H@P	0.04
	H3O3O4H5O5H@P	0.04
	H2O3H3O4H4O4H@R	0.03

Pattern Group	Pattern	%
	H3O4H4O4H@R	0.03
	H2O2O2H3O3O3H4O4H4O4H@P	0.03
	H3O3O3O3H4O4H@O	0.03
	H2O2H2O3O3H3O4H@Sh	0.03
	H2O2H3O4O5O5H@P	0.03
	H2O2O2O2H4O4H@P	0.03
	H1O1H3O3H5O5H@Sh	0.03
	H2O2H2O2O5H@P	0.03
	H2O3O3H4O5H@P	0.03
	H2O2H2O2H3O3O3H4O4H@P	0.03
	H2O2O3O3H3O3H@P	0.03
	H1O1H2O3H@P	0.03
	H3O3O3H4O4O4O4H@P	0.03
	H3O3H3O3H4O4H@Sh	0.03
	H2O2O2H3O3O3H@Sh	0.03
	H1O3H3O5H@B	0.03
	H2O2O4H5O5H@Sh	0.03
	H1O1H3O3H4O4H@P	0.03
	H1O2H2O4H@B	0.03
	H1O3H4O5H@O	0.03
	H2O3H3O4H4O5H@P	0.03
	H2O2H2O5H5O5H5O5H@Sh	0.03
	H1O2H3O5H@P	0.03
	H3O3H3O3O4H@P	0.03
	H2O2O2H3O3H4O5H@P	0.03
	H2O2H2O2H2O3H4O4H5O5H@P	0.03
	H2O4H4O4H@P	0.03
	H2O4H4O4H@R	0.03
	H3O3H4O5H@O	0.03
	H2O2H2O3H4O5H@O	0.03
	H1O1H3O4H@O	0.03
	H3O3O3H5O5H@Sh	0.03
	H1O2H2O3H3O4H@P	0.03
	H2O2H2O3O3O4H@O	0.03
	H1O2H4O5H@Sh	0.03
	H2O2O2O3H3O3H@P	0.03
	H2O3H4O4H5O5H@P	0.03
	H2O2H3O3O3H@Sh	0.03
	H3O4H5O1H@P	0.03

Pattern Group	Pattern	%
	H2O2O2H3O3O3H3O3H@P	0.03
	H2O2H2O3O3H4O5H@P	0.03
	H1O2H3O4H4O5H@Sh	0.03
	H2O2O2O2H3O3H@R	0.03
	H2O2H2O3H4O4H@P	0.03
	H2O2H2O2O2H@P	0.03
	H2O2H2O2O4H4O5H@Sh	0.03
	H2O2H3O3O3H4O5H@P	0.03
	H2O2O2O2H3O3O3O3H@P	0.03
	H2O2H3O5H@Sh	0.03
	H1O1H2O3H@O	0.03
	H2O2H2O2H3O3H3O4O4H@P	0.03
	H2O2H2O2H2O2H3O3H3O3H4O4H@P	0.03
	H3O4H5O5H@B	0.03
	H2O2H3O3O4H@Sh	0.03
	H2O2H3O3H3O5H5O1H@P	0.03
	H1O2H2O3H@P	0.03
	H2O2O2H2O2H3O3O3O3H4O4H4O4H4O4H@P	0.03
	H2O2O3O3H4O4H@O	0.03
	H1O1H2O2H3O3H5O5H@P	0.03
	H1O2H2O3O3O3H@R	0.03
	H2O2O2H3O3O4O4H@P	0.03
	H2O2H3O3H4O5H@B	0.03
	H1O2H2O2H3O3H3O5H@P	0.03
	H1O1H3O3H4O4H4O5H@R	0.03
	H2O2O2H4O4O5H@P	0.03
	H2O2O3H3O4O4H@P	0.03
	H2O2H2O2O3O3H@P	0.03
	H2O2H2O2O2H2O3O3H3O4H4O4O4H4O5H5O5H@P	0.03
	H2O2H2O2H2O3O3H3O4H@P	0.03
	H2O3H4O5H5O5H@Sh	0.03
	H3O3H3O3O3H@P	0.03
	H2O2H4O4H4O5H@P	0.03
	H1O1H2O3H@B	0.03
	H1O3H3O3H@P	0.03
	H2O3O4H5O5H@P	0.03
	H2O3H3O3H3O3H4O4H4O5H@P	0.03
	H1O2O2H3O4H@P	0.03
	H2O2H2O2H3O3O3H@Sh	0.03

Pattern Group	Pattern	%
	H1O2H2O2H3O3H@Sh	0.03
	H2O4H5O1H@O	0.03
	H2O2H2O2H2O3H@P	0.03
	H2O2O2H2O3O3H3O5H@P	0.03
	H2O5H5O5H@Sh	0.03
	H2O2H2O3H3O4H4O5H@P	0.03
	H2O2H3O3H3O4H4O5H@Sh	0.03
	H2O3O3H5O5H@P	0.03
	H2O2H2O3H4O5H@Sh	0.03
	H2O2H3O3O3H3O4H4O5H@P	0.03
	H2O2H3O3H4O5H@R	0.03
	H1O2H4O4H5O5H@P	0.03
	H2O3H3O3H3O5H@B	0.03
	H1O3H4O4H4O4H@O	0.03
	H2O2H2O4H@B	0.03
	H1O2H2O2H@P	0.03
	H2O3H3O5H@O	0.03
	H3O4H4O5O5H@P	0.03
	H2O2O2O3O3H3O3H@P	0.03
	H2O2H3O3O3H4O4H5O5H@P	0.03
	H2O2H2O2H2O2H3O3H@P	0.03
	H2O3H4O5H@O	0.03
	H3O3O3H3O3H4O4H@P	0.03
	H3O4H4O5H@Sh	0.03
	H1O1H2O3H4O4H@P	0.03
	H2O3H3O3H3O3H@P	0.03
	H2O2H2O4H5O5H@Sh	0.03
	H1O2O2H3O3H3O3H@P	0.03
	H2O3H3O4O4H@L	0.03
	H2O2O3O3H4O4H@Sh	0.03
	H2O2O2O2H3O3H3O3O3H@P	0.03
	H2O2H4O4O5H@P	0.03
	H2O2H2O2O2H2O3H3O3H3O3H@P	0.03
	H2O2H2O4H4O4H@P	0.03
	H2O2H2O3H3O3H4O4H4O4H@P	0.03
	H1O2O3H4O4H@Sh	0.03
	H2O2H2O2O4H@P	0.02
	H2O2H2O2H2O2H3O3H3O4H@P	0.02
	H2O3O3O3H3O3H@O	0.02

Pattern Group	Pattern	%
	H1O2H2O2O2H2O2H@P	0.02
	H2O2H3O3H@B	0.02
	H2O2O3H5O5H@P	0.02
	H1O2H2O2H3O3H@P	0.02
	H2O2O2H2O3H3O3H@P	0.02
	H4O4O4H5O5H@P	0.02
	H4O4O4H5O5H@Sh	0.02
	H2O2O2H4O5H@P	0.02
	H3O3O3H4O4O5H@P	0.02
	H2O2H3O3H4O4H4O4H5O5H@P	0.02
	H2O3H3O4H4O4H@P	0.02
	H1O2H4O4H@O	0.02
	H1O1H2O4H@P	0.02
	H2O2H1O1H@P	0.02
	H2O4H5O5H@O	0.02
	H2O2H2O3H3O3H@O	0.02
	H1O2H2O4H@Sh	0.02
	H3O4O4H4O5H@Sh	0.02
	H2O2H3O3H3O3H4O4O4H4O4H@P	0.02
	H2O2H2O2H2O2H3O3H@Sh	0.02
	H2O2H2O2H2O3O3H4O5H@P	0.02
	H1O4H5O5H@Sh	0.02
	H2O2H3O3H4O4H5O5H@P	0.02
	H2O5H5O5H@P	0.02
	H1O2H2O3O3H4O4H@P	0.02
	H2O2H3O3H3O3H3O4H@P	0.02
	H4O4H4O5O5H@Sh	0.02
	H2O2H3O4O4H@P	0.02
	H4O4H5O1H@P	0.02
	H1O2H3O3H4O4H@R	0.02
	H2O2H2O3H3O3H3O4H@P	0.02
	H3O4H4O4O4H5O5H@P	0.02
	H2O2O3O3H5O5H@P	0.02
	H2O2H5O5H@B	0.02
	H2O3H3O4O5H5O5H@B	0.02
	H2O2H2O3H4O5H@B	0.02
	H1O1H2O2H2O3H3O3H3O3H3O3H4O4H@P	0.02
	H2O2H3O3H4O5H@O	0.02
	H3O3H4O4H5O5H@R	0.02

Pattern Group	Pattern	%
	H3O3H3O4H@R	0.02
	H2O3H3O3H4O5H@Sh	0.02
	H2O2H2O2H3O3H3O3H3O3H4O4H@Sh	0.02
	H2O2H4O4O4H@Sh	0.02
	H1O2H3O3H@B	0.02
	H1O2H4O4H@B	0.02
	H3O3H3O3H@B	0.02
	H2O2H2O4H4O4H@B	0.02
	H3O3O3H3O3H@Sh	0.02
	H1O2H3O4H@O	0.02
	H2O2H2O2H2H4H4O4H@Sh	0.02
	H1O2H3O1H@Sh	0.02
	H3O4H4O5H@O	0.02
	H2O2H2O2H3O3H3O3H3O3H@P	0.02
	H2O2O4O4H5O5H@P	0.02
	H1O3H3O4H@Sh	0.02
	H1O1H4O5H@Sh	0.02
	H1O4H4O4H@Sh	0.02
	H1O2H2O3H4O4H@R	0.02
	H1O2H2O3H@R	0.02
	H1O3H3O5H@O	0.02
	H2O2H2O2H5O5H@B	0.02
	H2O2O2H4O4H@R	0.02
	H2O2H2O3O3H3O5H@P	0.02
	H5O5H1O1H@P	0.02
	H2O2H3O3H4O1H@P	0.02
	H1O3H3O3H@Sh	0.02
	H2O2H2O2H2O2H3O3O3O3O3O3O3H4O4H4O4H@O	0.02
	H3O3O3H4O5H@Sh	0.02
	H1O2H2O2H3O3H3O3H4O5H@Sh	0.02
	H4O4H4O4H5O5H@O	0.02
	H1O1H2O2H5O5H@P	0.02
	H2O2H4O5O5H@P	0.02
	H2O2H2O2H2O3H3O4H4O4O4H@P	0.02
	H2O4H4O4H5O5H@P	0.02
	H2O2H4O4H4O5H5O5H@P	0.01
	H2O2H3O3H3O3H3O4H4O4H@L	0.01
	H2O2H3O3H3O4H4O4H@L	0.01
	H2O2H3O1H@O	0.01

Pattern Group	Pattern	%
	H4O5H5O5H@R	0.01
Single Tour - B (42)	H2O4H@B	73.9
	H2O3H@B	9.88
	H2O5H@B	6.04
	H3O3H@B	1.99
	H3O4H@B	1.61
	H1O4H@B	1.44
	H2O2H@B	1.19
	H1O3H@B	1.16
	H1O2H@B	0.71
	H4O4H@B	0.52
	H3O5H@B	0.34
	H1O5H@B	0.13
	H4O5H@B	0.11
	H2O2O4H@B	0.10
	H2O3O3H@B	0.09
	H2O3O5H@B	0.08
	H1O3O4H@B	0.05
	H2O3O3O5H@B	0.05
	H2O3O3O4H@B	0.05
	H1O1O1H@B	0.04
	H1O3O4O4H@B	0.04
	H2O3O4O4H@B	0.04
	H2O2O2O3H@B	0.04
	H1O1H@B	0.04
	H2O3O3O3H@B	0.04
	H2O3O3O4O4H@B	0.04
	H2O2O2H@B	0.04
	H1O1O3H@B	0.04
	H3O3O3H@B	0.03
	H2O2O4O4H@B	0.03
	H1O3O3O4H@B	0.03
	H2O3O4H@B	0.03
	H2O2O5H@B	0.02
Single Tour Off peak - P (49)	H3O3H@P	78.9
	H1O3H@P	9.89
	H3O3O3H@P	2.19
	H5O5H@P	2.19
	H3O3O4H@P	1.95

Pattern Group	Pattern	%
	H3O5H@P	1.81
	H1O5H@P	1.31
	H3O3O3O3H@P	0.42
	H3O3O3O4O4H@P	0.34
	H1O1H@P	0.32
	H3O3O4O4H@P	0.15
	H3O3O5H@P	0.13
	H3O3O3O3O3H@P	0.12
	H3O3O4O5H@P	0.06
	H5O5O5H@P	0.06
	H1O1O5H@P	0.04
	H1O3O4H@P	0.04
Single Tour Off peak - Sh (47)	H3O3H@Sh	90.3
	H3O3O3H@Sh	2.77
	H5O5H@Sh	1.99
	H3O5H@Sh	1.29
	H1O3H@Sh	0.99
	H3O3O4H@Sh	0.92
	H1O5H@Sh	0.54
	H1O1H@Sh	0.36
	H3O3O3O4H@Sh	0.18
	H3O3O3O3H@Sh	0.18
	H1O1O3H@Sh	0.09
	H3O3O4O4H@Sh	0.08
	H1O3O3H@Sh	0.07
	H1O1O2H@Sh	0.07
	H3O3O3O3O4O4H@Sh	0.06
	H3O3O3O5O5H@Sh	0.04
	H1O3O5H@Sh	0.04
	H3O3O4O4O4O4H@Sh	0.04
	H5O5O5O5O5O5H@Sh	0.04
Single Tour - L & O (45)	H2O3H@O	18.4
	H2O4H@O	18.1
	H3O3H@O	12.7
	H3O4H@O	7.43
	H2O3H@L	4.48
	H2O5H@O	3.46
	H2O2H@O	3.40
	H4O4H@O	3.39

Pattern Group	Pattern	%
	H2O4H@L	3.15
	H4O5H@L	3.12
	H4O4H@L	3.04
	H3O4H@L	2.64
	H4O5H@O	2.42
	H3O3H@L	1.78
	H1O3H@O	1.68
	H3O5H@O	1.58
	H1O4H@O	0.99
	H2O2H@L	0.95
	H5O5H@O	0.77
	H1O2H@O	0.64
	H3O5H@L	0.52
	H1O4H@L	0.48
	H2O5H@L	0.46
	H1O5H@O	0.39
	H2O3O3H@O	0.33
	H2O3O3O3H@O	0.29
	H3O3O3O4H@O	0.24
	H5O5H@L	0.24
	H1O2H@L	0.24
	H1O3H@L	0.23
	H3O3O3H@O	0.20
	H1O5H@L	0.20
	H2O3O3O3O3H@O	0.18
	H4O4O5H@L	0.16
	H4O4O4O4H@O	0.15
	H2O4O4H@O	0.15
	H2O2O3H@O	0.12
	H1O1H@O	0.12
	H2O2O3O4H@O	0.12
	H1O1H@L	0.11
	H1O1O2H@L	0.09
	H2O2O2H@L	0.08
	H2O3O3O4H@O	0.08
	H2O2O3H@L	0.08
	H2O5O5O5H@O	0.07
	H2O2O4O4H@O	0.07
	H2O3O3H@L	0.07

Pattern Group	Pattern	%
	H4O4O5H@O	0.07
	H2O4O5H@O	0.07
	H3O3O4H@O	0.07
	H2O2O4H@L	0.06
	H2O2O3O3H@O	0.06
	H2O3O4H@L	0.06
Single Tour - R (40)	H2O3H@R	24.3
	H4O5H@R	14.6
	H3O3H@R	14.2
	H4O4H@R	13.7
	H2O2H@R	11.2
	H2O4H@R	4.89
	H3O4H@R	4.66
	H5O5H@R	2.79
	H2O5H@R	1.40
	H1O2H@R	0.79
	H1O1H@R	0.71
	H1O4H@R	0.69
	H2O3O3H@R	0.68
	H1O5H@R	0.66
	H1O3H@R	0.63
	H2O2O3H@R	0.58
	H3O3O4H@R	0.54
	H4O5O5H@R	0.41
	H2O4O4H@R	0.39
	H4O4O5H@R	0.39
	H3O5H@R	0.39
	H2O2O2H@R	0.36
	H3O3O4O4H@R	0.23
	H3O3O3H@R	0.21
	H4O4O4H@R	0.20
	H2O3O3O3H@R	0.18
	H2O3O4H@R	0.07
	H2O3O5H@R	0.07
	H2O3O3O5H@R	0.05

Appendix – III: Sample Choice Model Code (Level 1)

```
# Initialise the code----

rm(list=ls())

apollo_initialise()

apollo_control=list(modelName ="Pattern_Choice_Model - Level 1",

                    modelDescr = "Choice model for activity patterns",

                    indivID = "ID",

                    nCores = 6

)

# Load data and preprocessing ----

database = read.csv("dataL1.csv",header = TRUE)

# Define parameters and starting values ----

apollo_beta = c(b_ageS1 = 0,

                b_ageS2     = 0,

                b_ageS3     = 0,

                b_ageS4     = 0,

                b_ageNS1     = 0,

                b_ageNS2     = 0,

                b_ageNS3     = 0,

                b_ageNS4    = 0,

                b_genS1     =0,

                b_genS2     =0,

                b_genNS1     =0,
```

```
            b_genNS2     =0,
            asc_S = 0,
            asc_NS = 0
)
apollo_fixed =
c("b_ageNS1","b_ageNS2","b_ageNS3","b_ageNS4","b_ageS4","b_genNS1","b_ge
nNS2","b_genS2","asc_NS"
)

# Validate inputs ----
apollo_inputs = apollo_validateInputs()

# apollo_probabilities function ----
apollo_probabilities = function(apollo_beta, apollo_inputs, functionality =
"estimate"){

  ### Attach inputd and detach after function exit
  apollo_attach(apollo_beta, apollo_inputs)
  on.exit(apollo_detach(apollo_beta, apollo_inputs))

  ### Create list of probabilities P
  P = list ()

  ### List of utilities
```

```
  V = list()


  V[['S']] = asc_S + b_ageS1*age1+ b_ageS2*age2+ b_ageS3*age3+
b_ageS4*age4+ b_genS1*gen1+ b_genS2*gen2


  V[['NS']] =  0
  ### Define settings for MNL model component
  mnl_settings   = list(
    alternatives = c(S=1, NS=2
    ),
    avail        = 1,
    choiceVar    = Category,
    V            = V
  )
  ### Compute probabilities using MNL model
  P[['model']] = apollo_mnl(mnl_settings, functionality)
  ### Prepare and return outputs of function
  P = apollo_prepareProb(P,apollo_inputs, functionality)
  return (P)
}
# Model estimate ----
model = apollo_estimate(apollo_beta, apollo_fixed, apollo_probabilities,
apollo_inputs)
```

```
# Model outputs ----

# To file

apollo_saveOutput(model)
```