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The dissertation titled "Investigating trip generation behavior during Medical Emergency in Bangladesh" submitted by Fardin Farhan Khan has been accepted as partial fulfillment of the requirement for the degree, Bachelor of Science in CivilEngineering.

Supervisor

____

Dr. Moinul Hossain

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Department of Civil and Environmental Engineering (CEE)

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Board Bazar, Gazipur, Bangladesh.

INVESTIGATING TRIP GENERATION BEHAVIOR DURING MEDICAL EMERGENCY IN BANGLADESH

BY

FARDIN FARHAN KHAN (170051003)

A Thesis Submitted in Partial Fulfilment of the Requirements for the Degree of

BACHELOR OF SCIENCE IN CIVIL ENGINEERING

DEPARTMENT OF CIVIL AND ENVIRONMENTAL ENGINEERING

ISLAMIC UNIVERSITY OF TECHNOLOGY

MAY 2022

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Declaration

This is to certify that the work provided in this thesis is the result of Fardin Farhan Khan's analysis and investigations under the direction of Dr. Moinul Hossain, Professor of the Department of Civil and Environmental Engineering (CEE), Islamic University of Technology (IUT), Dhaka, Bangladesh. It is also stated that neither this thesis nor any part of this thesis has been submitted for any degree or certificate elsewhere. The book acknowledges information obtained from others published and unpublished research, and a list of references is provided.

____

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Dedication

To my parents, relatives, all the well-wishers and respected faculty members for their utmost support, instructions and most importantly trusting me in my every stage of life.

Acknowledgement

All glory be to Almighty Allah, by whose mercy I was able to complete my research work. Allah, the most compassionate, the most benevolent, will always have my heartfelt gratitude.

I would like to show my utmost gratitude towards **Dr. Moinul Hossain**, Professor, Department of Civil & Environmental Engineering, IUT because of beinga mentor throughout this long journey. His intuition, support, and notion played a significant role during this research. This research was beyond thinking without his guidance and constant supervision. His time, motivation and ideas throughoutthe entire research work taking from the primary phase of the thesis which includes literature review, research topic finalization, methodology, analysis, revision, andfinalization is offered unconditionally. His constant instruction not only aided mein doing my thesis work without any difficulty but also helped me to finish it on time. I owe him a lot in this entire journey.

Dr. Md. Asif Raihan, Assistant Professor, Accident Research Institute (ARI), Bangladesh University of Engineering and Technology (BUET), has been extremely patient and helpful to me, because of that I am grateful to him. It would have been impossible to turn the study into an actuality in absenceof his careful oversight.

I would like to show respect and utmost gratitude to everyone involved throughout the journey who gave their time to help me in collecting all the data so that I couldcreate our own datasets. Finally, praise to my family members and everyone involved directly and indirectly who helped me bringing this research in light.

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List of Acronyms

AUC	Area Under the Curve
BBN	Bayesian Belief Network
CI	Conditional Independence
CPT	Conditional Probability Table
DAG	Directed Acyclic Graph
EM	Expectation Maximization
PC	Peter and Clark
FGD	Focus Group Discussion
IUT	Islamic University of Technology
LOO	Leave One Out

Abstract

Bangladesh being a densely populated country, the usage of private and public transportation is getting higher, thus increasing the rate of accidents day by day. The spike of road accidents creates an impact on road condition, vulnerability of different modes used by mass people and the chances of emergency dispatch im-mediately after the occurrence of emergency situations. Despite being the fastest growing country, Bangladesh is still lagging when it comes to ensuring road safety, emergency dispatch, infrastructure, and adequate treatment.

Research done before shows the lack of infrastructures as well as medical facilities, problems regarding trip generation and modal choice behavior when it comes to dispatching any victim by their family members and bystanders. Difficulties at the time of choosing proper mode impacts on the travel time to reach the destination,thus making patient more vulnerable before reaching any medical facility. Traffic congestion or narrow lanes creates a barrier to reach desired mode to reach the accident spot timely. In previous research, the uniqueness due to socio-economic aspects were not considered at all cases for a developing country like Bangladesh.The following research establishes a pathway with the socio-economic variables and creates dependency with the trip generation factors.

To determine the components, a causal link has been created between factors that indicate both demographic and risk perception that creates an impact on trip generation in urban and rural cities in Bangladesh. The Bayesian Belief Networkwas used to create the network, which itself was supported by previous research findings and technical expertise. The conditional independence-based PC technique has been used to create the Bayesian network. The data set was gathered from metropolitan like Dhaka, Rajshahi, Barishal and nearby districts. Usage of the expectation-maximization technique and sensitivity analysis, the Bayesian network was utilized to calculate the posterior probability considering all variables respectively to determine factors affecting trip generation.

Result shows that the type of mode selected, time of waiting, type of injury, in- come or educational background of both bystander and patients impacts on the trip generation of any emergency dispatch. The result from this research can be useful when it comes to decision making of a patient or bystander, companies working to ensure quick dispatch, policy makers, law enforcement agencies and medical service providers.

Keywords: Trip generation, Socio-economic, Bystander, Developing country, Bayesian network.

Chapter 1

Introduction

1.1 Background and Motivation

Individuals are evacuated from regions where they are suffering imminent or possible harm towards safer locales. Though rescue operations are commonly used in the aftermath of catastrophes of different scales, they may not always be the optimal protection mechanism for just about every threat. The success of an evacuation is influenced by the intensity of the threat as well as the amount of prior notice provided. Evacuees may as well be exposed to the danger if a high numberof cars deploy in a short time span, causing considerable delays in accessing refuge. Furthermore, because each place is physically distinct, the transportation systemsthat may be seen during an evacuation may differ (Herrera, Smith, Parr, & Wolshon, 2019).

Because Bangladesh is indeed a highly overcrowded country having limited geo- graphic territory, every piece of land is valuable, modifying and expanding road-ways is challenging because it involves several complex issues such as develop-mental projects, relocation, and user hardship. As a result, an unorganized mass transit system will result in future wealth, health, and time losses. (Hassan, Sarkar, Uddin, & Rahman, 2016).

In densely populated locations, the issue is aggravated by increased transportation. It is indeed crucial to figure out how road congestion impacts EMS accessibility insuch locations, especially where individuals are much more susceptible. Connectivity to EMS in intra city neighborhoods, which become generally occupied by impoverished populations, may just have exacerbated congestion problems much higher than other regions. Analyses that ignore traffic might not indicate the entire amount of EMS service differential, particularly the periodic unpredictability of such discrepancy. The issue is especially severe in metropolitan areas in emerging economies, which are frequently clogged with traffic at all hours of each day (Hu, Tan, Li, Wang, & Wang, 2020).

The state of mobility is always changing, and road system has been a key contributor especially in metropolitan regions. Analyzing EMS's reliance upon mass transit necessitates, a multi-faceted study that was taken into account a wide range of data, including EMS dispatching destinations, transport network geometry, and speed data. (Cho, You, & Yoon, 2017).

One sort of attempts is really to deploy Emergency Medical Services to the collision site rapidly and effectively. As being among the post-crash remedies, EMS has played an important part in minimizing deaths by delivering immediate assistance and evacuation to local hospitals. All health specialists agree that first six minutes following an accident are critical for saving the victim. There are three different forms of EMS pre-hospital service. One being the timestamp between the accident and confirmation to EMS, that is known as the crash-reporting intermission; the second is the timestamp between the confirmation to the Emergency management depot and the emergence of the EMS vehicle on site, which would be known as the reporting-scene intermission; and the third is the timestamp here between accession on the incident and the emergence at the health center, which is known as the scene-hospital intermission (Lee, Abdel-Aty, Cai, & Wang, 2018).

The allocation of the two factors of response time, travel time and waiting time which are required for exact forecasting of these performance metrics. The journey time towards location is generally the longest part of the reaction times for ambulances. Whereas these ambulance service' system performance objectives correlate to quantiles of the response time dispersion, knowing the complete response time dispersion is often beneficial for predicting indicators that are more directly linkedto victim's health outcomes (Ingolfsson, Budge, & Erkut, 2008).

EMS personnel, on the other hand, frequently react to all aspects of medical crises, and there may not be a specialized agency to deal with just one area of healthissue. Certainly, there seem to be ethical concerns about getting medical supplies that can then be utilized form of emergency since they are rigorously allotted to those other types of disasters. To address post-crash reaction, one need addresses the entire acute ambulance system in the hopes of improving EMS reaction to roadway collisions (Amorim, Antunes, Ferreira, & Couto, 2019).

EMS responsiveness studies have recently focused on fluid EMS, in which vehicles are dynamically assigned, deployed, or redirected to better prepare for the nearest future. Reduced roundtrip of modes times and cost savings together suggest increased BLS vehicle capability. The suggested method has the advantage upper hand of giving a much more realistic BLS vehicle proportioning since it prevents overestimating the resource's peak demand. Despite having a 30% error terms in demand projections, this strategy is still intriguing if we are positive of the hospitals covering each demand region (Hammami & Jebali, 2021).

This will not appear appropriate if a non-US situation to apply widely used in generalized EMS pre-hospital duration prediction focusing on US statistics. Authentic EMS travel data obtained from the research proposal study location should really be preferred by scholars. The EMS pre-hospital duration estimations will be improved by using regionally pertinent data that properly reflects the research area's practices (Patel, Waters, Blanchard, Doig, & Ghali, 2012).

Monitoring and evaluating medical information of arriving victims helped identify the mode and trip generation of transport to the emergency unit and delaying periods. The administration of inbound emergency calls as well as paramedic rides have also been logged. Numerous research findings in the HIC’s found that accelerated transportation from the spot of an encounter to a suitable health center, as well as instant resuscitation with effective professional basic first aid and highly developed life support pre-clinical care, might provide prompt and consistent clinical services and lessen many fatalities and disabilities. Thereis indeed a lack of concentration on emergency medical care in pre-hospital and between hospitals health care settings in low- and middle-income countries, which are ill-equipped and poorly organized to provide suitable, instant, and convenientexpert rescue care including first aid in crisis situations, resulting in higher strain of avoidable death and morbidity (Berg & Ihlström, 2019).

1.2 Purpose and Objectives

Identifying the socioeconomic characteristics which have a stronger impact on changes, interruption, and latency in trip generation during emergency dispatch which might be beneficial to policymakers, medical care providers, and patients. The prime objectives of our study are:

- Identifying the key elements influencing selection of mode during emergency.
- Establishing a causal link between individual elements
- To determine the influence of socioeconomic parameters such as age, gender, income, and level of education in terms of trip generation.
- Identifying the influence of trip variables which includes waiting time, travel time, and arrival time.

1.3 Scope of Study

The focus of the research is to identify crucial characteristics that motivate trip generation among patients or bystanders during emergency dispatch and to demon- strate a causal link in between these variables. During the survey section of this research, respondents and focus group participants came from various districts around the nation. The surveyed participants' variety guaranteed the most com- prehensive answer.

1.4 Thesis Outline

The dissertation is divided into six chapters. The following are brief descriptionsof the chapters:

Chapter 1: **Introduction-** The context, problem statement, goal, and objectiveof the study are all explained in this chapter.

Chapter 2: **Literature Review-** This section covers the pertinent pieces of literature that aided in the development among the most appropriate research planning process.

Chapter 3: **Study Area and Data Collection-** Scoping, bounding, and data acquisition strategies are discussed.

Chapter 4: **Methodology-** This chapter discusses the study's working process and displays the approach used to examine the data collected.

Chapter 5: **Analysis and Results-** This chapter examines how the data wasanalyzed and how the results were interpreted.

Chapter 6: **Conclusion and Recommendations-** This part summarizes the study's key results and discusses policy implications.

Chapter 2

Literature Review

2.1 Introduction

In a developing country like Bangladesh, the population growth increases the chance of the rate of accidents to occur and for all these cases emergency dispatchis a must to save the life of a victim. Study on the trip generation at the timeof emergency dispatch is not a well discussed scenario to the researchers workingon transportation in Bangladesh. This chapter begins with a discussion about trip generation and modal behavior at the time of emergency dispatch and impact of socioeconomic variables. Furthermore, alongside their approach and ultimate findings, a synopsis of current relevant literature undertaken locally and worldwide is examined in depth.

2.2 Trip Generation in Transportation Engineering

The traditional four-step transportation modeling approach generally employed for anticipating travel demand starts with trip generation. It forecasts the quantity of journeys that originate or end in a certain traffic monitoring region. Trip generation is considered a result of the socioeconomic characteristics of commune- ties on the domestic end of view. The number or frequency of travels is generatedby linking person, zone, and transportation infrastructure factors to the number or frequency of journeys. Techniques for predicting trip generation has typically placed a strong emphasis on statistical technique. These approaches need a thorough understanding of system connections present in the fundamental collected data. Again for operative transportation planners, many strategies for trip creation were also suggested (Christopher & Sydney, 1986).

2.3 Previous Studies on Trip Generation

Connecting patients and onlookers having different exercises is the primary objective of emergency medical services. The major goal of the investigation is to particularly operate by trip generation. Unsatisfactory medical functionality at the time of emergency would lead to less convenient methods and ineffective trip generation procedure. The capacity to connect with multiple events is how emergency medical services are typically described in the literature review.

When considering the benefits of EMS in the big and densely populated cities, the variation of spatial accessibility of related services has emerged as a significant problem. Response speed as well as time is crucial for providing immediate care, unlike certain government services. The time of response can be considerably influenced by serious traffic congestion that can be observed in the major cities. By impact on car ownership, site usage and mobility or accessibility factors may have some influence on household domestic trip patterns. Although studies that haven't always taken sociodemographic variations into account between householders and residential density (Ewing, DeAnna, & Li, 1996).

The goal is still to locate ambulance units which is modular and can have the smallest expense to the emergency medical service while as well as maintaining a predetermined time of response. One of the unique strategies is suggested that accounts for ambulance busy percentages while taking into consideration for-knowledge about paramedic travel. Such method is contrasted with its standard version, which disregards ambulance trips. We create two (2) linear mixed integer algorithms (Ben Cheikh, Tahon, & Hammadi, 2017).

EMS is mostly defined by the utility functions accounted for emergency vehicles, the destination and generation of the trip, and the length of the trip, with minimal consideration for personal preferences. The variety of the time taken for trip generation, the social economic as well as trip characteristics, time and cost in pursuing different dispatch vehicles can all have an effect on relative ease of access, based on study (Cascetta, Cartenì, & Montanino, 2013).

Based on the standpoint of Bangladesh being a developing country, the connection between trip generation and other socio-economic as well as demographic aspects discussed in such research.

Chapter 3

Study Area and Data Collection

3.1 Study Area

The data was collected by a survey conducted in different districts, the survey mostly covers districts that are nearby Dhaka which includes Naryanganj, Narsh- ingdi, Gazipur, also some other districts that are densely populated and requires quick dispatch. The districts are- Dhaka, Chittagong, Barishal, Rajshahi, Sylhet and so on.

Figure 3.1: Study Area

3.2 Data Collection

With a total of 2352 data is collected from 8 districts and parameters socio- economic demographic, destinations and time is considered throughout the entire survey. The questionnaire survey contains 57 questions, the information's considered are described below-

3.1.1 **Socioeconomic-** The age, gender income, education level of patient and bystander.

3.1.2 **Demographic-** Name of hospitals, accident location.

3.1.3 **Trip Characteristics-** Trip duration, waiting time, preferred mode of patient or bystander.

3.1.4 **Accident Characteristics-** Previous health condition, accident severity etc.

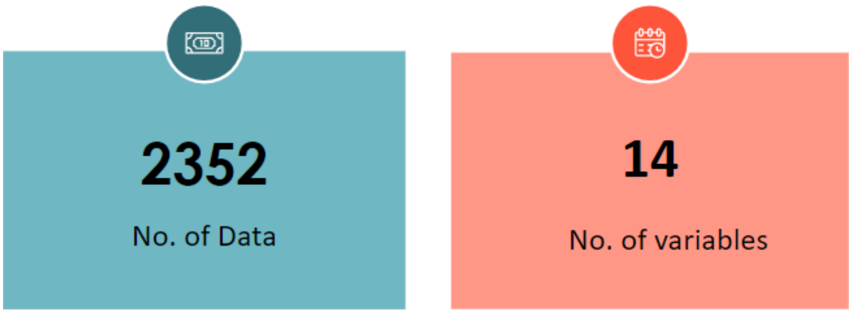


Figure 3.2: Data Collection

Chapter 4

Methodology

4.1 Introduction

The methodological strategy used for this study is described in depth in this chapter. The primary goal of this research has been to identify the socioeconomic parameters that influence trip generation during emergency dispatch scenarios in Bangladesh and to demonstrate a causative link between them. Be- cause such components are frequently interdependent and impacted by previous beliefs, conditional probability, likelihood functions can be utilized to demonstrate a causal link between them using the Bayesian Belief Network (BBN). The chapter offers a quick but detailed insight to the Bayesian Belief Network (BBN),as well as a demonstration of its usefulness to our study.

4.2 Workflow of the Research

The workflow of the research is given below:

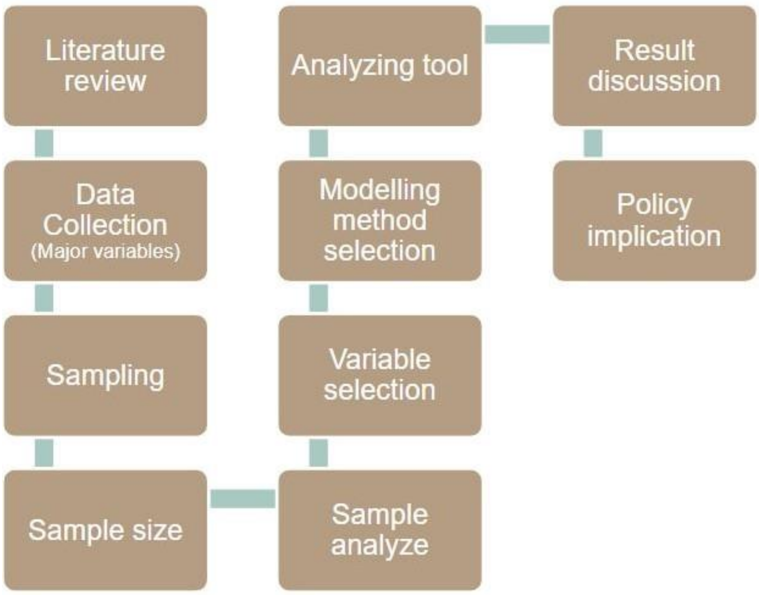


Figure 4.1: Workflow of the Research

The study process was initiated with a rigorous and extensive literature evaluation, that set the foundation for the survey questionnaire. Data was gathered througha field survey in which the questionnaire's significance and efficacy had previously been assessed through a pilot run and focus group discussion. After that, the data was processed and was run into a Bayesian network in method called DAG (Directed Acyclic Graph). Expert judgment and information gathered based on detailed literature review were used to trim and improve the proposed method. Upon completing all the preceding processes, the model was eligible to be asked questions and get responses.

4.3 Bayesian Belief Network (BBN)

The Bayesian Belief Network (BBN) is used in this study to determine the fundamental link among socioeconomic metrics and characteristics based on demography, as well as how these variables impact trip generation in emergency scenarios. A Bayesian network is a probabilistic graphical type of model for describing in- formation regarding an uncertain kind of domain, with each nodes expressing a random variable and each edge indicating the conditional distribution for those random variables. It has another name which is called as BNs. A BN relates toa directed acyclic graph (DAG) without any loops or internal connections due to interdependence and likelihood of an event.

The DAG is a very significant tool to generate a probabilistic model. Each DAG contains nodes which relate to arcs. There is an arc from where the entire network starts, which is called mother network. The Quantitative Prob-ability Table (CPT) shows the relation with one network with the other. The entireBayesian Network is formulated based on Bayes Rule (Wang & Vassileva, 2003).

$$P(A|B) = \frac{P(B|A)P(A)}{P(B)}$$

(1)

P(A) the probability of occurrence of A and P(B) is the probability of occurrence of B. P(A/B) indicates the probability of occurrence of A given that B has already occurred, and P(B/A) is the probability of B given that A has already occurred.

This theorem denotes the joint probability distribution systems in graph and can be shown as-

$$P(X_1, X_2, \ldots\ldots X_n) = \prod_{i=1}^{n} P(X_i | pa(X_i))$$

(2)

For learning Bayesian Network, proper set of data is required. The specialization in it and technical knowledge is also much required. The much-needed data was collected from the survey questionnaires conducted in different districts. Thedata was imported in GeNIe 2.5 Academic Version and the structured learning was done through PC algorithm. This method is constraint-focused, so it can be used for discovery. Conditional Intelligence (CI) is conducted by the software to find relations between the variables and for achieving joint probability distribution, it uses Expectation Maximization (EM) algorithm. EM first estimates the values of latent variables and then continues iterative process.

Bayesian Network can be used to determine 4(Four) kind of main analytical disciplines

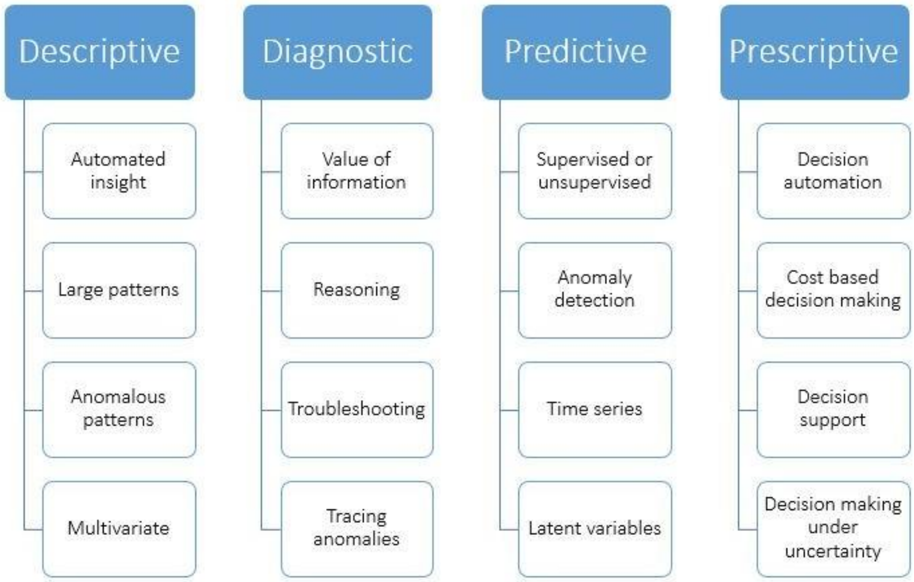


Figure 4.4: Descriptive, diagnostic, predictive prescriptive analytics with Bayesian networks

4.4 GeNIe Workspace

GeNIe Modeler is a visual decision theoretical modeling testing framework. During 1995 and 2015, it became conceived and developed at the University of Pitts-burgh's Decision Systems Laboratory. The program was created with the intentionof being utilized as key education and learning tools in institutions of higher learning, and it is now used at hundreds of universities all over the globe. GeNIe modelsmay well be integrated into any software and operate on any computing system.Propositions are represented by nodes in an acyclic directed graph in all these frameworks. Such nodes have always been propositional, with True and Falseas the only two possibilities. The program is built around several features that aid in determining the intended outcome, such as observing pre and posterior marginal probabilities, sensitivity analysis, tornado diagrams, and intensity of effect, among others.

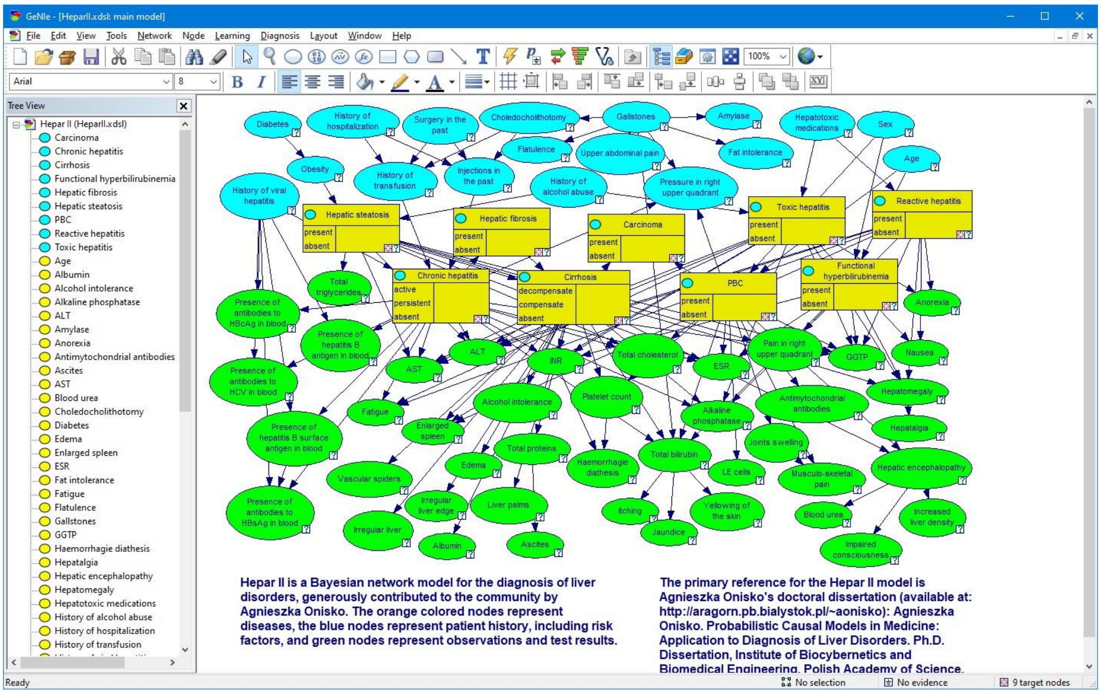


Figure 4.5: GeNIe Workspace

4.4 Model Development

The initial model was done by using PC algorithm. The network was further adjusted based on the correlation done using IBM SPSS Statistics 26 in order to find significance between two different variables. The correlation analysis is shown below-

Correlation

		Patient - Age	Patient - Gender	Patient - Income	Patient - Education Level	One who brought - Age	One who brought - Gender	One who brought - Income	One who brought - Education level	Time of accident	Trip duration	Mode choice	Transportation cost (In hundreds)	Accident Severity	Waiting time (In 20 minutes)
Patient - Age	Pearson Correlation	1.00	.064**	0.01	-.218**	-.079**	-.050*	.108**	.116**	.062**	.048*	-.191**	.211**	.486**	.228**
	Sig. (2-tailed)		0.00	0.50	0.00	0.00	0.01	0.00	0.00	0.00	0.02	0.00	0.00	0.00	0.00
	Sum of Squares and Cross-products	5487.26	114.48	105.61	-1670.01	-366.86	-81.03	901.94	708.94	175.04	126.96	-902.57	10267.14	1665.54	459.36
	Covariance	2.33	0.05	0.05	-0.71	-0.16	-0.03	0.38	0.30	0.07	0.05	-0.38	4.37	0.71	0.20
	N	2352.00	2352.00	2352.00	2352.00	2352.00	2352.00	2352.00	2352.00	2352.00	2352.00	2352.00	2352.00	2352.00	2352.00
Patient - Gender	Pearson Correlation	.064**	1.00	-.482**	-.101**	.059**	.140**	.073**	.170**	-0.01	-0.02	-.151**	.067**	0.02	-.066**
	Sig. (2-tailed)	0.00		0.00	0.00	0.00	0.00	0.00	0.00	0.63	0.34	0.00	0.00	0.25	0.00
	Sum of Squares and Cross-products	114.48	592.20	-1211.43	-254.09	89.54	73.74	199.24	341.07	-9.16	-17.20	-233.89	1062.31	26.55	-43.82
	Covariance	0.05	0.25	-0.52	-0.11	0.04	0.03	0.09	0.15	0.00	-0.01	-0.10	0.45	0.01	-0.02
	N	2352.00	2352.00	2352.00	2352.00	2352.00	2352.00	2352.00	2352.00	2352.00	2352.00	2352.00	2352.00	2352.00	2352.00
Patient - Income	Pearson Correlation	0.01	-.482**	1.00	.438**	-.047*	0.03	-.080**	0.04	.065**	-.053*	-.069**	-.043*	-0.04	.042*
	Sig. (2-tailed)	0.50	0.00		0.00	0.02	0.11	0.00	0.08	0.00	0.01	0.00	0.04	0.08	0.04
	Sum of Squares and Cross-products	105.61	-1211.43	10681.50	4680.41	-306.89	74.98	-934.17	303.91	255.24	-195.48	-453.18	-2883.27	-173.18	117.55
	Covariance	0.05	-0.52	4.54	1.99	-0.13	0.03	-0.40	0.13	0.11	-0.08	-0.19	-1.23	-0.07	0.05
	N	2352.00	2352.00	2352.00	2352.00	2352.00	2352.00	2352.00	2352.00	2352.00	2352.00	2352.00	2352.00	2352.00	2352.00
Patient - Education Level	Pearson Correlation	-.218**	-.101**	.438**	1.00	.074**	.110**	-0.01	.292**	.085**	-.140**	-.161**	-.121**	-.175**	-.083**
	Sig. (2-tailed)	0.00	0.00	0.00		0.00	0.00	0.70	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Sum of Squares and Cross-products	-1670.01	-254.09	4680.41	10707.61	478.29	247.22	-91.26	2488.55	334.47	-521.69	-1060.14	-8201.66	-839.44	-233.89
	Covariance	-0.71	-0.11	1.99	4.55	0.20	0.11	-0.04	1.06	0.14	-0.22	-0.45	-3.49	-0.36	-0.10
	N	2352.00	2352.00	2352.00	2352.00	2352.00	2352.00	2352.00	2352.00	2352.00	2352.00	2352.00	2352.00	2352.00	2352.00
One who brought - Age	Pearson Correlation	-.079**	.059**	-.047*	.074**	1.00	0.00	.179**	0.01	.049*	0.01	-.062**	.051*	0.01	-.043*
	Sig. (2-tailed)	0.00	0.00	0.02	0.00		0.91	0.00	0.63	0.02	0.51	0.00	0.01	0.55	0.04
	Sum of Squares and Cross-products	-366.86	89.54	-306.89	478.29	3933.00	-3.21	1265.11	51.75	116.46	30.59	-248.00	2095.11	36.14	-73.60
	Covariance	-0.16	0.04	-0.13	0.20	1.67	0.00	0.54	0.02	0.05	0.01	-0.11	0.89	0.02	-0.03
	N	2352.00	2352.00	2352.00	2352.00	2352.00	2352.00	2352.00	2352.00	2352.00	2352.00	2352.00	2352.00	2352.00	2352.00

Table 1-Correlation

One who brought - Gender	Pearson Correlation	-.050*	.140**	0.03	.110**	0.00	1.00	-.504**	-.055**	-0.04	-.086**	-.140**	-.042*	-.077**	-0.01
	Sig. (2-tailed)	0.01	0.00	0.11	0.00	0.91		0.00	0.01	0.08	0.00	0.00	0.04	0.00	0.62
	Sum of Squares and Cross-products	-81.03	73.74	74.98	247.22	-3.21	470.76	-1231.02	-97.66	-30.03	-66.74	-193.64	-591.31	-77.46	-6.01
	Covariance	-0.03	0.03	0.03	0.11	0.00	0.20	-0.52	-0.04	-0.01	-0.03	-0.08	-0.25	-0.03	0.00
	N	2352.00	2352.00	2352.00	2352.00	2352.00	2352.00	2352.00	2352.00	2352.00	2352.00	2352.00	2352.00	2352.00	2352.00
One who brought - Income	Pearson Correlation	.108**	.073**	-.080**	-0.01	.179**	-.504**	1.00	.328**	.099**	0.03	-.190**	.138**	.127**	-.091**
	Sig. (2-tailed)	0.00	0.00	0.00	0.70	0.00	0.00		0.00	0.00	0.20	0.00	0.00	0.00	0.00
	Sum of Squares and Cross-products	901.94	199.24	-934.17	-91.26	1265.11	-1231.02	12666.83	3035.58	420.91	106.09	-1360.18	10201.72	661.16	-278.86
	Covariance	0.38	0.09	-0.40	-0.04	0.54	-0.52	5.39	1.29	0.18	0.05	-0.58	4.34	0.28	-0.12
	N	2352.00	2352.00	2352.00	2352.00	2352.00	2352.00	2352.00	2352.00	2352.00	2352.00	2352.00	2352.00	2352.00	2352.00
One who brought - Education level	Pearson Correlation	.116**	.170**	0.04	.292**	0.01	-.055**	.328**	1.00	.045*	-.127**	-.267**	-0.01	0.01	-.123**
	Sig. (2-tailed)	0.00	0.00	0.08	0.00	0.63	0.01	0.00		0.03	0.00	0.00	0.74	0.81	0.00
	Sum of Squares and Cross-products	708.94	341.07	303.91	2488.55	51.75	-97.66	3035.58	6774.98	139.27	-374.98	-1399.25	-376.71	19.44	-274.85
	Covariance	0.30	0.15	0.13	1.06	0.02	-0.04	1.29	2.88	0.06	-0.16	-0.60	-0.16	0.01	-0.12
	N	2352.00	2352.00	2352.00	2352.00	2352.00	2352.00	2352.00	2352.00	2352.00	2352.00	2352.00	2352.00	2352.00	2352.00
Time of accident	Pearson Correlation	.062**	-0.01	.065**	.085**	.049*	-0.04	.099**	.045*	1.00	-.049*	-.064**	-0.02	.112**	0.01
	Sig. (2-tailed)	0.00	0.63	0.00	0.00	0.02	0.08	0.00	0.03		0.02	0.00	0.45	0.00	0.76
	Sum of Squares and Cross-products	175.04	-9.16	255.24	334.47	116.46	-30.03	420.91	139.27	1436.78	-66.15	-155.11	-384.25	195.97	6.57
	Covariance	0.07	0.00	0.11	0.14	0.05	-0.01	0.18	0.06	0.61	-0.03	-0.07	-0.16	0.08	0.00
	N	2352.00	2352.00	2352.00	2352.00	2352.00	2352.00	2352.00	2352.00	2352.00	2352.00	2352.00	2352.00	2352.00	2352.00
Trip duration	Pearson Correlation	.048*	-0.02	-.053*	-.140**	0.01	-.086**	0.03	-.127**	-.049*	1.00	0.03	.418**	.155**	.202**
	Sig. (2-tailed)	0.02	0.34	0.01	0.00	0.51	0.00	0.20	0.00	0.02		0.12	0.00	0.00	0.00
	Sum of Squares and Cross-products	126.96	-17.20	-195.48	-521.69	30.59	-66.74	106.09	-374.98	-66.15	1292.93	73.13	9861.48	257.42	197.81
	Covariance	0.05	-0.01	-0.08	-0.22	0.01	-0.03	0.05	-0.16	-0.03	0.55	0.03	4.20	0.11	0.08
	N	2352.00	2352.00	2352.00	2352.00	2352.00	2352.00	2352.00	2352.00	2352.00	2352.00	2352.00	2352.00	2352.00	2352.00
Mode choice	Pearson Correlation	-.191**	-.151**	-.069**	-.161**	-.062**	-.140**	-.190**	-.267**	-.064**	0.03	1.00	-.206**	-.167**	-.042*
	Sig. (2-tailed)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.12		0.00	0.00	0.04
	Sum of Squares and Cross-products	-902.57	-233.89	-453.18	-1060.14	-248.00	-193.64	-1360.18	-1399.25	-155.11	73.13	4059.00	-8598.13	-493.57	-72.77
	Covariance	-0.38	-0.10	-0.19	-0.45	-0.11	-0.08	-0.58	-0.60	-0.07	0.03	1.73	-3.66	-0.21	-0.03
	N	2352.00	2352.00	2352.00	2352.00	2352.00	2352.00	2352.00	2352.00	2352.00	2352.00	2352.00	2352.00	2352.00	2352.00

Table 2 - Correlation (Contd.)

Transportation cost (In hundreds)	Pearson Correlation	.211**	.067**	-.043*	-.121**	.051*	-.042*	.138**	-0.01	-0.02	.418**	-.206**	1.00	.357**	.276**
	Sig. (2-tailed)	0.00	0.00	0.04	0.00	0.01	0.04	0.00	0.74	0.45	0.00	0.00		0.00	0.00
	Sum of Squares and Cross-products	10267.14	1062.31	-2883.27	-8201.66	2095.11	-591.31	10201.72	-376.71	-384.25	9861.48	-8598.13	430840.44	10843.71	4933.86
	Covariance	4.37	0.45	-1.23	-3.49	0.89	-0.25	4.34	-0.16	-0.16	4.20	-3.66	183.26	4.61	2.10
	N	2352.00	2352.00	2352.00	2352.00	2352.00	2352.00	2352.00	2352.00	2352.00	2352.00	2352.00	2352.00	2352.00	2352.00
Accident Severity	Pearson Correlation	.486**	0.02	-0.04	-.175**	0.01	-.077**	.127**	0.01	.112**	.155**	-.167**	.357**	1.00	.226**
	Sig. (2-tailed)	0.00	0.25	0.08	0.00	0.55	0.00	0.00	0.81	0.00	0.00	0.00	0.00		0.00
	Sum of Squares and Cross-products	1665.54	26.55	-173.18	-839.44	36.14	-77.46	661.16	19.44	195.97	257.42	-493.57	10843.71	2143.83	284.41
	Covariance	0.71	0.01	-0.07	-0.36	0.02	-0.03	0.28	0.01	P	0.11	-0.21	4.61	0.91	0.12
	N	2352.00	2352.00	2352.00	2352.00	2352.00	2352.00	2352.00	2352.00	2352.00	2352.00	2352.00	2352.00	2352.00	2352.00
Waiting time (In 20 minutes)	Pearson Correlation	.228**	-.066**	.042*	-.083**	-.043*	-0.01	-.091**	-.123**	0.01	.202**	-.042*	.276**	.226**	1.00
	Sig. (2-tailed)	0.00	0.00	0.04	0.00	0.04	0.62	0.00	0.00	0.76	0.00	0.04	0.00	0.00	
	Sum of Squares and Cross-products	459.36	-43.82	117.55	-233.89	-73.60	-6.01	-278.86	-274.85	6.57	197.81	-72.77	4933.86	284.41	741.63
	Covariance	0.20	-0.02	0.05	-0.10	-0.03	0.00	-0.12	-0.12	0.00	0.08	-0.03	2.10	0.12	0.32
	N	2352.00	2352.00	2352.00	2352.00	2352.00	2352.00	2352.00	2352.00	2352.00	2352.00	2352.00	2352.00	2352.00	2352.00

Table 3-Correlation (Contd.)

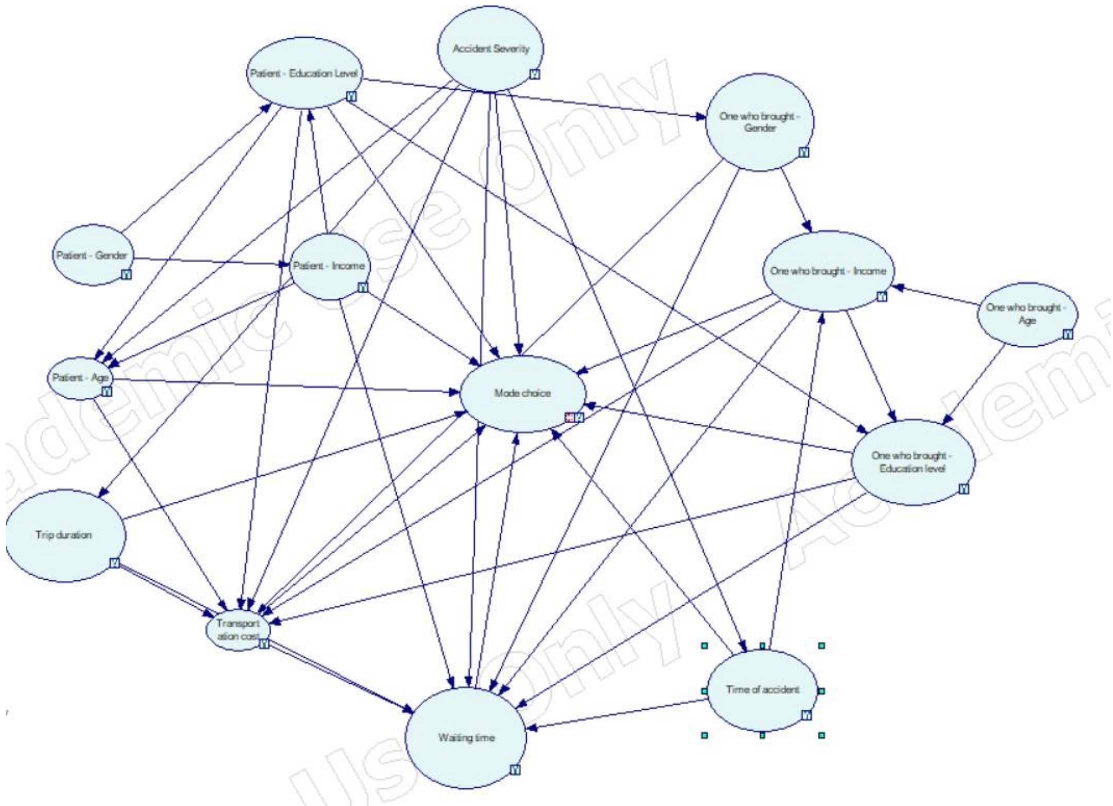


Figure 4.6: Bayesian Network for 'Trip Generation'

4.5 Model Validation

Leveraging GeNIe's built-in basic validation system, the models' correctness has been assessed. Because it would be the most effective approach having workable calculation period, the Leave One Out (LOO) technique was implemented during validation. LOO is indeed a technique for cross-validation in which the variable of interest is excluded from the records taken from the dataset during the network's training. This Receiver Operating Characteristics are now used to convey the evaluation's findings. (ROC) graph is technically a graph to plot sensitivity vs false positive rate in which the diagonal line denotes a perfect 50% probability of making a precise prediction. AUC is a number that ranges from 0 to 1, with a magnitude close to 1 indicating that the model being worked on is done effectively. AUC values greater than 0.7 are often regarded satisfactory for model evaluation.

In our study, the ROC curve for Trip Duration was 76% and ROC curve for waiting time was 86%. AUC value, suggestive of a good functioning model.

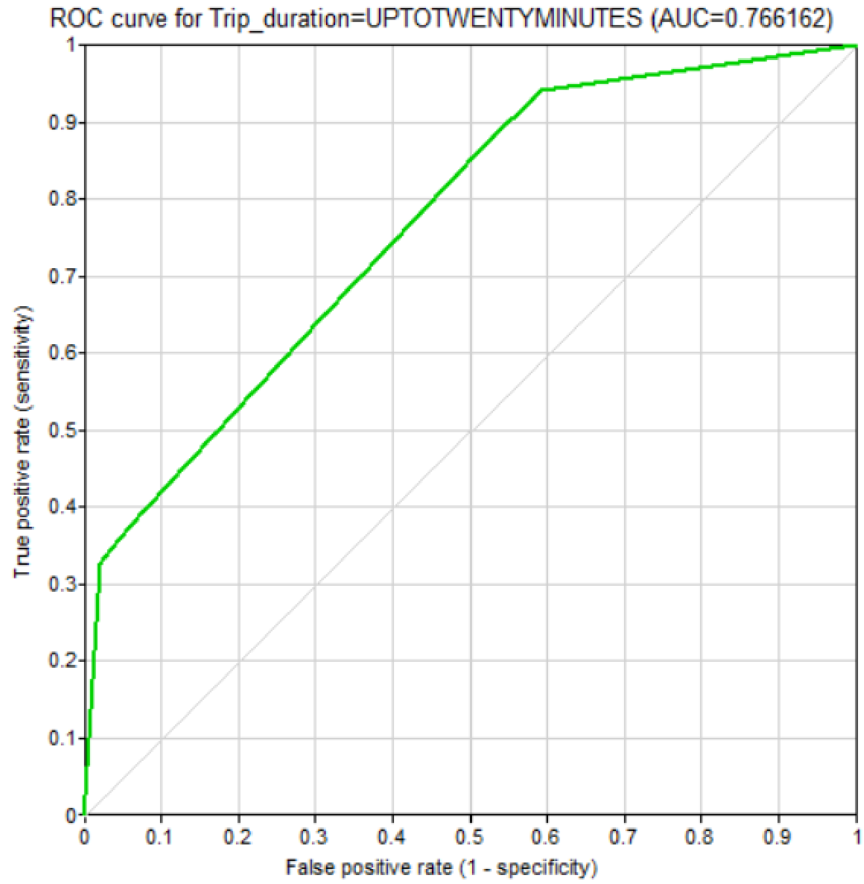


Figure 4.7: ROC curve for Trip Duration

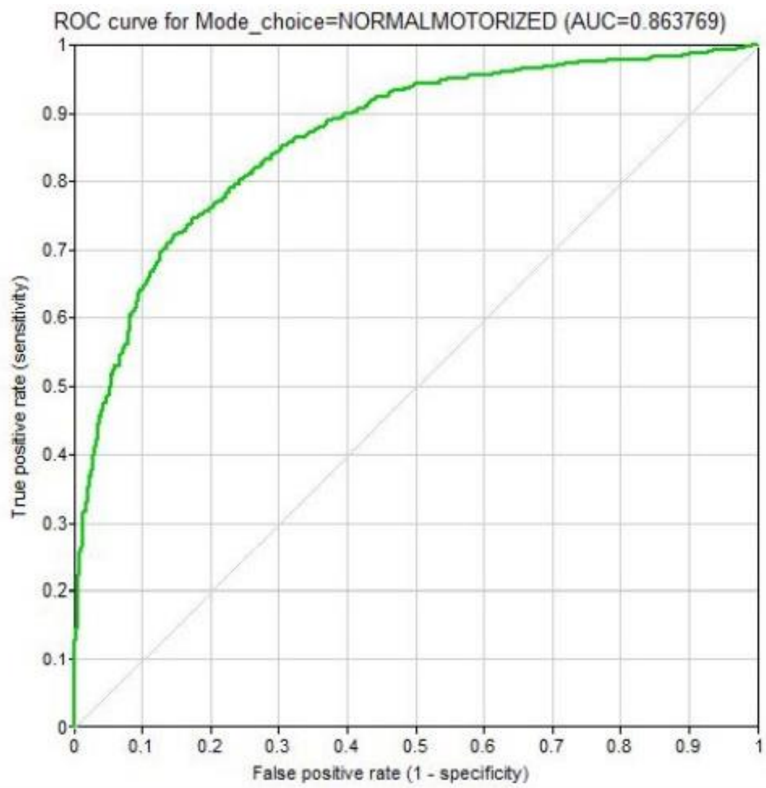


Figure 4.8: ROC curve for Waiting Time

A tabular design known as a confusion matrix aids in assessing an effectivenessof the algorithm. Every column inside a confusion matrix reflects the current classification, and that each row is for the anticipated class. The Confusion Matrix for waiting time and trip duration are shown below-

		Predicted		
		LESSTHAN...	TWENTYM...	TWENTYM...
Actual	LESSTHAN20MINUTES	**1018**	66	70
	TWENTYMINUTES	341	**71**	200
	TWENTYMINUTESPLUS	195	27	**364**

Figure 4.9: Confusion Matrix for Waiting Time

		Predicted			
		x	FOURTYMI...	TWENTYT...	UPTOTWE...
Actual	x	**0**	0	2	0
	FOURTYMINUTESPLUS	0	**38**	38	2
	TWENTYTOFOURTYMINUTES	0	14	**137**	7
	UPTOTWENTYMINUTES	0	6	28	**28**

Figure 4.10: Confusion Matrix for Trip Duration

Chapter 5
Analysis Result

5.1 Introduction

Upon finishing data processing through using BBN framework, following chapter highlights the study's key conclusions. Focusing on descriptive statistics, the questionnaire data was originally reclassified and reallocated. After that, the refined data was fitted together into Bayesian network. To comprehend the effects from every variable in chosen target variable, the Bayesian Network nodes have been adjusted and evaluated. The model underwent several analyses, including sensitivity analysis and tornado diagrams. Using the academic version of GeNIesoftware, its built-in model validation tool helped to evaluate the correctness ofthe model. The research's findings have been compiled once the analytical phase was finished and succinctly reported in this chapter.

5.2 Model Analysis

Initial phase of the analytical procedure utilizing GeNIe program is parameter learning. For this, GeNIe employs it's in-built EM (Expectation-Maximization) method. Upon completing EM method, marginal probabilities of each node were determined. This same total or combination of all the other possibilities of occurrences involving other variables for a specific incident involving the targeted variable is known as marginal probability. The study-based goal or variablesin this research," Trip Duration of a patient" and" Waiting time of a patient," strengthened the algorithms by removing the biased data.

The analysis has been broken up into the two segments" Trip Duration of a patient" and" Waiting Time of a patient" and looked at for changes in socioeconomic parameters to determine decisions regarding trip generation during an emergency.

5.3 Analysis of Waiting Time

The waiting time of a patient has been segmented into 3 parts, these contains the waiting time, which is below twenty minutes, waiting time equal to twenty minutes and waiting time more than twenty minutes.

At first, the data was imported as a csv. format in the GeNie software to conductthe research and after creating network, the parameters for trip duration was learnt using the default EM Algorithm of the software.

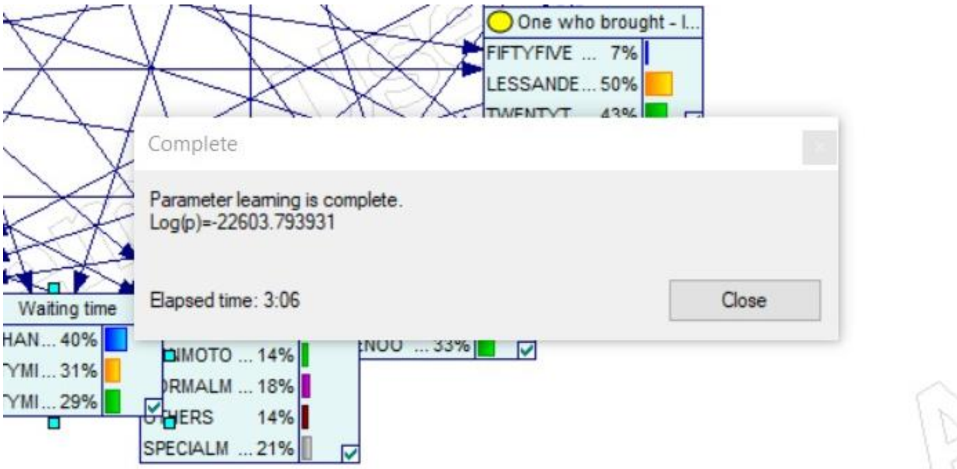


Figure 5.1: EM of Waiting Time

Upon completion of the EM algorithm, the new parameters were found using the learn parameters option. This is how the Prior marginal probability distribution diagram of ‘Waiting Time’ was achieved.

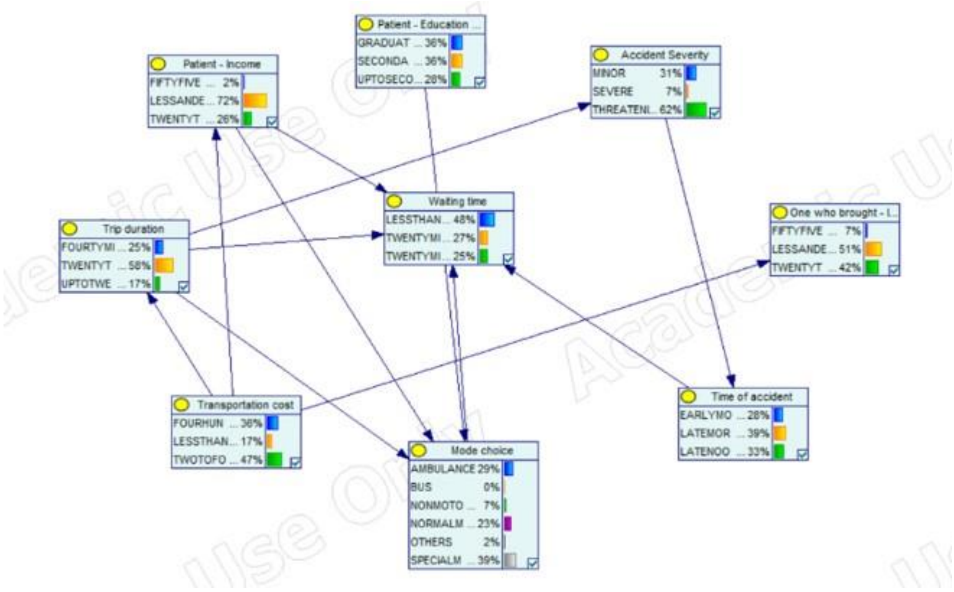


Figure 5.2: Prior marginal probability distribution diagram of ‘Waiting Time’

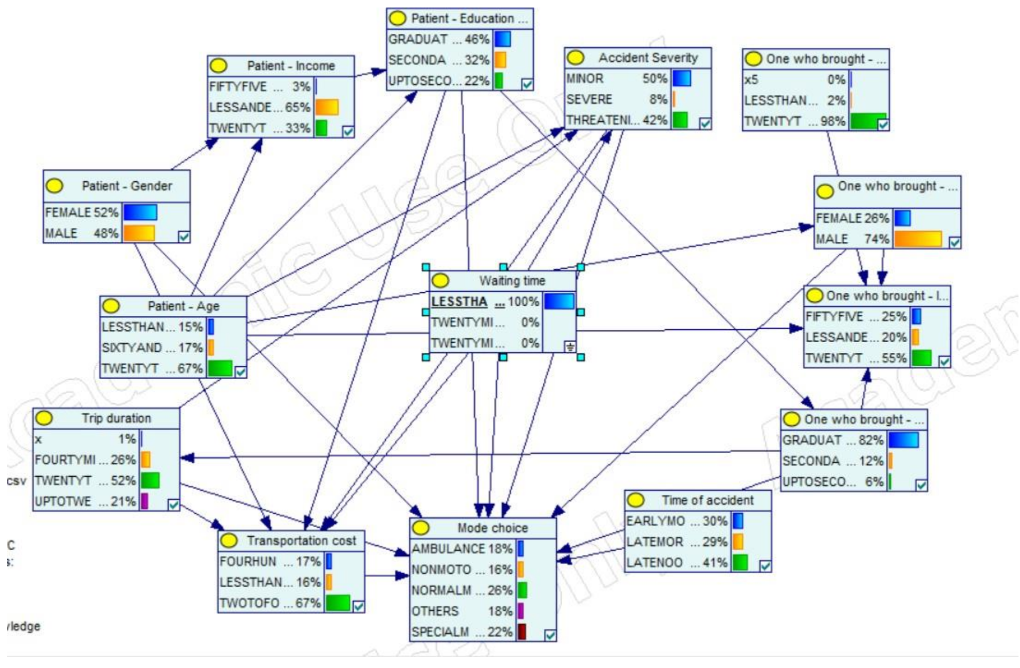


Figure 5.3: Posterior marginal probability distribution diagram of ‘Waiting Time’ when the duration of patient takes less than 20 minutes before trip

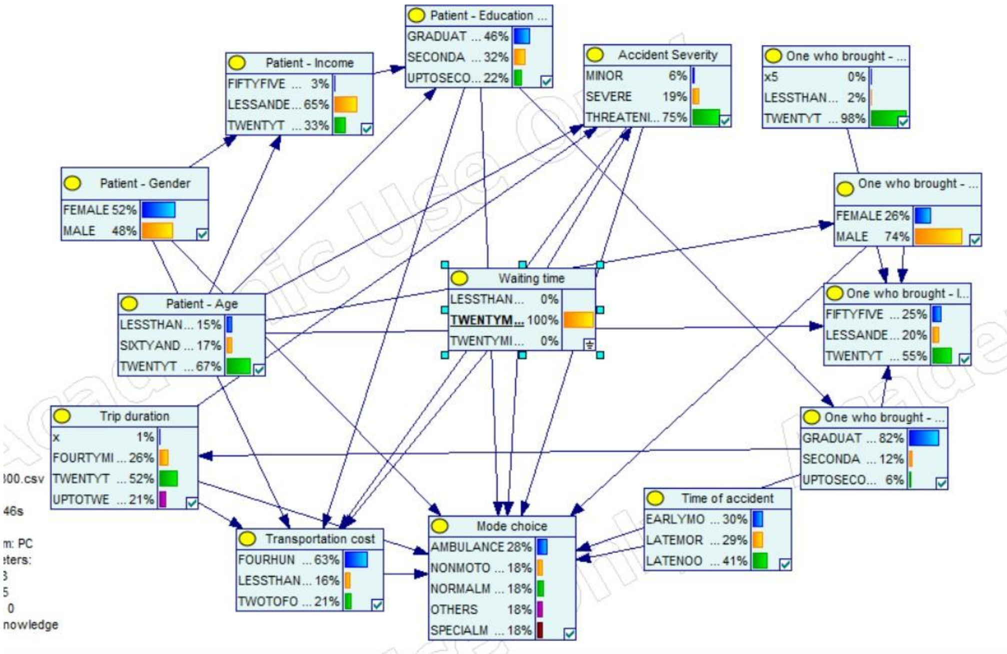


Figure 5.4: Posterior marginal probability distribution diagram of 'Waiting Time' when the duration of patient takes equal to 20 minutes before trip

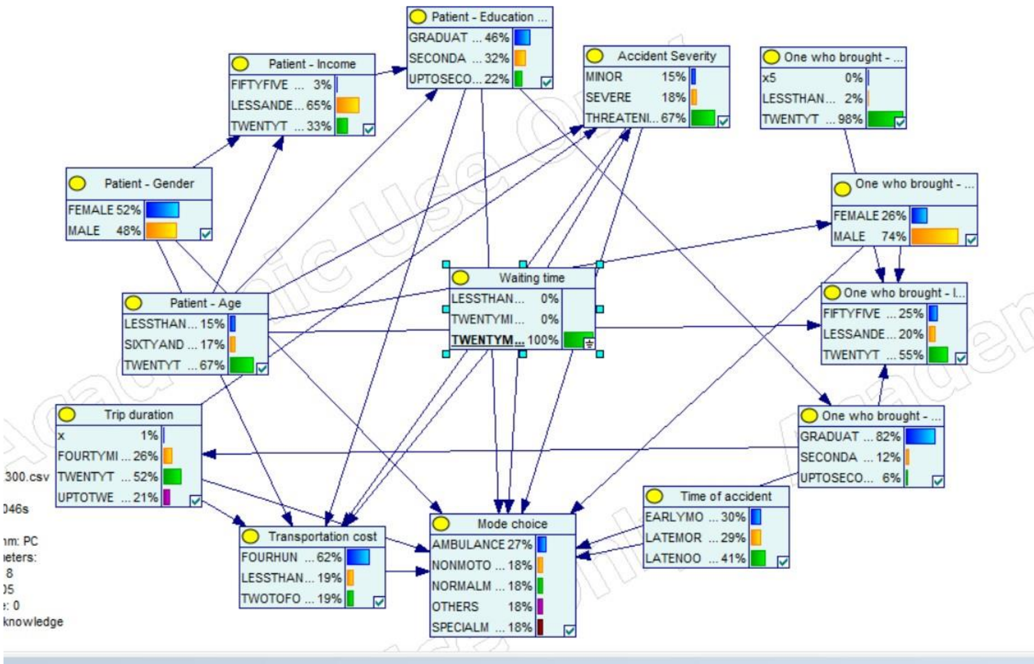


Figure 5.5: Posterior diagram of more than 20 minutes

The analysis shows that upon maximizing the percentage of waiting time being less than 20 minutes, the cost of transportation increases as the quick accessibility depends on high quality and fast vehicle, the percentage becomes high and stick to 67%. On the other hand, the usage of normal motorized vehicles increases and becomes 26%. It can also be seen that the severity also plays a key role because fast dispatch is needed when the accident is in a threatening level.

If the waiting time is maximized for the probability of the patients are waiting to get a mode more than 20 minutes, the trip duration is between 20 to 40 minutes by a percentage of 52%, the transportation cost becomes higher and 62% shows that the amount needs to be high to pressure modes like ambulance or other hospital-based dispatch service. The time of the accident is mostly late afternoon or at night because then is the time when the traffic is higher.

The maximization of the value of the time taken equal to 20 minutes doesn't affect that much in the model as the decision mostly varies based on the severity of the emergency, drip duration, selected mode and the distance from the spot of accident.

5.4 Sensitivity Analysis of Waiting Time

To learn more over the most important factors, sensitivity analysis was done on the current network model. GeNIe demonstrates the impact of changes in the target variable in a study which is called Sensitivity Analysis.

Target variable was mostly affected by the factors that are dark red in hue. The effect steadily reduces with a reduction in red color opacity. While the factors in grey really had no influence, those in white have a rather minimal effect on the targeted parameter.

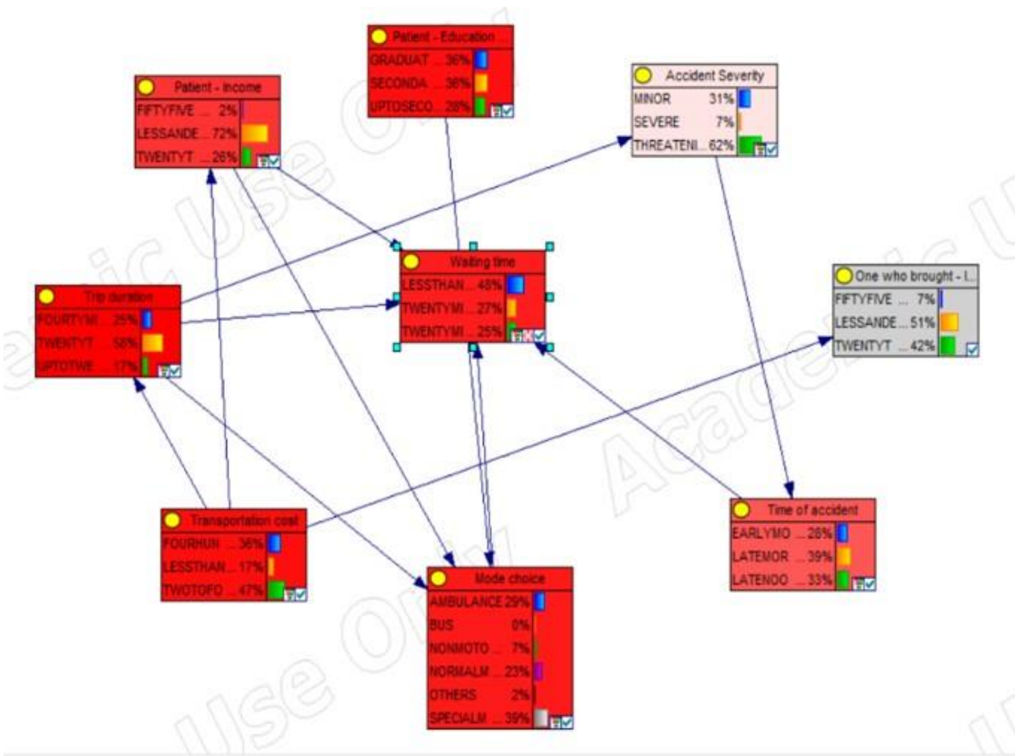
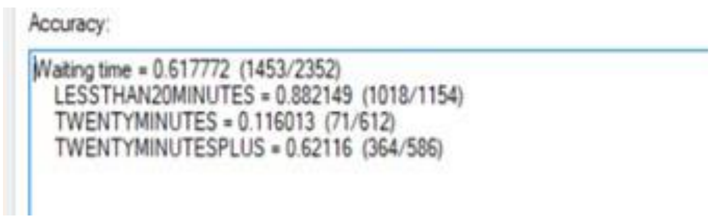


Figure 5.6: The BBN and key variables for ‘Waiting Time’

Based on observation after validation of the model, the accuracy test is also essential to evaluate target.

Figure 5.7: Model Accuracy for ‘Waiting Time’



For trip duration, accuracy test assessed for more than 20 minutes, it has been figured out 0.62116. For twenty minutes, it has been figured out 0.1160 and for less than twenty minutes 0.8821.

ROC curves are figured out later for all the three possibilities of waiting time.

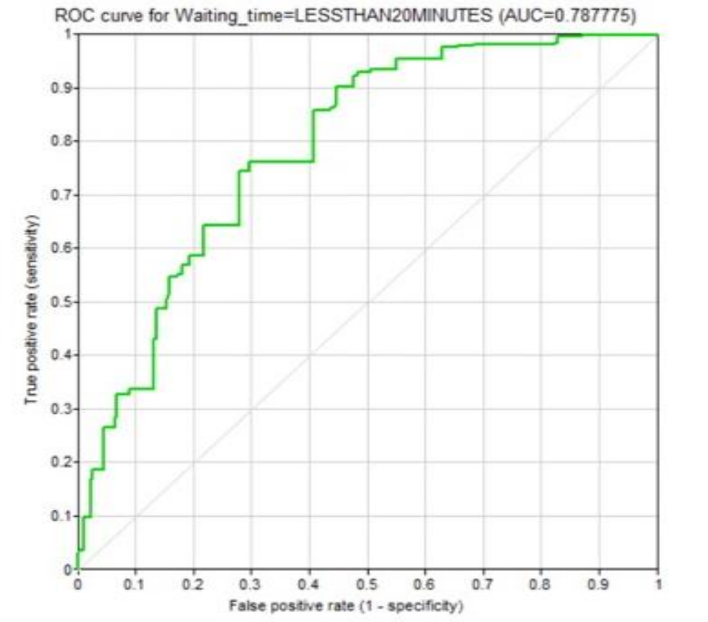


Figure 5.8: ROC curve for less than 20 minutes

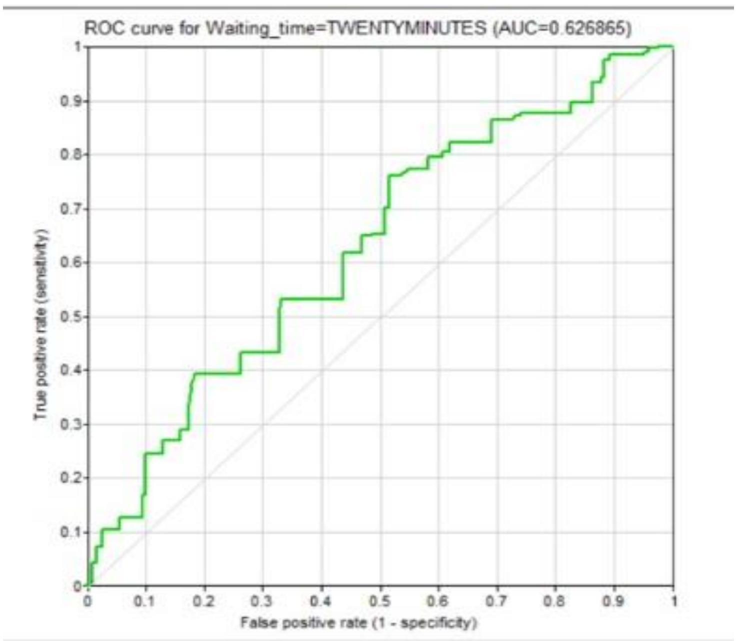


Figure 5.9: ROC curve for equal to 20 minutes

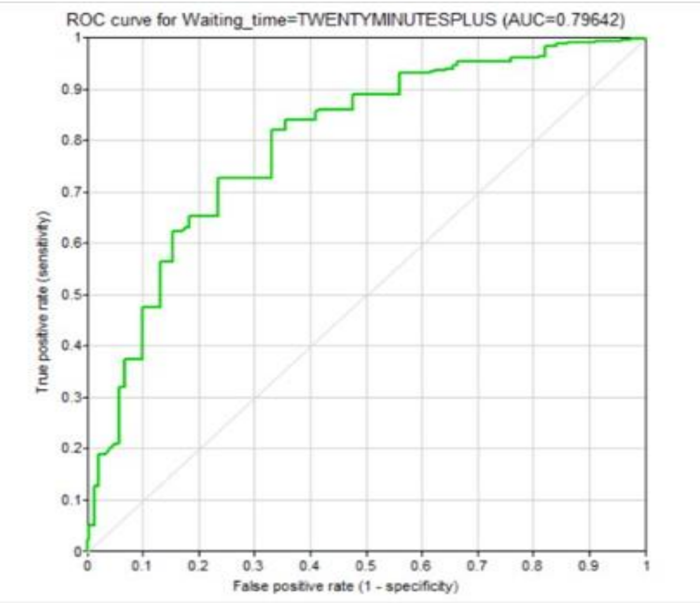


Figure 5.10: ROC curve for More Than 20 minutes

It can be seen that, ROC curve for waiting time less than 20 minutes is 0.787. For waiting time equal to 20 minutes, the curve is 0.626 and lastly the ROC curve for waiting time being more than 20 minutes stand into 0.796.

5.5 Analysis of Trip Duration

The trip duration of a patient has been segmented into 3 parts, which is the duration that are more than forty minutes, duration that are between twenty to forty minutes and lastly the duration of patient that are less than twenty minutes.

At first, the data was imported as a csv. format in the GeNie software to conductthe research and after creating network, the parameters for trip duration was learnt using the default EM Algorithm of the software.

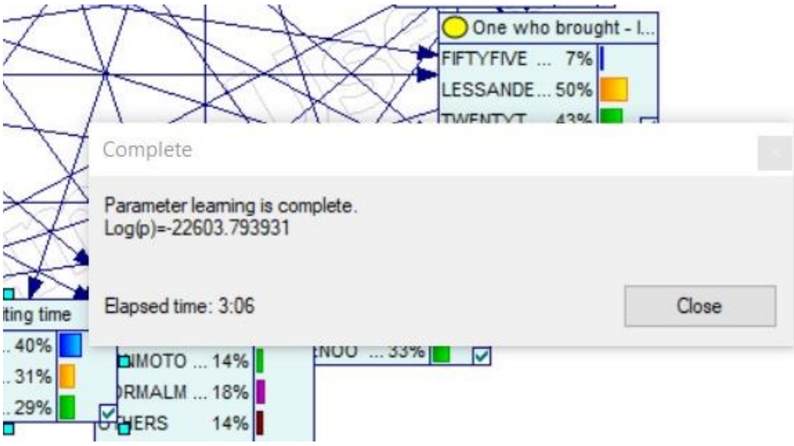


Figure 5.11: EM of Trip Duration

After the completion of the EM algorithm, the new parameters were found usingthe learn parameters option. This is how the Prior marginal probability distribution diagram of ‘Trip Duration’ was achieved.

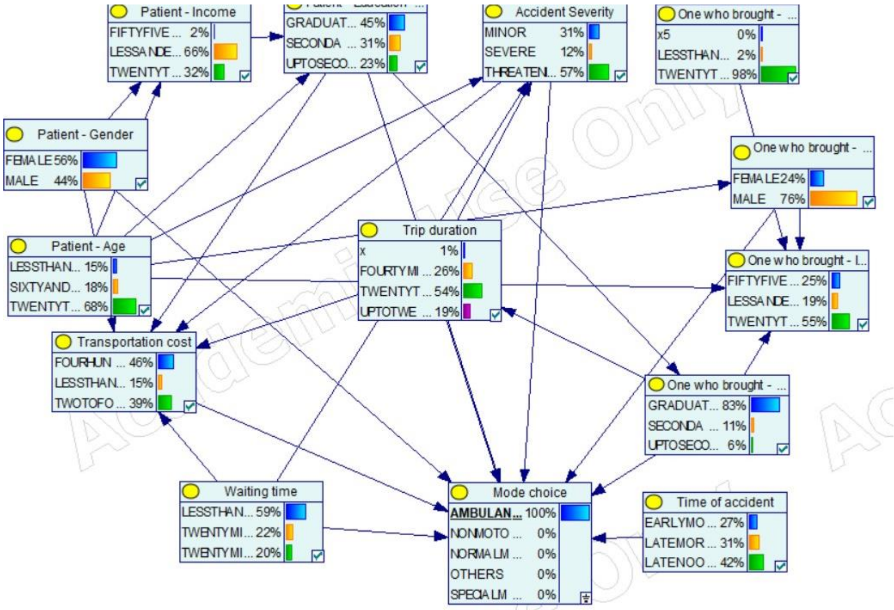


Figure 5.12: Prior marginal probability distribution diagram of ‘Trip Duration’

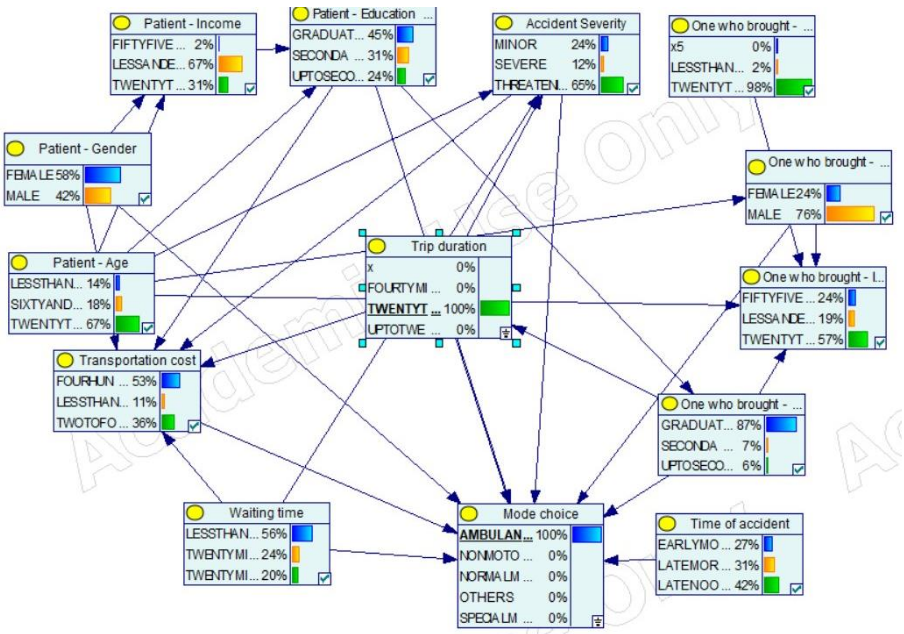


Figure 5.13: Posterior marginal probability distribution diagram of ‘Trip Duration’ when the duration of patient takes 20 to 40 minutes for trip

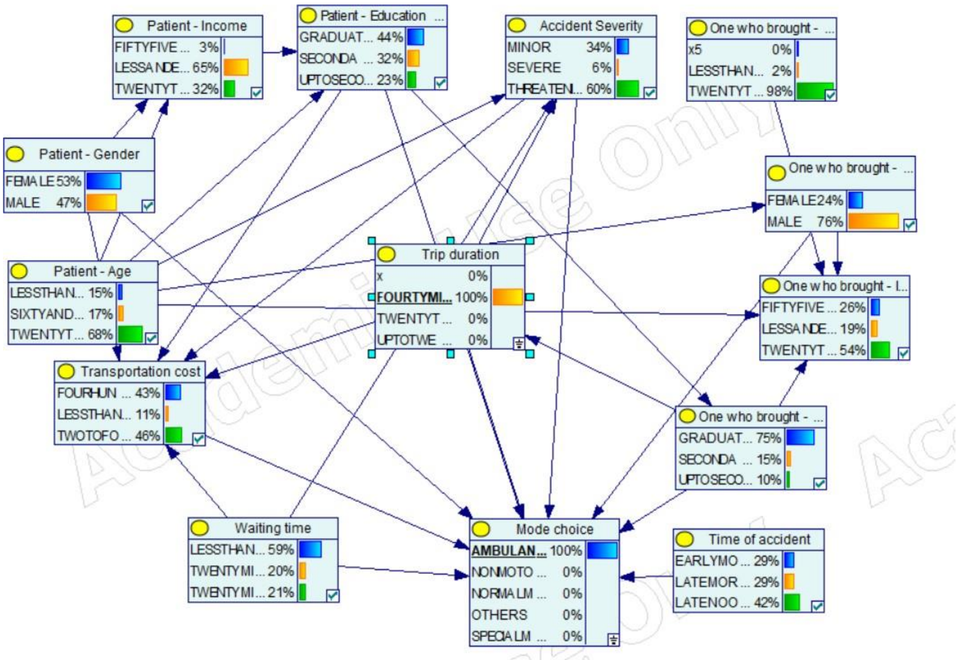


Figure 5.14: Posterior marginal probability distribution diagram of 'Trip Duration' when the duration of patient takes More Than 40 Minutes to trip

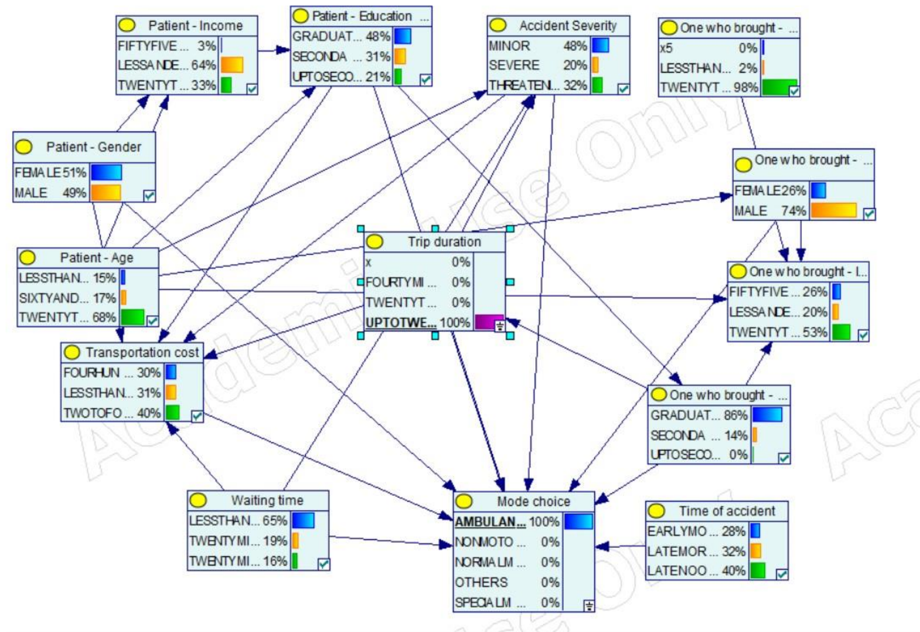


Figure 5.15: Posterior marginal probability of patient up to 20 minutes to trip

The analysis shows that upon maximizing the trip duration more than forty minutes, the transportation cost rises, and the higher value becomes 43%, the chance of getting an ambulance as a mode of transport becomes 100 % and waiting time also increases as ambulance takes more time the reach the spot. The severityof accident also changes since the need of ambulance is mostly needed when thepatient is in threatening condition.

If the trip duration is maximized for the probability of the patient's reaching hospital in up to 20 minutes, the waiting time decreases and the percentage of the severity of the accident moves towards the level where the patient faces a minoraccident. The mode is mostly focused on the unconventional ones since it takes less times to reach the medical facility than the ambulance. The transportation cost is shifted towards Taka two to four hundred by a margin of 40%.

The maximization of the value of the time taken between twenty to forty minutes doesn't affect that much in the model as the decision mostly varies based on the severity of the emergency and the distance from the spot of accident.

5.6 Sensitivity Analysis of Trip Duration

To learn more over the most important factors, sensitivity analysis was done onthe current network model. GeNIe demonstrates the impact of changes in the target variable in a study which is called Sensitivity Analysis.

Target variable was mostly affected by the factors that are dark red in hue. The effect steadily reduces with a reduction in red color opacity. While the factors ingrey really had no influence, those in white have a rather minimal effect on the targeted parameter.

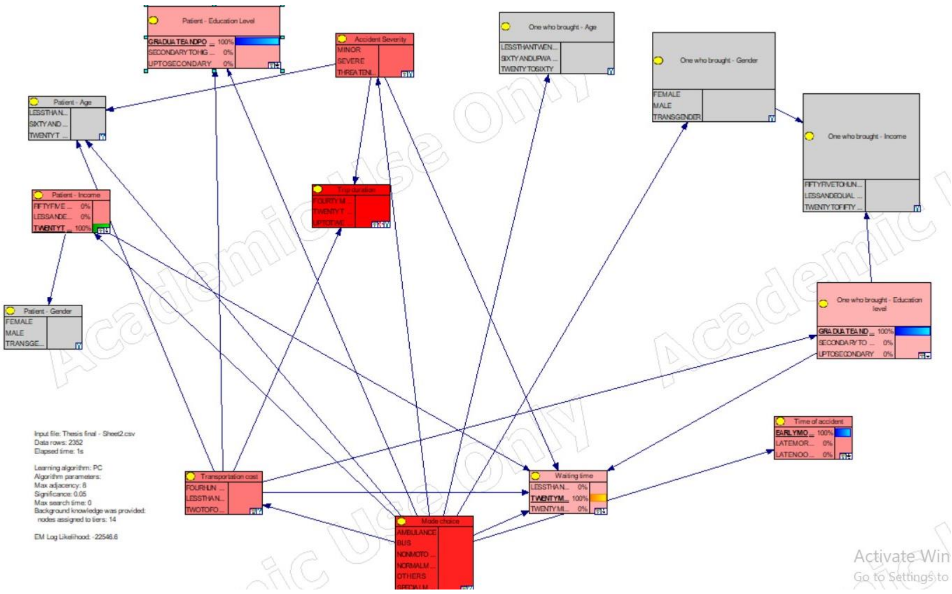


Figure 5.16: The BBN and key variables for ‘Trip Generation’

Based on observation after validation of the model, the accuracy test is also essential to evaluating target.

Accuracy:

Trip duration = 0.676667 (203/300)
x = 0 (0/2)
FOURTYMINUTESPLUS = 0.487179 (38/78)
TWENTYTOFOURTYMINUTES = 0.867089 (137/158)
UPTOTWENTYMINUTES = 0.451613 (28/62)

Figure 5.17: Model Accuracy for ‘Trip Generation’

For trip duration, accuracy test assessed for forty minutes plus, it has been figured out (40¿ minutes=0.48719). For twenty to forty minutes, it has been figured out (20-40 minutes=0.8670) and for up to twenty minutes (¡20 minutes=0.4516)

ROC curves are figured out later for all the three possibilities of trip duration.

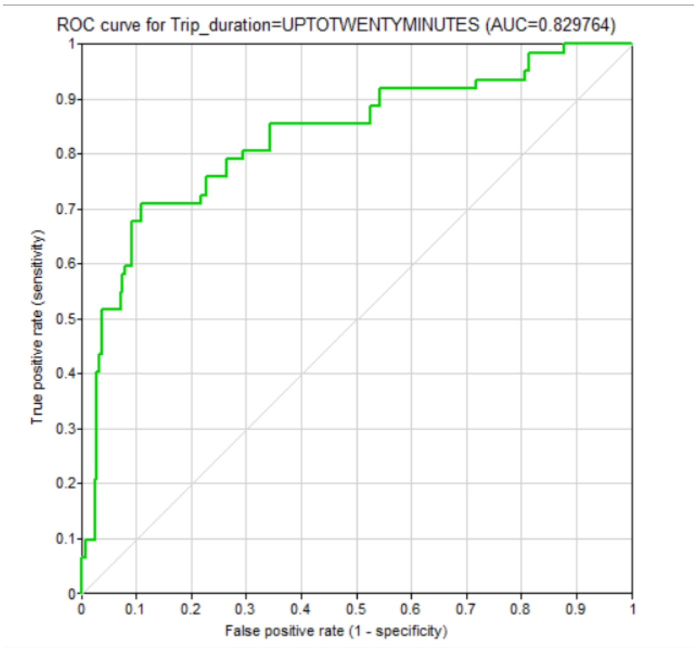


Figure 5.18: ROC curve for Up to 20 minutes

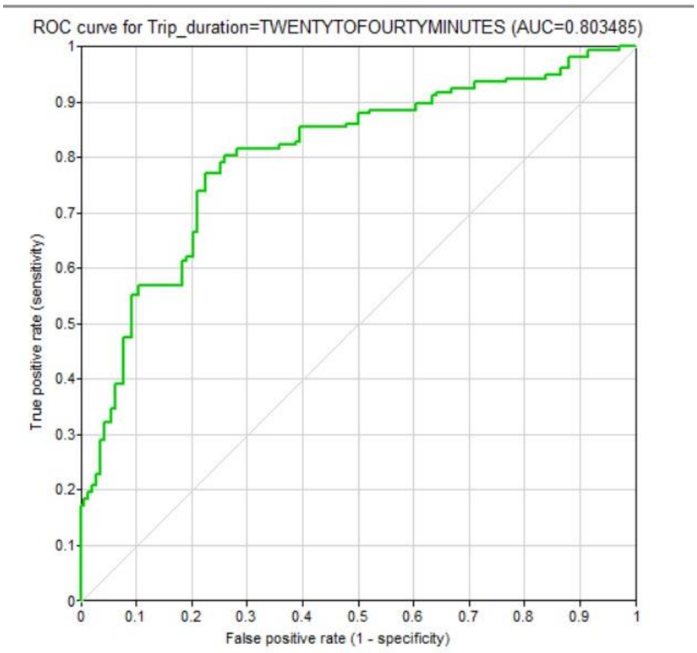


Figure 5.19: ROC curve for 20-40 minutes

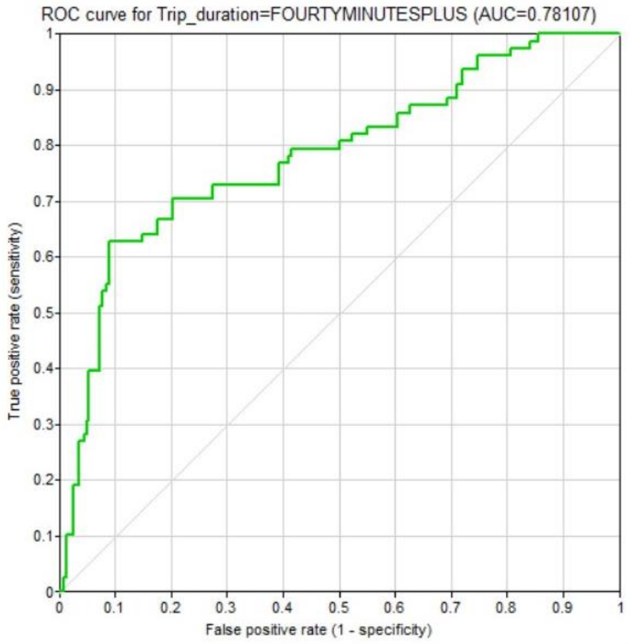


Figure 5.20: ROC curve for More Than 40 minutes

It is observed that ROC curve for trip generation time less than 20 minutes is 0.829. For trip generation time equal to 20-40 minutes, the curve is 0.803 and lastly the ROC curve for trip generation time being more than 40 minutes stand into 0.781.

Chapter 6
Conclusion and Recommendation

6.1 Introduction

In the final chapter, the main conclusions of research study are outlined, and based on the results, reasonable recommendations can be provided. Legislators, transportation engineers, different mode users, and any other right individuals may find the study, results, recommendations, and consequences useful. The limits and potential future directions of our work have indeed been discussed in the conclusion statement.

6.2 Key Findings of Trip Generation

6.2.1 Findings from Waiting Time

The main purpose of our study to link the waiting time before finding out a proper mode of dispatch with all the socioeconomic and demographic variables. Itis observed that the choice of mode varies based on the severity of any emergency and the arrival time of any mode is directly interconnected with the patient's waiting time. Here, the choice of selecting any mode of dispatch is also relatedto the income and education level of patient or bystander. The final observation suggests that the ambulance takes more amount of time to reach the accident site.

6.2.2 Findings from Trip Duration

The trip duration time denotes the time it takes to reach a certain destination. Thedata shows that the duration is based on the road condition and the mode chosenby the patient and bystander. Accident severity plays a pivotal role. If the type of themodes is different, the waiting time increases based on the study. Unconventional modes take much time to reach the destinations than the conventional ones.

6.3 Limitation and Future Study

Analyzing recent times, a significant focus has been given on deeperknowledge of the characteristics that impact patient and bystander experiences and observations including both advanced and emerging nations to im- prove the effectiveness of EMS. This is believed that one key factor influencing the continuous improvement of heavily populated areas would be the accessible of emergency vehicles.

Additionally, causal link between the elements that were found has been created, allowing for relatively easy observation of effects from one parameter upon other. This research may be regarded for the first of its type to investigate these elements throughout this manner. Nevertheless, there are several issues with limitations that need to be resolved.

The primary limitation is the survey location, with the wide range of data coming from different districts makes the analysis versatile. For this reason, much more variables can be considered in the future study. Focusing on one district and conducting multiple analysis may give more specific results. The destination of the patient and bystanders was not specified; hence it can be added in future.Participation of stakeholders, local government organization, medical facilities will be needed for more recommendations and policy implications.

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Appendix

EMS Questionnaire

Event specific (socioeconomic)

1. What is the age of the patient?
   ☐ <18 ☐ 18 – 25 ☐ 25 – 35 ☐ 35 – 50 ☐ 50 – 60 ☐ 60 – 65 ☐ ≥65

2. What is the sex of the patient?

   ☐ Male ☐ Female ☐ Transgender
   ☐ Prefer not to say

3. What is the income of the patient (in BDT)?
   ☐ <10k ☐ 10-15k ☐ 15-20k ☐ 20-25k ☐ 25-35k
   ☐ 35-45k ☐ 45-55k ☐ 55-65k ☐ 65-100k ☐ 100k+

4. What is the education level of the patient?
   ☐ Illiterate
   ☐ No formal education
   ☐ Drop-out from Primary level education
   ☐ Primary/ Ibtedayi
   ☐ Drop-out from Secondary level education
   ☐ Secondary (Includes Trace Certificate/SSC Vocational)/ Dakhil
   ☐ Higher Secondary (Includes 2 years of 4-year Diploma in Engineering & Nursing, HSC Vocational)/ Alim
   ☐ Diploma/Vocational (Not a Bachelors, like Associates)
   ☐ Graduate / Fazil
   ☐ Postgraduate / Kamil

5. What is the profession of the patient?
   ☐ Govt. employee
   ☐ Teacher
   ☐ Private employee
   ☐ Doctor
   ☐ Self-employed (business)/Freelance
   ☐ Engineer
   ☐ Garment worker
   ☐ Student
   ☐ Day laborer/ Rickshaw-puller
   ☐ Other: ____________________
6. How severe was the emergency?

   ☐ Severely life threatening
   ☐ Life threatening
   ☐ Not life threatening but will cause long term damage

☐ Minor injury / will not cause long term damage
☐ Non injury/ neutral / recovered

7. Did the patient have similar medical history before?
   ☐ Yes ☐ No ☐ Don't know

8. Who brought the patient to the hospital? (MA)

   ☐ Family/Relative ☐ Neighbor ☐ Bystander
   ☐ Others (Specify): ____________

9. What is the age of the person who brought the patient to the hospital?
   ☐ <18 ☐ 18 – 25 ☐ 25 – 35 ☐ 35 – 50 ☐ 50 – 60 ☐ 60 – 65 ☐ ≥65

10. What is the sex of the person who brought the patient to the hospital?

    ☐ Male ☐ Female ☐ Transgender
    ☐ Prefer not to say

11. What is the income of the person who brought the patient to the hospital (in BDT)?
    ☐ <10k ☐ 10-15k ☐ 15-20k ☐ 20-25k ☐ 25-35k
    ☐ 35-45k ☐ 45-55k ☐ 55-65k ☐ 65-100k ☐ 100k+

12. What is the education level of the person who brought the patient to the hospital?
    ☐ Illiterate
    ☐ No formal education
    ☐ Drop-out from Primary level education
    ☐ Primary/ Ibtedayi
    ☐ Drop-out from Secondary level education
    ☐ Secondary (Includes Trace Certificate/SSC Vocational)/ Dakhil
    ☐ Higher Secondary (Includes 2 years of 4-year Diploma in Engineering & Nursing, HSC Vocational)/ Alim
    ☐ Diploma/Vocational (Not a Bachelors, like Associates)
    ☐ Graduate / Fazil
    ☐ Postgraduate / Kamil

13. What is the profession of the person who brought the patient to the hospital?
    ☐ Govt. employee
    ☐ Teacher
    ☐ Private employee
    ☐ Doctor
    ☐ Self-employed (business)/Freelance ☐ Engineer
    ☐ Garment worker
    ☐ Day laborer/ Rickshaw-puller
    ☐ Student
    ☐ Other: ______________________

14. Did person who brought the patient to the hospital have similar experience (Taking an emergency patient to hospital) before?
    ☐ Yes ☐ No

(Spatial and Temporal Data)

15. What was the approximate time of the emergency?

16. When did you decide to take the patient to the hospital?

17. Where did you leave from?

18. What time did you leave?

19. When did you arrive at the hospital?

20. Which hospital did you take the patient to?

21. When did the patient first get medical attention?

22. Did the patient receive any prehospital medical care?

☐ Yes ☐ No

(Mode Choice)

23. Does the patient's family have a car?

☐ Yes ☐ No ☐ Don't know

If yes:

i. Was it available during the emergency?

☐ Yes ☐ No

24. What was your method of transportation?

☐ Your own car ☐ Rental car ☐ Rickshaw
☐ Ambulance ☐ CNG ☐ Taxicab
☐ Human hauler ☐ Electric rickshaw ☐ Van
☐ Motorcycle ☐ Tractor ☐ Pick up
☐ Bus ☐ private vehicle of bystander
☐ Uber ☐ Other (Specify): _______________

25. Why did you choose the mode you used to bring the patient to hospital?

26. How many minutes did you have to wait to get that mode of transport?

27. What was the cost of transportation (in BDT)?

28. Did you call 999 for assistance?

☐ Yes ☐ No

If yes,

i. How long did they take to connect you to an ambulance? (In minutes)

ii. How long did it take for the ambulance to arrive? (In minutes)

If no,

i. Why did you not call 999?

29. Do you know how to contact an ambulance?

☐ Yes ☐ No

If yes and you didn't avail, it:

i. Why did you not take an ambulance?

☐ Costly ☐ Unreachable/Unavailable

☐ Slow to respond ☐ Access to private vehicle

☐ Accident close to hospital ☐ Others (Specify): ____________________

ii. If the ambulance overcame the problem you mentioned in previous question, would you avail it?

☐ Yes ☐ No

If you took or tried to take an Ambulance:

i. At what time did you call the ambulance?

ii. Did they answer?

- ☐ Immediately
- ☐ Took long time to answer
- ☐ Line was busy
- ☐ No answer

30. Do you have any smart phone?
    ☐ Yes ☐ No

(Destination Choice)

31. Do you know how to use your phone to find out nearby hospital locations and roadway traffic?
    - ☐ Yes
    - ☐ No
32. How did you determine the route used to access hospital?
    - ☐ Using google map
    - ☐ Taking help from the bystanders
    - ☐ Relying on the driver of the vehicle
    - ☐ Others (Specify)______________________
33. Based on the emergency, did you use the wrong side of the road while accessing the hospital?
    - ☐ Yes
    - ☐ No
34. Does the hospital you brought the patient to provide ambulance to bring patient to hospital?
    ☐ Yes ☐ No ☐ Don't know
35. Do you know the phone number of the hospital you took the patient to?

    ☐ Yes ☐ No

36. Did you contact the hospital before bringing the patient?

    ☐ Yes ☐ No

37. Did you face any difficulty while bringing the patient to hospital?
    ☐ Traffic congestion ☐ Bad weather ☐ Bad Road condition
    ☐ Political unrest situation ☐ Legal issues ☐ Other (Specify)_____
38. Do you know any other nearby hospitals you could take the patient and get treatment immediately?

    ☐ Yes ☐ No

    If yes:

    i. Please name the hospitals and mention why you decided not to take the patient there.

39. Why did you take the patient to this hospital?

40. What was the initial out of pocket expenditure at the hospital?

(Mode choice- General)

41. In terms of calling emergency support, what do you prefer?

- ☐ Government helpline (999)/app
- ☐ Third party app
- ☐ Dial up numbers
- ☐ Help from bystanders/nearby police
- ☐ Others (Specify)________________

42. How do you rate the availability of transport in that area?

	Readily available	Available	Somewhat available	Not so available	Very difficult to avail
Ambulance					
Rickshaw					
Rental car					
CNG					
Taxicab					
Human hauler					
Taxicab					
Van					
Motorcycle					
Electric Rickshaw					
Tractor					
Pickup					
Uber/Pathao					

43. How do you rate the rapidness of transport of these modes for that particular case?

	Very Rapid	Rapid	Neutral	Slow	Very Slow
Ambulance					
Rickshaw					
Rental car					
CNG					
Taxicab					
Human hauler					

Taxicab					
Van					
Motorcycle					
Electric Rickshaw					
Tractor					
Pickup					
Uber/Pathao					

44. How do you rate the convenience of each mode?

	Very convenient	Convenient	Neutral	inconvenient	Very inconvenient
Ambulance					
Rickshaw					
Rental car					
CNG					
Taxicab					
Human hauler					
Taxicab					
Van					
Motorcycle					
Electric Rickshaw					
Tractor					
Pickup					
Uber/Pathao					

45. How do you rate the expense of the modes?

	Very Expensive	Expensive	Neutral	Cheap	Very cheap
Ambulance					
Rickshaw					
Rental car					
CNG					
Taxicab					
Human hauler					
Taxicab					
Van					
Motorcycle					
Electric Rickshaw					
Tractor					
Pickup					

Uber/Pathao					

46. Which factor do you consider the most important while choosing a mode for emergency transfer?

☐ Availability ☐ Rapidness ☐ Expense ☐ Convenience

☐ Other (Specify)________________________

47. If there were no constraints (time/convenience/rapidness/expense) what would be your preferred mode?

☐ Your own car ☐ Rental car ☐ Rickshaw
☐ Ambulance ☐ CNG ☐ Taxicab
☐ Human hauler ☐ Electric rickshaw ☐ Van
☐ Motorcycle ☐ Tractor ☐ Pick up
☐ Bus ☐ private vehicle of bystander
☐ Uber ☐ Other (Specify): _______________

(Destination Choice)

48. Which factor do you think have the most impact in choosing a hospital?

☐ Nearest to the emergency point
☐ Specialization of the hospital for the specific type of emergency
☐ Recommendation (of the driver, police, neighbor, or bystander)
☐ Patient preference (most known to patient)
☐ Attendant's preference (most known to attendant)
☐ Sudden decision
☐ Others (Specify): _______________________________________

49. While accessing hospitals, which matter do you think need improvement the most according to your opinion?

☐ Better integration of ambulance to 999 ☐ Ambulance dispatch time

☐ Quality of ambulances ☐ Affordability of ambulances ☐ Emergency response time ☐ Integration of ambulances with hospitals

☐ Others (Specify)___________________________

50. Which type of hospital do you prefer in general?

☐ Government ☐ Private
☐ Hospitals with medical colleges
☐ Specialized for specific purpose
☐ Others (Specify)_______________

51. What do you think is the main advantage of Government hospitals?

☐ Cost ☐ Easily accessible ☐ Availability in proximity

☐ Qualified doctors ☐ Well-equipped

☐ Others (Specify)____________________

52. What do you think is the main disadvantage of Government hospitals?

☐ Slow to respond ☐ Over-crowded ☐ Negligence

☐ Delayed test results ☐ Service ☐ Under staffing

☐ Doctors' unavailability at a vital time ☐ Others (Specify)_______________

53. What do you think is the main advantage of Private hospitals?
☐ Rapid response ☐ Service ☐ Availability of doctors at vital time

☐ Qualified doctors ☐ Well-equipped ☐ Availability in close proximity

☐ Priority given to patients ☐ Presence of dedicated emergency vehicles ☐ Others (Specify)_________________

54. What do you think is the main disadvantage of Private hospitals?
☐ Cost ☐ Distance ☐ Lack of equipment ☐ Service

☐ Others (Specify)_______________

55. What do you think is the most significant factor in choosing the hospital?

☐ Cost ☐ Rapid response ☐ Service ☐ Equipment ☐Staffing
☐ Distance ☐ Situation ☐ Other (Specify)_____

56. If there were no constraints (expense/availability/service) where would you take the patient?

☐ Public Hospital ☐ Private hospital ☐ Others (Specify)__________________

57. In hospitals which sector in your opinion needs improvement the most?
☐ Affordability ☐ Equipment ☐ Qualified doctors ☐ Proper staffing
☐ Faster emergency response ☐ Faster test results ☐ Service
☐ Ambulance attachment ☐ Increasing number of hospitals
☐ Control overcrowding ☐ Resource allocation
☐ Other (Specify)_____________________

58. How satisfied are you with the existing Emergency Response Facility?

☐ Very satisfied ☐ Satisfied ☐ Neutral ☐ Unsatisfied ☐ Very unsatisfied

59. What is the condition of the patient?

☐ Brought dead ☐ Died at the hospital after treatment ☐ Undergoing treatment
☐ Discharged ☐ Others (Specify) _________________

If the patient died at the hospital after treatment,

i. Did he/she die because of the emergency to which he/she was admitted??
☐ Yes ☐ No
ii. After how many days of treatment did, he/she die?

If the patient was discharged,

i. The patient was discharged in which condition?

☐ Handicapped/ Permanently damaged
☐ Temporarily damaged
☐ Discharged immediately after minor treatment
☐ Others (Specify)___________