TRAFFIC SIM: A TRAFFIC MODELING APPLICATION

A Capstone Project Proposal

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By

Jochelle Agapay

Janice Bornea

Ephrem Anthony Geotoro

Jam Tinber Medequillo

Kenny Jay Pepito

Mr. Eric Ortega

Adviser

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The Researchers
Agapay, Jochelle D.
Bornea, Janice C.
Geotoro, Ephrem Anthony Q.
Medequillo, Jam Tinber L.
Pepito, Kenny Jay L.

DEDICATION

To University of Cebu - Banilad

To Faculty Instructors and Students

To Cebu City Traffic Office

To our Parents

To Almighty God

iv

APPROVAL SHEET

This Research/Capstone Project Study titled **TRAFFIC SIM: A TRAFFIC MODELING APPLICATION** prepared and submitted by Jochelle D. Agapay, Janice C. Bornea, Ephrem Anthony Q. Geotoro, Jam Tinber a. Medequillo and Kenny Jay L. Pepito has been examined and is recommended for approval and acceptance.

RECOMMENDED:

Eric Ortega
Adviser

Eric Ortega
Program Research Coordinator

APPROVED by the Examining Tribunal on *Proposal Hearing* with a group verdict of PASSED on October 28, 2016.

Moma D. Ortega, MCS
Chairman

Judy Ann F. Gimena, DBA
Member

Ramon Penalosa, MSCJ
Member

Miriam Flores, MA-Lit
Censor

ACCEPTED and APPROVED in partial fulfillment of the requirements in Bachelor of Science in Information Technology.

Moma D. Ortega, MCS
Dean, UC-CCS

Date:___________

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CHAPTER I

INTRODUCTION

As part of the people's daily routine, transportation plays a significant role to everybody's life. It is one of our most basic human needs. It allows people to travel from one place to another. Without transportation, it would be totally different. In the land transportation, people may encounter some issues or problems in the transportation system in a certain place. Traffic in many cities around the world is severe but things may change by the help of technology.

Since technology is rising so fast nowadays, implementing new ways to lessen traffic issues can be now easier and faster. The ways of testing traffic flows can be tested through mobile application that can simulate the actual traffic flow. It's a better alternative to test and change the current transportation system without physical implementation.

Rationale of the Study

In the current transportation system in Cebu City, people are having a hard time in engaging into traffic. The government finds a solution to reduce the heavy traffic that the city is experiencing. The main problem of the Cebu City's traffic is the traffic congestion. There are certain circumstances which causes traffic congestion. According to Rosen (2013), "Too many cars for the roadway due to inadequate mass transit options and obstacles in the road causing a blockage and merger are some of the multiple causes of traffic congestion." Increasing number of vehicles in the city is one of the reasons why it shrinks the roads space. When the roads are being loaded with different kinds and classes of vehicles it would cause chaos to the road.

The government is taking an action to reduce this problem. They conducted an actual or physical implementation in testing the traffic flows in the city. Traffic authorities are trying to control the vehicular traffic by changing traffic signs and routes. But as they going to implement it, the commuters and drivers are the most who will be affected by it because of its time-consuming and a waste of efforts.

In controlling the traffic, sometimes, authorities would conduct a monthly rerouting in the reason to test the traffic. It is their way to determine if there is an alternative route that could lessen the traffic congestion. But the impact of this to the commuters is quite annoying and hassle especially when there are people that wasn't properly informed about the rerouting. Also, changing of traffic signs is one of their ways to reduce the traffic congestion. Traffic signs are very important and must be followed by the drivers in order for them not to break rules and obtain violations. This factor considered as a problem because drivers would be confused and wondered why it changes the traffic sign today and by the next day it would be taken out from the road.

The physical implementation of testing the traffic flows is quite inefficient. In the world where technology is everywhere, it doesn’t fit anymore. Conducting a test for traffic flows can easily be done with a system wherein it gives real-time information. Traffic officials should be well-equipped with technical facilities.

Therefore, the researchers proposed a mobile application that will be called “Traffic Sim”. It is a traffic modeling application where it can plan, design, monitor, and operate transportation system. It simulates the real-time traffic flows, allows testing and changing of the transportation system.

Objectives of the Study

The study aims to develop a traffic simulator application for traffic authorities.

To achieve this aim, the specific objectives are:

1. to gather data on the density of vehicles;
2. to identify the traffic rules and regulations;
3. to define the modeling algorithm for the traffic; and
4. to determine the mechanism in identifying the route status.

Scope and Limitations of the Study

This study will develop a traffic modeling application which will be called “Traffic Sim”. This study will be limited to the CCTO for planning, designing, monitoring, and operating transportation system of the Philippines, specifically the main intersections from Talamban to Ayala, Cebu City.

Traffic Sim is a shortened term for Traffic Simulator, a traffic modeling application that simulates traffic flow based on the data gathered, traffic signs assigned, traffic light operated and number of vehicles passed by in a specific routes. It cannot access any private routes and won’t allow road accidents. New and existing traffic schemes can be easily examined if it is appropriate in a specific route for all public and private utility vehicles operating in the City without actual implementation. The application will be compatible to the Android OS prior to Kitkat version.

In order to gather data and information which can be used in developing Traffic Sim, the proponents will conduct an interview from the Cebu City Transportation Office (CCTO).

Significance of the Study

The following entities are vital beneficiaries upon the creation of the project. Effective traffic solution can be accomplished with advantages to:

CCTO (Cebu City Transportation Office). CCTO Officers are the direct benefactors of this project. Instead of experimenting and testing specific routes on the road, they can now simulate several traffic situations without causing inconvenience to real time traffic.

Vehicle Drivers. Drivers will not be confused anymore with the changes of routes by the CCTO, this help them focus more on their duties. This also lessens the hassle caused by both traffic and route changing.

Researchers. Researchers have a solid aspiration of changing the inefficient system of the existing traffic simulation system. It is an honour to exhibit the different skills of the researchers in implementing the project. Along the process, they shall gain new learning, dynamic thinking, and deep understanding of the development, which are critical factors in dwelling on the IT industry.

Future Researchers. Hence forth, the present researchers do impart the paper for the researchers who are willing to venture the project for future reference or improvements.

Flow of the Study

This section presents the flow of the study of the system. It indicates the input, process, and output of the study.

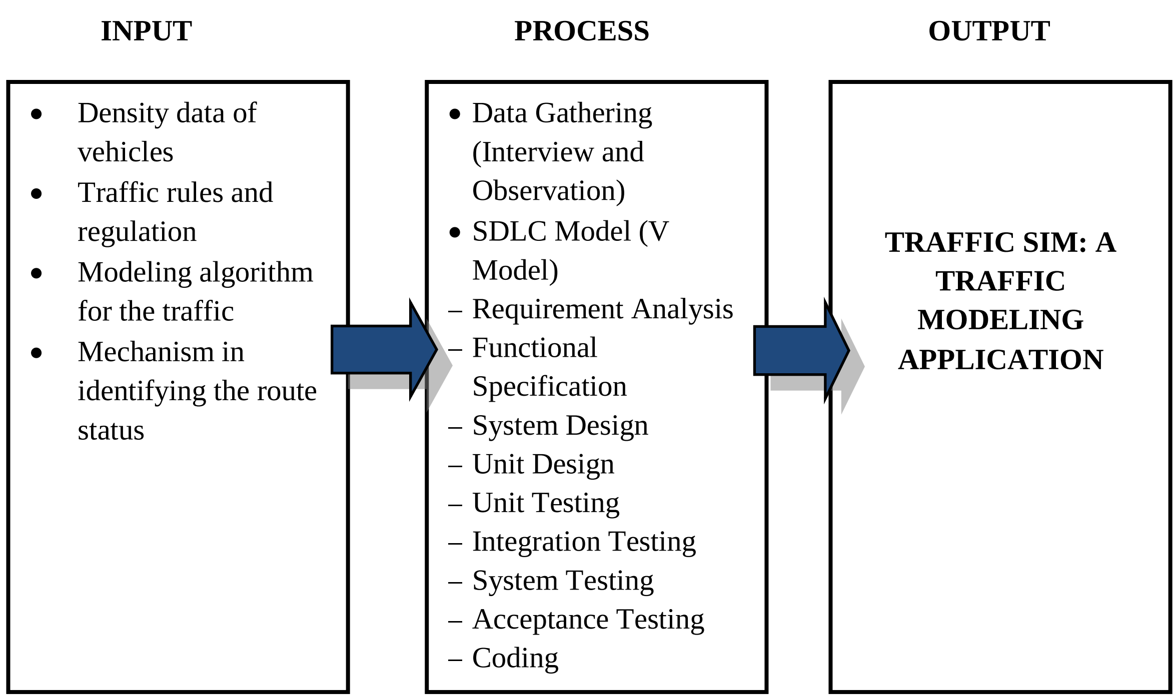

Figure 1: **Flow of the Study**

Figure 1 presents the research flow of the study. The method to be used in gathering the data and information will be conducted through interview and by observation. A set of questions is provided for interviewing the traffic authorities. For the observation, the researchers will examine vehicles in natural settings or naturally occurring situation. The result from the interview and observation will serve as the basis in developing the study.

The inputs are the density data of vehicles, the traffic rules and regulations, the modeling algorithm for the traffic, and the mechanism in identifying the route status.

The process of the study will be implemented by the use of a Software Development Lifecycle Methodology which is the V-Shaped Model. It is composed of 9 phases. For the left side of the V, which is the verification phase, it consists of Requirements Analysis, Functional Specification, System Design, and Unit Design. For the bottom part of the V, it contains the Coding Phase and for the right side of the V, which is the validation phase, it consists of Unit Testing, Integration Testing, System Testing, and Acceptance Testing.

The output of the study will be a traffic simulator in mobile application which is descriptively entitled as “Traffic Sim: A traffic modeling application”.

Definition of Terms

To avoid misconceptions in understanding the terminologies used, the following terms are defined operationally within the context of the study:

Density of Vehicles – These refer to the quantity or the average number of vehicles passing through a particular place or route.

Modeling algorithm – These refer to the process on how to model for traffic flows in a routes.

Route Status – These refer to the traffic flow status of a route.

Traffic Authorities – These refer to a public official who directs traffic by traffic enforcement on rules and regulations and providing traffic management services.

Traffic Rules and Regulations – These refer to the traffic policies to assure the smooth flowing of vehicles in the road.

Traffic Simulator – These refer to the simulation of traffic flows of a specific area with a specific day and time.

CHAPTER II

REVIEW OF RELATED LITERATURE AND STUDIES

This section contains background discussion about mobile application, android application, and several traffic simulators to obtain wide understanding on the objectives of the study.

Related Literature

Congestion in transportation facilities like walkways, stairways, roads, bus ways, railways, etc, happens when demand for their use exceeds their capacity. Travellers, truck drivers and transit service tend to complain about traffic congestion because it adds to their travel time, it reduces their productivity and increases their operating costs and it increases the number of buses and drivers needed to provide the service. Congestion increases business costs, air pollutant emissions and fuel consumed (Falcocchio & Levinson, 2015). Road traffic collisions have formed part of our everyday lives (Loo & Anderson, 2015). Traffic congestion is a phenomenon caused by too many vehicles trying to use the same infrastructure at the same time (Rossetti & Liu, 2014). The first step toward experimentation with control was the comprehensive collection and analysis of traffic volume and travel time data under uncontrolled conditions on the expressway and the major arterial streets (Horton, 2012).

In the last 30 years, the total number of vehicles, commuters and of kilometres driven on the highways increased more than the size of the network did (Brugmann, 2015). The mobility of patterns of people and corporations in the end determine the share of road, railroad, air or sea traffic in the overall transportation services (Kuhn, 2013). Traffic and transportation applications are rapidly expanding in scope due to their potential impacts on community and environmental decision making. These applications range from planning and assessment of road infrastructure to evaluation of advanced traffic management and information systems and testing technologies and systems to increase safety, capacity, and environmental efficiency of vehicles and roads (Daamen et al, 2014). Traffic can be directly observed by cameras on top of a tall building or mounted on an airplane (Treiber & Kesting, 2012).

Mobile computing has changed the game. Your personal data is no longer just stored on your desktop in the sanctuary of your office or home. You now carry personally identifiable information, financial data, personal and corporate email, and much more in your pocket, wherever you go (Chell et al, 2015). The Android framework, on the other hand, is written in

Java, and can be developed using any Java tools. The specific tooling recommended by Google and the Android community is Eclipse with the Android toolkit. Unlike IOS, it can be developed on PC, Mac, or Linux (McWherter & Gowell, 2012).

Android represents a clean break, a mobile framework based on the reality of modern mobile devices designed by developers, for developers (Meier, 2012). Mobile development is difficult because the paradigms of design and functionality differ between it and types of development that have existed for decades (McWherter & Gowell, 2012).

A microscopic traffic flow simulator such as VISSIM contains the software including the mathematical models. The simulator itself does not include any application specific data or additional tools which are required for additional modeling and data analysis tasks. In any traffic simulator a mathematical model is needed to represent the transportation supply system simulating the technical and organizational aspects of the physical transportation supply (Barcelo, 2011).

The microscopic modeling system comprises the simulator, all additional tools needed to operate an application and the data of a particular application (Barcelo, 2011). Simulators determine whether the stochastic model chosen is consistent with a set of actual data (Ross, 2013). Simulators will not only increase the confidence of the users of the equipment and new technique but will also contribute to their safety (Henson & Lee, 2013). Designing a simulator is a truly interdisciplinary challenge because each simulator is a prototype in itself and there are no norms for its construction (Arioui & Nehaoua, 2013).

This section covers several topic related to mobile applications, android applications and traffic simulations. It tackles about related concepts to know the depth of the existing problem along with its associated factors.

Related Studies

In the study entitled “An Integrated Framework Combining a Traffic Simulator and a Driving Simulator”, it provides a simulation framework based on the integration of a driving simulation engine and a traffic simulation that can respond to the issues addressed by offering multi-level and multi-domain simulation models. The integration of the driving simulator SCANER and the traffic simulator Aimsun, where the driving simulator (including visual, audio and kinaesthetic restitution) manages the simulation in the immediate driver environment and the traffic simulator manages the whole road network situation, creating a large-scale, realistic and minutely detailed virtual world (That & Casas, 2011).

Simulation of Urban Mobility (SUMO) is a microscopic road traffic simulation made available as open source under the GPL license. The complete suite includes tools for importing road networks, generating routes from different sources, and two versions of the traffic simulation itself, one started from the command line and one including a graphical user interface. The traffic simulation offers a socket-based interface to external applications, allowing to interact with a running simulation online. Values and states of objects the simulation consists of can be both retrieved and changed. SUMO can be enhanced with custom models and provides various APIs to remotely control the simulation (Krajzewicz, 2010).

In the study entitled “A Real Time Traffic Simulator Utilizing an Adaptive Fuzzy Inference Mechanism by Tuning Fuzzy Parameters”, the system implemented a real time traffic simulator with an adaptive fuzzy inference algorithm that arranges the foreseen light signal duration. It changes the time duration of lights depending on waiting vehicles behind green and red lights at crossroad. The simulation has also been supported with real time graphical visualization. It also creates random traffic flows according to specified parameters (Uzun et al., 2011).

Osogami et al., (2012) conducted a study on “IBM Mega Traffic Simulator” can build its model of simulation by directly estimating some of the parameters of the model from probe-car data. Probe-car data records trajectories of vehicles that are measured with the Global Positioning System (GPS). This capability is in contrast to existing agent-based simulators of traffic flows, where the values of their parameters are calibrated with iterative simulation. It can also run on massively parallel computers and simulate the microscopic traffic flows in the scale of an arbitrary city.

Traffic data management and simulation system integrates geographical information systems (GIS) with traffic simulation processes to allow a user to analyze traffic patterns and loads at specific geographic locations of regions. Additionally, these systems allow for traffic analysis over a wide scale traffic network that may encompass the traffic network that exists within a geographic region. The system includes the traffic simulators that can adaptively or controllably select between multiple traffic simulation models for simulating traffic across different segments of the traffic network (U.S. Patent No. 11/614,617, 2013).

In the study entitled “Evaluation of Metropolitan Traffic Flow with Agent-based Traffic Simulator and approximated vehicle behavior model near intersections”, the system considers each microscopic vehicle as agent, which travels through a given road network with Crosspoints (node) and Roads (links). The simulator creates the agent at the origin at the departure time and chooses a route from the origin to the destination, according to a model of the route choice, and travels along that route. Then it tracks the location of each agent and records information of vehicles (position and speed), roads (average speed, number of vehicles, CO_2 emissions on the road) and trips (travel time and total CO_2 emissions of each vehicle) into log files which are used for analysis and visualization (Mizuta, 2015).

SMARTS: Scalable Microscopic Adaptive Road Traffic Simulator can simulate traffic in arbitrary road networks. It is possible to include any number of vehicle types in a simulation. Each vehicle follows a specific route plan, which can be imported or be generated by the simulator itself. A vehicle with user-defined route plan can start moving at a specific time and make temporary stops in its trip. It simulates real driver behaviour based on a car-following model and a lane-changing model. Traffic lights and various traffic rules are also implemented. The simulator offers a Graphical User Interface (GUI) to visualize simulations. The GUI allows users to configure, monitor and control simulations (Ramamohanarao et al., 2016).

In the study entitled “Integrated Traffic-Driving-Networking Simulator for the Design of Connected Vehicle Applications: Eco-Signal Case Study”, the system allows a human driver to control a subject vehicle in a virtual environment which is capable of communicating with other vehicles and infrastructure with CTS messages as well as sending warning messages to the driver. ITDNS combines the main features of a traffic simulator (TS), a networking simulator (NS) and a driving simulator (DS), and therefore may be referred to as an integrated 3-in-1 simulator (Zhao et al., 2014).

Al-Dmour’s (2011) “TraffSim: Multiagent Traffic Simulation” used microsimulation and macrosimulation system to generate hundreds and thousands of independent agents all operating in parallel. A vehicle in TraffSim is considered as an agent that discovers other vehicles on road and how they move. It looks at other vehicles on the road continuously and moves to reach its destination safely in the fastest possible way. The user can construct roads, cars, traffic lights, etc. The user can easily specify the number of cars generated per second on the roads. TraffSim is capable of modeling vehicle following and lane changing.

Related Studies imparts the precise features, and conveys the capacities and limitations of the existing studies. The inventions' information stands as the guiding information for the implementation of the proposed system.

Table 1

COMPARATIVE MATRIX

Related Studies	**Features**	**Limitations**	**Platform Details**
(1) Name: An integrated framework combining a traffic simulator and a driving simulator URL: http://www. sciencedirect.com /science/article/pii/ S1877042811014522 Year: 2011 Proponents: 1. Thomas Nguen That 2. Jordi Casas	• a simulation framework based on a driving simulation engine and a traffic simulation that can respond to the issues addressed • driving simulator that manages the simulation in the immediate driver environment • traffic simulator that manages the whole road network situation • creates a large-scale, realistic and minutely detailed virtual world • allows the driver to drive in a simulator with a local traffic situation • provides a realistic global traffic situation in terms of flow and density	• the result will depend on the size of the nano traffic window • the result of the micro traffic simulation may have less impact when: ○ a simulation needs to be found between a large window that will favour driver immersion and a small one that could provoke visual defects	• Hardware ○ Personal Computer • Software ○ SCANeR™ simulation engine ○ Aimsun ○ ADAS

Table 1.1

COMPARATIVE MATRIX CONT'D

Related Studies	Features	Limitations	Platform Details
(2) Name: Traffic Simulation with SUMO-Simulation of Urban Mobility URL: http://www.dlr.de/ts/en/desktopdefault.aspx/tabid-9883/16931_read-41000/ Year: June 28, 2010 Proponents: 1. Daniel Krajzewicz	• microscopic simulation where vehicles and pedestrians are modeled explicitly • Online interaction that controls the simulation with TraCI • Simulation of multimodal traffic • Time schedules of traffic lights can be generated automatically by SUMO • Supported imports like OpenStreetMap,VISUM, VISSIM, NavTeq	• Implemented in C++ and uses only portable libraries	• Hardware ○ Personal Computer • Software ○ command line simulation ○ simulation with a graphical user interface ○ network importer ○ abstract network generator ○ routes generator

Table 1.2

COMPARATIVE MATRIX CONT'D

Related Studies	Features	Limitations	Platform Details
(3) Name: A real time traffic simulator utilizing an adaptive fuzzy inference mechanism by tuning fuzzy parameters URL: http://210.30.190.120/ckwx/yuan/mhlj/201408250406.pdf Year: April 19, 2011 Proponents: 1. Alper Aksaç 2. Erkam Uzun 3. Tansel Özyer	• A traffic simulator that arranges the foreseen light signal duration. • Changes the time duration of lights depending on waiting vehicles behind green and red lights at crossroad. • The simulation has also been supported with real time graphical visualization.	• implemented in C# in order to simulate fuzzy logic controller • TSK (Takagi-Sugeno-Kang) and Mamdani models are used for simulation verification	• **Hardware** ○ Processor ○ Sensors • **Software** ○ implemented in .NET ○ MS SQL Server ○ Windows OS

Table 1.3

COMPARATIVE MATRIX CONT'D

Related Studies	Features	Limitations	Platform Details
(4) Name: IBM Mega Traffic Simulator URL: http://domino.research.ibm.com/library/cyberdig.nsf/papers/7BE8B8BF8CAE073A85257B1900190ACE/$File/paper.pdf Year: December 29, 2012 Proponents: 1. Takayuki Osogami 2. Takashi Imamichi 3. Hideyuki Mizuta 4. Tetsuro Morimura 5. Rudy Raymond 6. Toyotaro Suzumura 7. Rikiya Takahashi 8. Tsuyoshi Id´e	• directly estimates some of the parameters of the model from probe-car data ○ Probe-car data records trajectories of vehicles that are measured with the GPS ○ uses the probe-car data to set the values of the parameters - select routes - origins - destinations • Megaffic also provides tools for editing its input and output ○ road-network editor - a graphical interface that allows to add, modify and delete a road	• Uses microscopic model of traffic simulation • the scalability of traffic simulation	• **Hardware** ○ Processor • **Software** ○ Windows OS ○ X10-based Agents eXecutive Infrastructure for Simulation (XAXIS)

Table 1.4

COMPARATIVE MATRIX CONT'D

Related Studies	Features	Limitations	Platform Details
(5) Name: Traffic data management and simulation system URL: https://www.google.com/patents/US8484002 Year: July 9, 2013 Proponents: 1. Qi Yang 2. Howard Slavin 3. Kjarran Stefansson 4. Andres Rabinowicz 5. Simon Olsberg 6. Mary LaClair 7. Jonathan Brandon	• system integrates geographical information systems (GIS) ○ it allows the user to: - analyze traffic patterns - loads at specific geographic locations of regions - import and utilize existing data on travel demand, road network, and survey data from a wide range of sources	• Geographical information system (GIS) ○ are only as good as the remote sensing methods ○ represented by square cells with sides of length	• Software ○ Data processing system - UNIX workstation ○ Digital Signal Processing Applications ○ Geographical information systems (GIS)

Table 1.5

COMPARATIVE MATRIX CONT'D

Related Studies	Features	Limitations	Platform Details
(6) Name: Evaluation of Metropolitan Traffic Flow with Agent-based Traffic Simulator and approximated vehicle behavior model near intersections URL: https://pdfs.semanticscholar.org/4a17/946c8c6d219b31a34e1e6bb6ce08a76ef806.pdf Year: 2015 Proponents: 1. Hideyuki Mizuta	• the system considers each microscopic vehicle as agent ○ travels through a given road network with node and links. • the agent chooses a route from the origin to the destination according to: ○ a model of the route choice, and ○ travels along that route - travel time - travel distance and - number of turns • the system tracks the location of each agent and records information of vehicles into log files ○ vehicle's position and speed ○ roads and trips	• Within Tokyo • Virtual vehicle of traffic flows	• **Hardware** ○ Personal Computer • **Software** ○ Windows OS

Table 1.6

COMPARATIVE MATRIX CONT'D

Related Studies	**Features**	**Limitations**	**Platform Details**
(7) Name: SMARTS: Scalable Microscopic Adaptive Road Traffic Simulator URL: http://www.ruizhang.info/publications/TIST2016_SMARTS.pdf Year: 2016 Proponents: 1. Kotagiri Ramamohanarao 2. Hairuo Xie 3. Lars Kulik 4. Shanika Karunasekera 5. Egemen Tanin 6. Rui Zhang 7. Eman Bin Khunayn	• offers a Graphical User Interface (GUI) to visualize simulations ○ GUI allows users to: - configure - monitor and - control simulations • simulation features divided into three categories: ○ Input - Road Network - Routes - Setup Script ○ Simulation - Route Generation - Vehicle Generation - Car-Following - Lane-Changing - Traffic Lights - Traffic Rules - Route-Changing - Calibration and Prediction ○ Output - display - data Export	• can calibrate driver models by adjusting the relevant parameters	• **Hardware** ○ Personal Computer • **Software** ○ Windows OS

Table 1.7

COMPARATIVE MATRIX CONT'D

Related Studies	Features	Limitations	Platform Details
(8) Name: Integrated Traffic-Driving-Networking Simulator for the Design of Connected Vehicle Applications: Eco-Signal Case Study URL: https://www.researchgate.net/profile/Yunjie_Zhao/publication/271937865_Integrated_Traffic-Driving-Networking_Simulator_for_the_Design_of_Connected_Vehicle_Applications_Eco-Signal_Case_Study/links/5644ff3408aef646e6cc0f2a.pdf Year: June 2014	• allow a human driver to control a subject vehicle in a virtual environment • it combines the main features of the 3 simulators ○ traffic simulator - were used to evaluate the operational efficiency of transportation networks ○ networking simulator - it allows users to examine and modify its internal components ○ driving simulator - were used to examine the behavior of individual human subjects within a virtual environment	• can be performed in a high speed non-graphic mode - 2D and 3D visual modes	• **Hardware** ○ Personal Computer • **Software** ○ written in C++ - used to achieved a plug-in of traffic simulator

Table 1.8

COMPARATIVE MATRIX CONT'D

Related Studies	**Features**	**Limitations**	**Platform Details**
Proponents: 1. Yunjie Zhao 2. Aditya Wagh 3. Yunfei Hou 4. Kevin Hulme 5. Chunming Qiao 6. Adel W. Sadek			
(9) Name: TraffSim: Multiagent Traffic Simulation URL: ftp://161.24.19.221/ele/jrsantos/Leitura/Traffic/Simuladores/TraffSim_2011.pdf Year: 2011 Proponents: 1. Nidal Abid Al-Hamid Al-Dmour	• user can construct roads, cars, traffic lights • user can easily specify the number of cars generated per second on the roads • capable of modeling vehicle following and lane changing	• Within Jordan only • microscopic model tracks the location of individual vehicles • macroscopic model ○ cannot directly study the impact of traffic control	• **Hardware** ○ Personal Computer • **Software** ○ NetLogo - enables the user to model any number of agents in a variable-size environment using a simple programming language derived from Logo

Table 1 imparts the information of the existing inventions in a tabular layout. The comparison is shown through presenting the features, limitations, and platform details which shall be used as a reference for developing the proposed system. In our study, we will be utilizing a macroscopic model of simulation for our modeling algorithm. Macroscopic model can track speed and density. The formulas used in getting the density of vehicles are useful in our study.

CHAPTER III

RESEARCH METHODOLOGY

This section covers the methodology used in the study and other technical specification that will help to strengthen the study. It also covers techniques, diagrams, designs, the features, and the materials used to implement a traffic modeling application that will meet the requirement of objectives of the study.

Software Engineering Methodology

The study will use the V-Model Methodology as the project's Software Engineering Methodology. The proponents will use this model because it is the most applicable model for the Traffic Sim. This will be used because the application should be executed in a sequential manner. In every phases completed, it should be tested according to its corresponding testing plan. This will be used in order for us, the proponents, to identify the system's issues as early as possible.

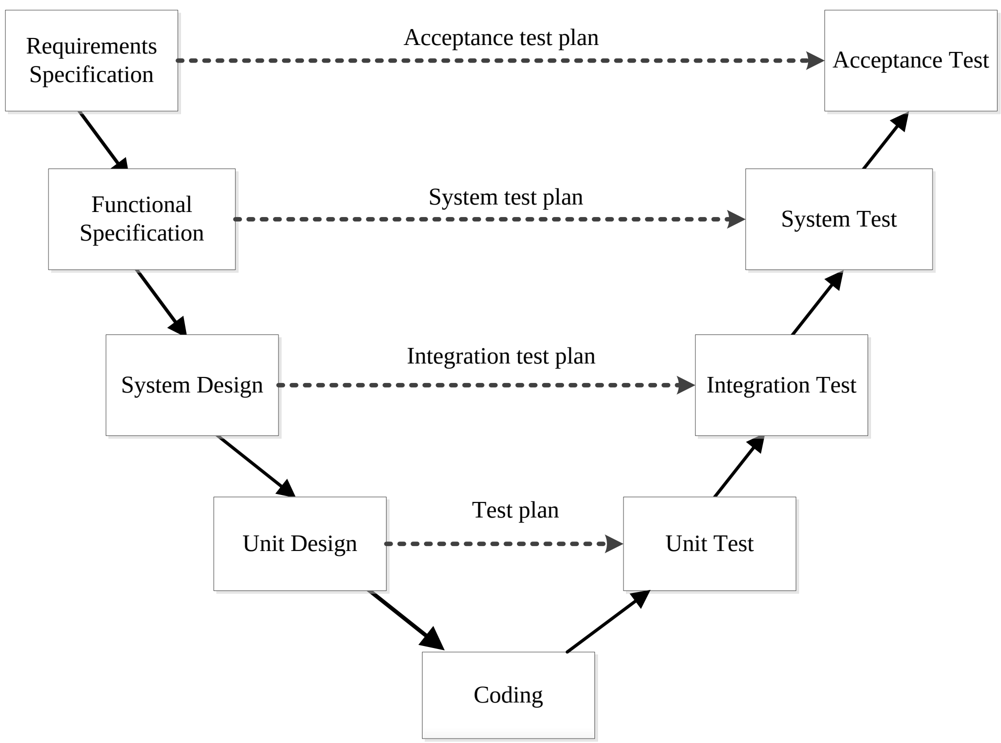

Figure 2: **<u>V-Model</u>**

Each phases of the V model has its own work and contribution for the development of the system. The first phase must be completed first before starting to the second phase. The same goes for the succeeding phases of the V Model. The following are the phases:

Business Requirement Analysis or Requirements Specification – This is the first phase in the development cycle where the potential requirements are identified. In this study, the proponents or developers discussed on how will be the system should be implemented. The developers decided to conduct an observation method to examine the vehicles and an interview to the traffic authorities in order to gather the data and information needed for developing the application requirements. The developers thoroughly discussed the features for the users satisfactory. The acceptance test plan was done by the team at this stage as business requirements can be used as an input for acceptance testing.

Functional Specification – This phase describes in detail the application's intended capabilities, appearance, and interaction with user. In this study, the developers will tackle about the different system functionalities. The initial deliverables of the previous phase will be used for the system's capability such as simulates traffic flows, and generates traffic rules and regulations. After this phase, a system test plan is developed for the System Testing.

System Design – In this phase, the developers or proponents analyzed and understood how the system would be implemented as a whole. The developers will identify the specific functions in order to create a system design for the application. The user interfaces will be made in a simplest form where the users can easily adapt. For the software requirements, it will use an Android platform prior to KitKat version, Unity as an IDE, and C# as a programming language. After this phase, an integration test plan is developed for the Integration Testing.

Unit Design – In this phase, the developers will create a list of modules based on our application's design. The modules are broken up into smaller units and will be divided among the team so that the coding phase could be started. After this phase, a test plan is developed for the Unit Testing.

Coding Phase – The actual coding of the system modules is taken up in the Coding phase. In this phase, the developers will execute the modules by using C# as the programming language. The coding is performed based on the coding guidelines and standards. The programmer will collect each module to finalize the overall workflow. After this phase, a series of tests will be initiated for the system's validation. The following testing activities are as follows:

Unit Testing – The developers will now test the application based on the unit design phase. In this study, all units or modules will be executed at code level during this validation phase in order to help eliminate issues of the application as early as possible.

Integration Testing – Integration testing is associated with the system design phase. The developers will test the coexistence and its communication towards the internal modules within the application. In this study, the developers will gather all the modules created will be tested as a whole.

System Testing – This phase is directly associated with the Functional specification phase. The developers will test the entire system functionality using the system test plan. Software issues will be identified during system test execution. In this study, the developers will test the application and made sure it was working properly.

Acceptance Testing – Acceptance testing phase is associated with the business requirement analysis phase. In this study, the developers will allow the traffic officer to test the application in the user environment to know if the system can be accepted.

Planning/Conception-Initiation Phase

The Planning/Conception-Initiation Phase will be the preparations in starting up in developing the proposed system.

Business Market Canvas (BMC)

This section outlines a concise presentation of the business plan by laying essential activities and entities, and bringing out connectivity that revolves around them.

Table 2

BUSINESS MODEL CANVAS

<table>
<tr><th>KEY PARTNERS</th><th>KEY ACTIVITIES</th><th>VALUE PROPOSITION</th><th>CUSTOMER RELATIONSHIP</th><th>CUSTOMER SEGMENTS</th></tr>
<tr><td rowspan="3">CCTO
LTO
Traffic Officers</td><td>Business Requirements
Architectural Design
Coding
Develop a traffic simulator</td><td rowspan="3">Provides traffic authorities an easier and faster experiment in traffic flows
Offer easy work environment
Offer progress over years</td><td>Developers updates the system of the modeling application</td><td rowspan="3">Government agency
Traffic Officers</td></tr>
<tr><th>KEY RESOURCES</th><th>CHANNELS</th></tr>
<tr><td>Direct Selling
Endorsement
Referrals</td><td>Direct Selling
Endorsement
Referrals</td></tr>
<tr><th colspan="3">COST STRUCTURE</th><th colspan="2">REVENUE STREAMS</th></tr>
<tr><td colspan="3">Marketing Cost
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Overhead Cost</td><td colspan="2">Direct Sales
Maintenance
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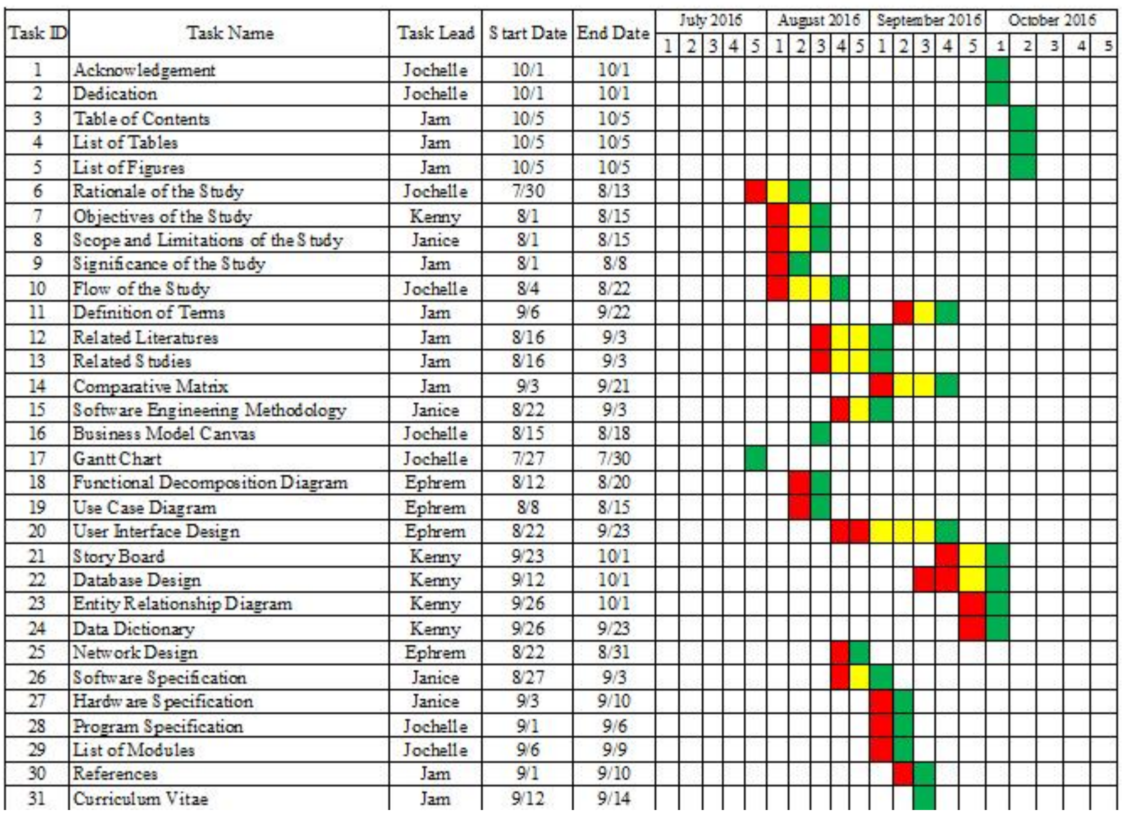
</table>

Table 2 shows the business model canvas of Traffic Sim. This specifies the business importance and strategies that see through on the proposed system. The key partners of Traffic Sim will be the CCTO, LTO, Traffic Officers which are the buyers and suppliers of the system, the customer will be the government agency and the traffic officers. The customers can purchase or reach the system through direct selling, endorsement and referrals. Customer relationship shows the relationship of the key partners and the system's developers. The key activities are the phases in the methodology of the system that the value proposition requires. The value proposition conveys the worth of the product in terms of its benefits to the customer. The Traffic Sim costs inherent in marketing, systems development and overhead cost. The developers can gain money from direct sales, maintenance and updates of the system to the customer.

Gantt Chart

This section presents the tasks accomplished within the given time frame. It lists the activities in a suitable time scale reflecting the duration from start to end date.



Task ID	Task Name	Task Lead	Start Date	End Date	July 2016					August 2016					September 2016					October 2016				
					1	2	3	4	5	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5
1	Acknowledgement	Jochelle	10/1	10/1																				
2	Dedication	Jochelle	10/1	10/1																				
3	Table of Contents	Jam	10/5	10/5																				
4	List of Tables	Jam	10/5	10/5																				
5	List of Figures	Jam	10/5	10/5																				
6	Rationale of the Study	Jochelle	7/30	8/13																				
7	Objectives of the Study	Kenny	8/1	8/15																				
8	Scope and Limitations of the Study	Janice	8/1	8/15																				
9	Significance of the Study	Jam	8/1	8/8																				
10	Flow of the Study	Jochelle	8/4	8/22																				
11	Definition of Terms	Jam	9/6	9/22																				
12	Related Literatures	Jam	8/16	9/3																				
13	Related Studies	Jam	8/16	9/3																				
14	Comparative Matrix	Jam	9/3	9/21																				
15	Software Engineering Methodology	Janice	8/22	9/3																				
16	Business Model Canvas	Jochelle	8/15	8/18																				
17	Gantt Chart	Jochelle	7/27	7/30																				
18	Functional Decomposition Diagram	Ephrem	8/12	8/20																				
19	Use Case Diagram	Ephrem	8/8	8/15																				
20	User Interface Design	Ephrem	8/22	9/23																				
21	Story Board	Kenny	9/23	10/1																				
22	Database Design	Kenny	9/12	10/1																				
23	Entity Relationship Diagram	Kenny	9/26	10/1																				
24	Data Dictionary	Kenny	9/26	9/23																				
25	Network Design	Ephrem	8/22	8/31																				
26	Software Specification	Janice	8/27	9/3																				
27	Hardware Specification	Janice	9/3	9/10																				
28	Program Specification	Jochelle	9/1	9/6																				
29	List of Modules	Jochelle	9/6	9/9																				
30	References	Jam	9/1	9/10																				
31	Curriculum Vitae	Jam	9/12	9/14																				

Legend:

Incomplete **On Going** **Complete**

Figure 3: **Gantt Chart**

Figure 3 presents the task's scheduling. It composed of a task id, task name, task lead, start and end date. Each of the proponents was given an assigned task according to his/her role.

The color of red indicates that the task was started but it's not yet finished, the color of yellow indicates the on-going task of the leader, and the color of green indicates that the task has been completed. The colors will be place in the month column and in the number of week column.

Functional Decomposition Diagram

This section displays the hierarchal breakdown of various business processes into detailed operations, functions and activities. As the name implies, it covers on the overall functionality of the components and their interaction with each other.

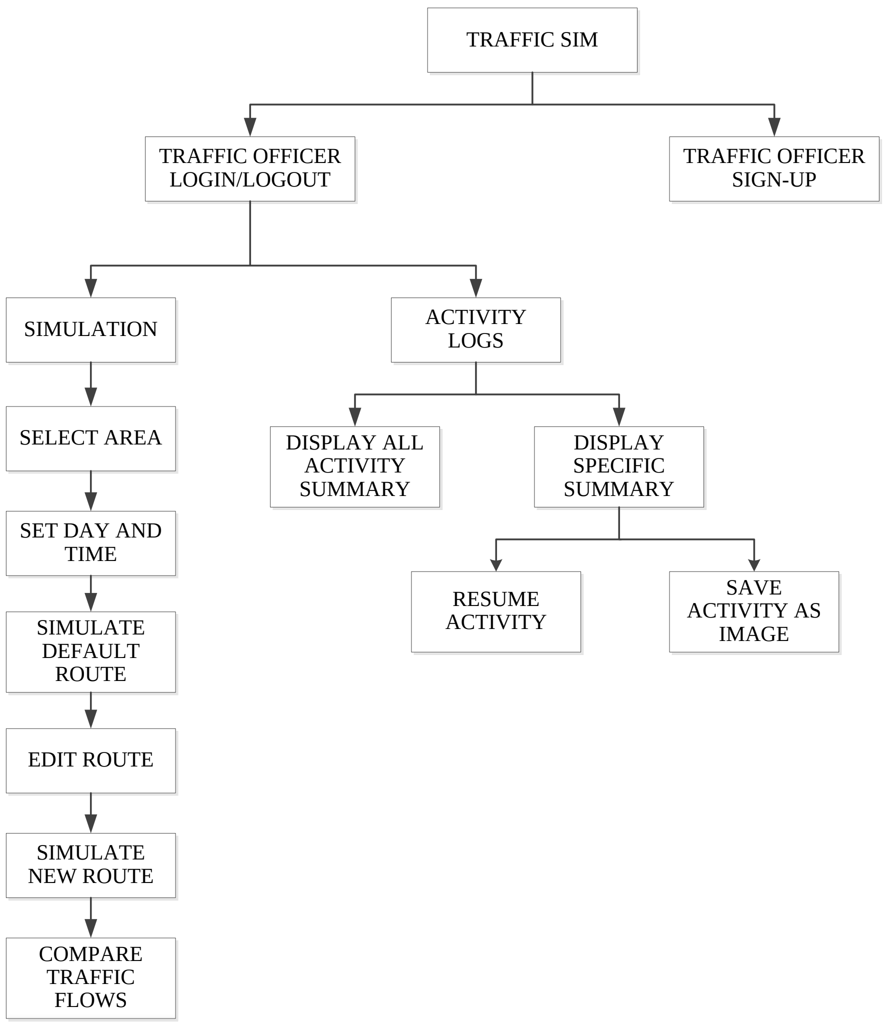


Figure 4: **Functional Decomposition Diagram**

Figure 4 shows the function flow of the study. The break down begins from the system itself going down to its fundamental processes, as to how the user will make use the proposed system. It visualizes what the proposed system is able to perform.

The application is intended for a specific user, the traffic officer, who could login and logout. After the traffic officer could login, he could choose whether he wants to test a particular traffic flow or to view the activity logs. If the traffic officer has no account, he can create his account.

If the traffic officer wants to test a particular traffic flow, he can select an area. After selecting an area, he can set the desired day and time then it simulates the default route. If the traffic officer wants to modify or experiment the traffic flow, then he can modify it by tapping the edit button where it allows changing the traffic schemes by setting the traffic signs. Then, the traffic enforcer can now simulate the new route. It also allows comparing the traffic flows between the actual and simulated traffic flows.

If the traffic officer wants to view his recent activities, then he could view all or specific activities in the activity logs. The traffic officer can resume a specific activity and can save an image copy of the activity summary with its corresponding information (Activity name, traffic status, hours, density of vehicles, average speed, traffic rules and regulations, the user’s name and his position).

Analysis-Design Phase

This section is consists of use case diagram, user interface diagram, storyboard, database design, entity-relationship diagram, and data dictionary of the system.

Use Case Diagram

This section illustrates the graphic presentation of set of actions within a system and depicts the business process of the system.

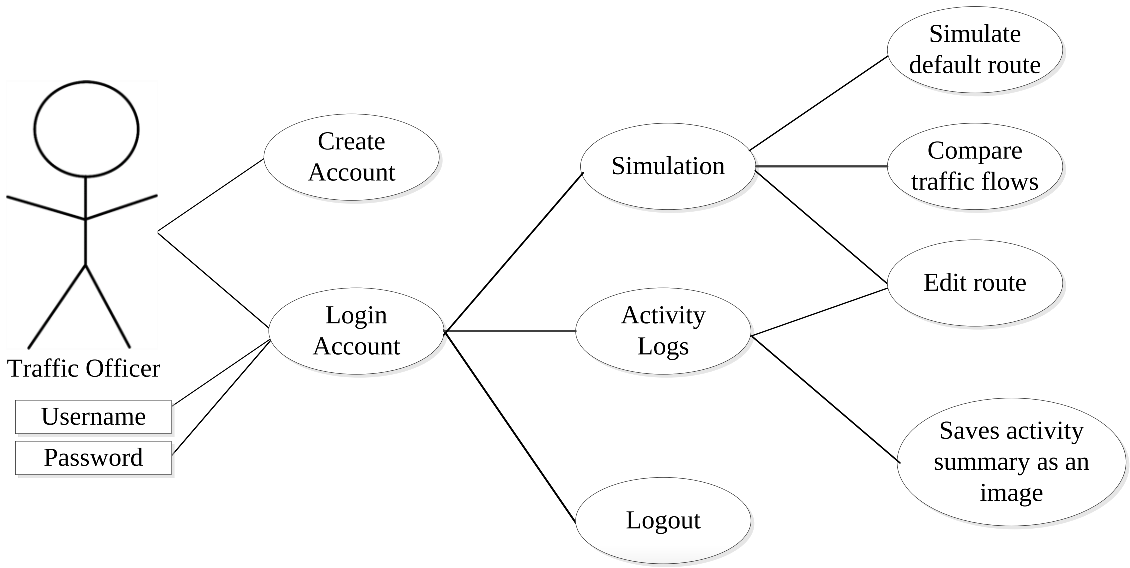


Figure 5: **Use Case Diagram**

Figure 5 shows the user's point of view of the application. The figure shows that the traffic officer must create an account before logging in to the application. When the traffic officer logs in, he will be directed to the home/menu page where he can choose two options: the simulation and the activity logs. For simulation, it is where the traffic officer can simulate a default route by selecting a specific area of intersection and by setting a desired day and time of the traffic. It could also edit a route where the traffic officer could test the traffic flows and could compare it between default routes. For the activity logs, it is where the traffic officer could view his recent activities. If the traffic officer wants to continue his activity, then he can resume it. If the traffic officer wants to hold a summary of his activity, then he can have it by saving the activity summary as an image.

User Interface Diagram

This section presents the linked interfaces which are artistically designed to entertain the user and be satisfied with its usability.

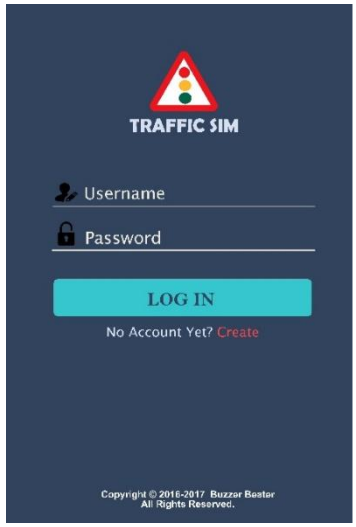


Figure 6: **User Login**

Figure 6 shows the first interface where the user uses his account to log in and create a new account if he doesn't have one.

Figure 7: **Create Account**

Figure 7 shows the create account interface where the unregistered user creates and register new account by filling up the needed requirements.

Figure 8: **Home/Menu**

Figure 8 shows the home/menu interface where it has two options the simulation and activity log. The user is given a chance to choose his desired option. At this section the ID of the current user can be viewed and can also be edited.

Figure 9: **Select Area**

Figure 9 shows the simulation section where the system allows the user to select an area to simulate.

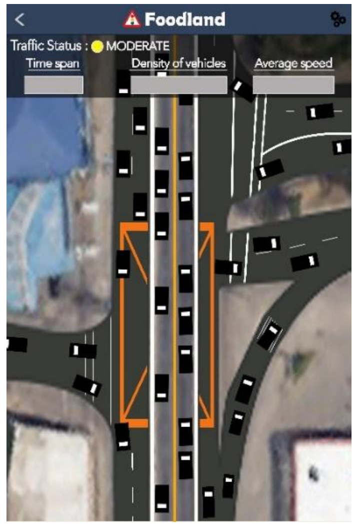


Figure 10: **Default traffic flow**

Figure 10 shows the default traffic flow of the selected area and shows its current traffic status.

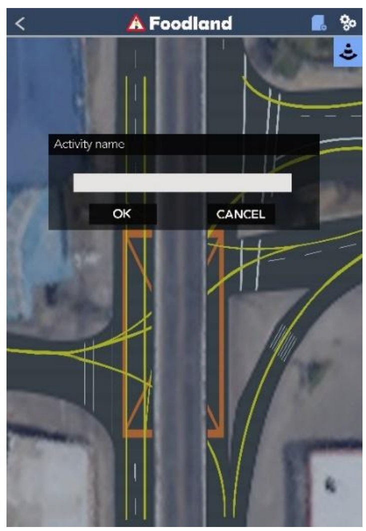


Figure 11: **Edit Route**

Figure 11 shows the edit route section where the user is required to input the activity name of the current editing activity. At this section the users will be able to reroute a particular route and add traffic signs which will be used to determine possible traffic rules and regulation.

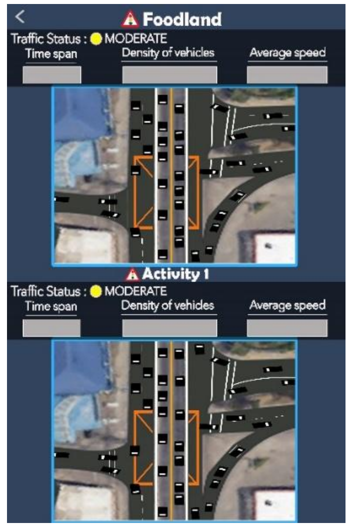


Figure 12: **Compare traffic flows**

Figure 12 shows the comparing of traffic flows where the newly edited simulation activity will be compared to the default traffic flow of a specific area.

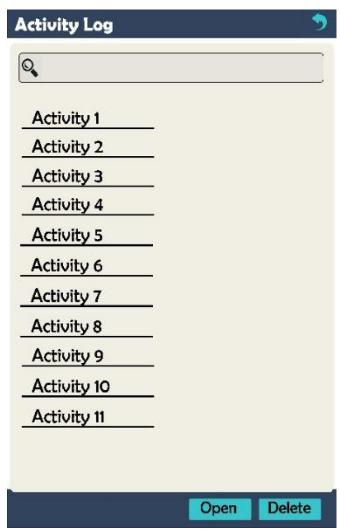


Figure 13: **Activity Log**

Figure 13 shows the activity log section where it displays the list of all activities. It allows the user to delete or open his desired activity.

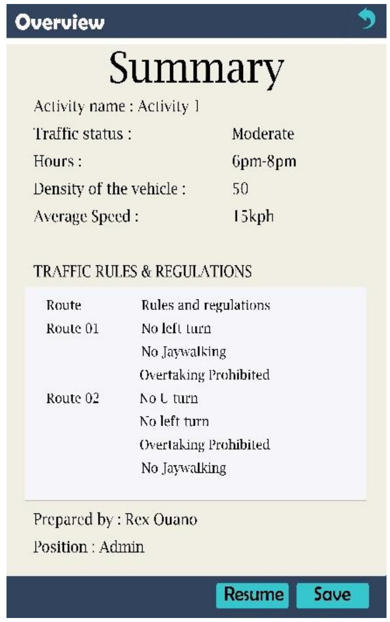


Figure 14: **Activity Summary**

Figure 14 shows the overview section where it displays the summary information of a specific activity. This section allows user to choose whether he wants to resume and edit again the activity or saved it as an image.

Storyboard

This section presents the sequential manner of the systems interface for the user to be able to understand the story and know its connectivity.

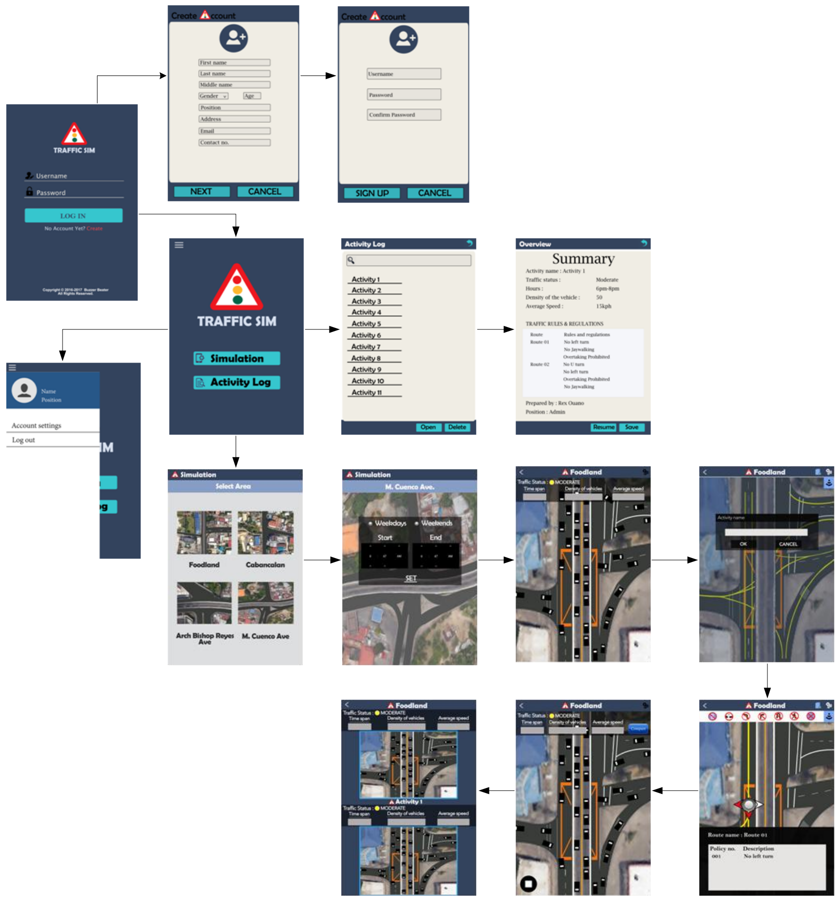


Figure 15: **Storyboard**

Figure 15 presents the visual story wherein the application begins when the traffic officer login to his account to the login form. If the traffic officer doesn't have an account, then he can create an account in the create account form. When the traffic officer successfully log in, he will be directed to the home/menu page. In this section, the traffic officer has given two options: the simulation and the activity log. Also in the upper-left corner of the user's interface, there's a button where when the user taps on it, there will be a slide menu showing the user who is currently logged-in and also there will be an option showed where he can choose whether he wants to edit or logout his account.

If the user selects the simulation button, it will directly display the dashboard where the traffic officer will be ask to select an area that he wishes to simulate. After selecting the area, the traffic officer will be asked to set the day whether weekdays or weekends and also set the start time and end time that the will traffic simulate. After which, the default traffic flow of the area will simulate. If the traffic officer taps the edit button there will be a dialog box that will ask him to input the name of the activity. After setting the name, the traffic officer can now edit a particular route and can assign a traffic signs with a corresponding traffic rules and regulation. When all the customizations are done, the traffic officer can test-run it by tapping the play button and also he can compare his newly simulated routes to the default traffic flow to determine whether his newly edited activity is successful or not.

If the traffic officer selects the activity log button, it will direct him to the activity log section where it displays the list of all recent activities. The traffic officer can select his desired activity and given to options whether open the file or delete. If the traffic officer wants to open his activity, summary information of the activity will be shown in the overview section where the user can save it as an image or resume the activity.

Database Design

This section exhibits the relationship of every table through its key information. Each database design table has corresponding keys which will be used to retrieve the contents of the tables. In relational databases' environment, primary key is a unique identifier, and cannot contain a null value. Foreign key, or the secondary key, is often a primary key of another table which links a table to another table.

Table 3

USER PROFILE

USER	
PK	Username
	UPassword UFirstname ULastname UMidname UAddress UGender UAge UPicture UContactNum UEmail UPosition UStatus

Table 3 shows the user's personal information which includes the user's username, first name, last name, middle initial, address, gender, age, picture, contact number, email address, position and status. The primary of this table, Username, will be compared to the primary key of TRAFFIC_SIM_HEADER table, TSHUSER, for user verification. This table holds the recorded information of the user.

Table 4

TRAFFIC SIGNS

TRAF_SIGNS	
PK	TS_ID
	TSName TSImage TSDesc

Table 4 shows the list of traffic signs including the traffic sign name, image, and description. The primary key, TS_ID, is compared with the POLICY_RAR's PolicyNo in order to verify the rules and regulations of a specific traffic sign.

Table 5

ROUTE POLICY HEADER

ROUTE_POLICY_HEADER	
PK	RPHName
	RPHArea RPHStatus

Table 5 presents the route header where it shows the list of routes including the road location and status. The primary key, RPHName, is compared to the ROUTE_POLICY_DETAIL's RDName in order to identify the details of the specific route.

Table 6

ROUTE POLICY DETAIL

ROUTE_POLICY_DETAIL	
PK	RPDName RPDPolicyNo
	RPD_Policy_Desc RPDStatus

Table 6 presents the route detail as a reference data. PRDName is a primary key compared to the ROUTE_POLICY_HEADER's RPHName to determine the name of the route and RPDPolicyNo primary key is compared to the POLICY's PolicyNo in order to identify what rules and regulations are being imposed to that specific route.

Table 7

TIME SCHEDULE

TIMESCHED	
PK	TSTimeID
	TSStartTime TSEndTime TSDensity TSCStatus

Table 7 shows the list of time schedule which includes time ID, vehicle ID, start time, end time, road name, day, density and status. The primary key, TSTimeID, is compared with the TRAFFIC_SIM_DETAIL's TSDTimeID to verify the time schedule. The other primary key, TSVehicleID, is compared with VEHICLE's VehicleID to determine the vehicle.

Table 8

POLICY

POLICY	
PK	PolicyNo
PK	PTD_ID
	PLabel
	PDescription

Table 8 shows the list of traffic policy or the rules and regulations. PolicyNo the primary key is compared to the ROUTE_POLICY_DETAIL's RPDPolicyNo to identify the policy that is being used and PTD_ID the primary key is compared to the TRAF_SIGNS's TS_ID to determine the policy assign to a specific traffic sign.

Table 9

TRAFFIC SIMULATION HEADER

TRAFFIC_SIM_HEADER	
PK	TSHActivityName
	TSHDate
FK	TSHUser
	TSHRouteName
	TSHStatus

Table 9 shows the transactional data where it saves all the activity progress that was done by the user. TSHActivityName the primary key is compared to TRAFFIC_SIM_DETAIL's TSDActivityName in order to identify the details of the system.

Table 10

TRAFFIC SIMULATION DETAIL

TRAFFIC_SIM_DETAIL	
PK	TSDActivityName
PK	TSDTimeID
	TSDNoOfVehicles
	TSDTimeSpan
	TSDTraffStatus
	TSDStatus

Table 10 shows the reference data of a traffic flow. TSDActivityName is a primary key that is compared to the TRAFFIC_SIM_HEADER's TSHActivityName to determine the activity name and TSDTimeID primary key is compared to the TIMESCHED's TSTimeID to identify the time schedule of the activity.

Entity Relationship Diagram

This section reveals the relationship of entities through a linked tabular presentation. The dependency is necessary to allow the tables function properly.

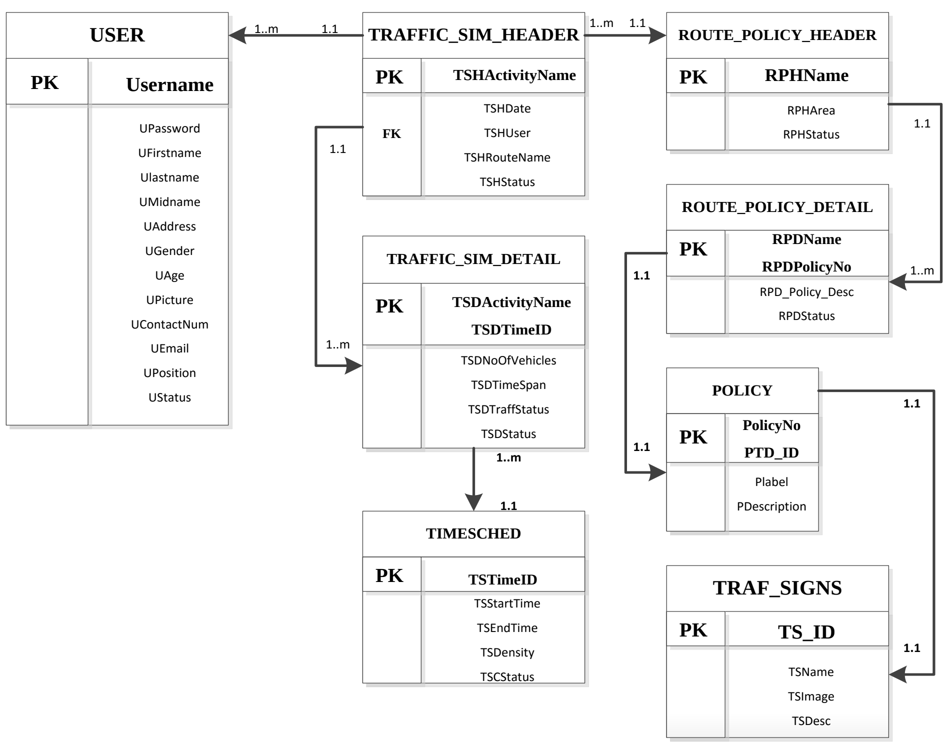


Figure 16: **Entity Relationship Diagram**

Figure 16 shows the relationships of the tables in the database. The relationship of the tables includes relation of TRAFFIC_SIM_HEADER to USER, TRAFFIC_SIM_DETAIL and ROUTE_POLICY_HEADER, TRAFFIC_SIM_DETAIL to TIMESCHED, ROUTE_POLICY_HEADER to ROUTE_POLICTY_DETAIL to POLICY and POLICY to TRAF_SIGNS. The figure 12 also shows how may can be recorded in the database with the same primary keys.

Data Dictionary

This section consist the several of fields and properties as a descriptive collection of data in the database which includes the table name, column name, data type, size, null column, and description respectively.

Table 11

USER PROFILE

Table Name	Column Name	Data Type	Size	Null	Description
USER	UUsername	Text	15	No	User's username and primary key of the table
	UPassword	Text	15	No	User's password
	UFirstname	Text	25	No	User's firstname
	ULastname	Text	25	No	User's lastname
	UMidname	Text	25	No	User's middle name
	UAddress	Text	25	No	User's address
	UGender	Text	2	No	User's gender M-male F-Female
	UAge	Number	2	No	User's age
	UPicture	Image	Fixed	No	User's image
	UcontactNum	Text	15	No	User's contact number
	UEmail	Text	25	Yes	User's email address
	UPosition	Text	25	No	User's position
	UStatus	Text	25	No	User's status AC –active NA – not active

Table 11 shows the field names of the user profile database table. It consists of Uusername, Upassword, Ufirstname, Ulastname, Umidname, Uaddress, Ugender, Uage, Upicture, UcontactNum, Uemail, Uposition, Ustatus. These are the fields needed to store the values of all registered users.

Table 12

TRAFFIC SIGNS

Table Name	Column Name	Data Type	Size	Null	Description
TRAF_SIGNS	TS_ID	Text	15	No	Traffic sign identification code and primary key of the table
	TSName	Text	25	No	Traffic sign name
	TSImage	Image	Fixed	No	Traffic sign image
	TSdesc	Text	30	No	Traffic sign description

Table 12 shows the field names which are the TS_ID, TSName, TSimage TSdesc. These are the fields needed to store the values of all traffic signs.

Table 13

ROUTE POLICY HEADER

Table Name	Column Name	Data Type	Size	Null	Description
ROUTE_POLICY_HEADER	RPHName	Text	25	No	Route's name and primary key of the table
	RPHArea	Text	25	No	Route's location area
	RPHStatus	Text	30	No	Route status

Table 13 shows the field names which are the RPHName, RPHArea, RPHStatus. These are the fields needed to store the values of the route header.

Table 14

ROUTE POLICY DETAIL

Table Name	Column Name	Data Type	Size	Null	Description
ROUTE_POLICY_ DETAIL	RPDName	Text	25	No	Route's name and primary key of the table
	RPDPolicyNo	Text	15	No	Route detail's policy no. and primary key of the table
	RPD_RAR_Desc	Text	225	No	Route details's policy description
	RPDStatus	Text	30	No	Route status

Table 14 shows the field names which are the RPDName, RPDPolicyNo, RPD_Policy_Desc, and RPDStatus. These are the fields needed to store the values of the route details.

Table 15

TIME SCHEDULE

Table Name	Column Name	Data Type	Size	Null	Description
TIMESCHED	TStimeID	Number	25	No	Timesched's time schedules and primary key of the table
	TSStartTime	Number	25	No	Timesched's start time
	TSEndTime	Number	25	No	Timesched's end time
	TSDensity	Number	225	No	Timesched's vehicle density
	TSCStatus	Text	30	No	Timesched's status

Table 15 shows the field names which are the TStimeID, TSStartTime, TSEndTime, TSDensity, TSCStatus. These are the fields that are needed to store the values of all the registered time schedules.

Table 16

POLICY

Table Name	Column Name	Data Type	Size	Null	Description
POLICY	PolicyNo	Text	25	No	Policy’s policy no. and primary key of the table
	PTD_ID	Text	25	No	Policy’s ID and primary key of the table
	PLabel	Text	25	No	Policy’s policy label/title
	PDescription	Text	225	No	Policy’s Policy Description

Table 16 shows the fields which are PolicyNo, PTD_ID, Plabel, PDescription. These are the fields needed to store the values of all the stored policy rules and regulations.

Table 17

TRAFFIC SIMULATION HEADER

Table Name	Column Name	Data Type	Size	Null	Description
TRAFFIC_SIM_HEADER	TSHActivityName	Text	25	No	Traffic_sim_header’s activity name and primary key of the table
	TSHDate	Text	25	No	Traffic_sim_header’s date created.
	TSHUser	Text	25	No	Traffic_sim_header’s name of the user
	TSHRouteName	Text	25	No	Traffic_sim_header’s route name
	TSHStatus	Text	225	No	Traffic_sim_header’s status

Table 17 shows the fields which are TSHActivityName, TSHDate, TSHUser, TSHRouteName, TSHStatus. These are the fields needed to store the values of all the traffic sim header data.

Table 18

TRAFFIC SIMULATION DETAIL

Table Name	**Column Name**	**Data Type**	**Size**	**Null**	**Description**
TRAFFIC_SIM_DETAIL	TSDActivityName	Text	25	No	Traffic_sim_detail's activity name and primary key of the table
	TSDTimeID	Number	25	No	Traffic_sim_detail's time schedule and primary key of the table
	TSDNoOfVehicles	Number	225	No	Traffic_sim_detail's density of the vehicle
	TSDTimeSpan	Number	25	No	Traffic_sim_detail's time span
	TSDTraffStatus	Text	25	No	Traffic_sim_detail's traffic status
	TSDStatus	Text	225	No	Traffic_sim_detail's status

Table 18 shows the fields which are TSDActivityName, TSDTimeID, TSDNoOfVehicles, TSDTimeSpan, TSDTraffStatus, and TSDStatus. These are the fields needed to store the values of all the traffic sim detatil data.

Software Specification

The software specification of the study includes the operating system, the platform, the front and back end programming language, design tools, and the database for the data storage.

Traffic Sim will use Android as its operation system and will be implemented in Unity as its IDE. It will run in variety of android device ranging from Version 4.4 (Kitkat) up to the latest version. It will utilize Java programming language as its front-end and C#, SQL, and Java as its back-end and SQLite as data storage for creating, retrieving, updating, deleting, and storing data.

Program Specifications

This section represents the list of algorithms needed for the system. It displays the list of modules designating the programmers' assigned modules, and assigned tasks.

Table 19

List of Modules

Programmer(s)	**Modules**	**User**
Ephrem Anthony Q. Geotoro	**LOGIN/LOGOUT**	
	1.) Create	
	2.) Retrieve	
	3.) Update	
No. of Points (1 point per module per user)		
Jochelle D. Agapay	**ACTIVITY LOG**	
	1.) Retrieve	
	2.) Edit	
	3.) Delete	
	4.) Save	
No. of Points (1 point per module per user)		
Janice C. Bornea	**SIMULATION**	
	1.) Create	
	2.) Retrieve	
	3.) Delete	
	COMPARE TRAFFIC FLOWS	
	1.) Retrieve	
No. of Points (1 point per module per user)		
Kenny Jay L. Pepito	**TRAFFIC POLICY**	
	1.) Retrieve	
	2.) Delete	
	DATABASE MANAGEMENT	
	1.) Create	
	2.) Retrieve	
	3.) Update	
	4.) Delete	
No. of Points (1 point per module per user)		

Table 19 shows the different modules and the different individuals assigned. The modules of the Traffic Sim include Login and Logout, Activity Log, Simulation, Traffic Policy and Database Management.

REFERENCES

Aksac, A., Uzun, E., & Özyer, T. (2011, April 19). *A real time traffic simulator utilizing an adaptivefuzzy inference mechanism by tuning fuzzy parameters*. Retrieved from http://210.30.190.120/ckwx/yuan/mhlj/201408250406.pdf

Al-Dmour, N. (2011). *TraffSim: Multiagent Traffic Simulation*. Retrieved from ftp://161.24.19.221/ele/jrsantos/Leitura/Traffic/Simuladores/TraffSim_2011.pdf

Arioui, H., Nehaoua, L. (2013, December 2). *Driving Simulation*. Retrieved from https://books.google.com.ph/books?id=Gi5IAgAAQBAJ&source=gbs_navlinks_s

Barcelo, J. (2010). *Fundamentals of Traffic Simulation*. Retrieved from https://books.google.com.ph/books?id=DrxcJygXDCcC&pg=PA66&dq=traffic+simulator&hl=en&sa=X&redir_esc=y#v=onepage&q=traffic%20simulator&f=false

Brügmann, J. (2015). *Modelling and implementation of a microscopic traffic simulation system*. Retrievedfromhttps://books.google.com.ph/books?id=uPpgCwAAQBAJ&pg=PA4&dq=traffic+simulation&hl=en&sa=X&redir_esc=y#v=onepage&q=traffic%20simulation&f=false

Chell, D., Erasmus, T., & Colley, S. (2005). *The Mobile Application Hacker's Handbook*. Retrieved from https://books.google.com.ph/books?id=UgVhBgAAQBAJ&pg=PR32&dq=mobile+application&hl=en&sa=X&redir_esc=y#v=onepage&q=mobile%20application&f=false

Daamen, W., Buisson, C., & Hoogendoorn, S. (2015). *Traffic Simulation and Data: Validation Methods and Applications.* Retrieved from https://books.google.com.ph/books?id=iI5qBAAAQBAJ&pg=PA1&dq=traffic+simulation&hl=en&sa=X&redir_esc=y#v=onepage&q=traffic%20simulation&f=false

Falcocchio, C. J., & Levinson, S. H. (2015). *Road Traffic Congestion: A Concise Guide*. Retrieved from https://books.google.com.ph/books?id=kbdnBwAAQBAJ&printsec=frontcover&dq=road+traffic&hl=en&sa=X&redir_esc=y#v=onepage&q=road%20traffic&f=false

Henson, C. L., & Lee, C. A. (2013, June 29). *Simulators in Anesthesiology Education*. Retrieved fromhttps://books.google.com.ph/books?id=dzegBQAAQBAJ&dq=simulator&source%20=gbs_navlinks_s

Hoog, A. (2011). *Investigation, Analysis, and Mobile Security for Google.* Retrieved from https://books.google.com.ph/books?id=zDibrpXTfxMC&printsec=frontcover&dq=mobile&hl=en&sa=X&redir_esc=y#v=onepage&q=mobile&f=false

Horton, R. H. (2012, December 6). *Traffic Control: Theory and Instrumentation*. Retrieved from https://books.google.com.ph/books?id=ZpUoBgAAQBAJ&source=gbs_navlinks_

Krajzewicz, D. (2010, June 28). *Traffic Simulation with SUMO-Simulation of Urban Mobility*. Retrieved from http://link.springer.com/chapter/10.1007/978-1-4419-6142-6_7

Kuhn, W. (2013). *Fundamentals of Road Design*. Retrieved from https://books.google.com.ph/books?id=pdikFUh4tmsC&dq=traffic+road&source%20=gbs_navlinks_s

Loo, B., & Anderson, T. (2016). *Spatial Analysis Methods of Road Traffic Collisions.* Retrieved fromhttps://books.google.com.ph/books?id=ysB5CgAAQBAJ&printsec=frontcover&dq=road+traffic&hl=en&sa=X&redir_esc=y#v=onepage&q=road%20traffic&f=false

McWherter, J., & Gowell, S. (2012). *Professional Mobile Application Development.* Retrieved fromhttps://books.google.com.ph/books?id=S7CIlnNkg8UC&printsec=frontcover&dq=mobile+application&hl=en&sa=X&sqi=2&redir_esc=y#v=onepage&q=mobile%20application&f=false

Meier, R. (2012). *Professional Android 4 Application Development.* Retrieved from https://books.google.com.ph/books?id=bmJIl_wPgQsC&printsec=frontcover&dq=mobile+application&hl=en&sa=X&redir_esc=y#v=onepage&q=mobile%20application&f=false

Mizuta, H. (2015). *Evaluation of Metropolitan Traffic Flow with Agent-based Traffic Simulator and approximated vehicle behavior model near intersections.* Retrieved from https://pdfs.semanticscholar.org/4a17/946c8c6d219b31a34e1e6bb6ce08a76ef806.pdf

Osogami, T., Imamichi, T., Mizuta, H., Morimura, T., Raymond, R., Suzumura, T., Takahashi, R., & Id´e, T. (2012, December 29). IBM Mega Traffic Simulator. Retrieved from http://domino.research.ibm.com/library/cyberdig.nsf/papers/7BE8B8BF8CAE073A85257B1900190ACE/$File/paper.pdf

Ramamohanarao, K., Xie, H., Kulik, L., Karunasekera, S., Tanin, E., Zhang, R., & Khunayn, E. (2016). *SMARTS: Scalable Microscopic Adaptive Road Traffic Simulator.* Retrieved from http://www.ruizhang.info/publications/TIST2016_SMARTS.pdf

Rosen, A. (2013, July 8). *What really causes traffic congestion.* Retrieved from http://www.sheepsheadbites.com/2013/07/what-really-causes-traffic-congestion/

Ross, S. (2013). *Simulation.* Retrieved from https://books.google.com.ph/books?id=1Dwsyyty3P8C&dq=simulation&source=gbs_navlinks_s

That, T., & Casas, J. (2011, September 6). *An integrated framework combining a traffic simulator and a driving simulator.* Retrieved from http://www.sciencedirect.com/science/article/pii/ S1877042811014522

Treiber, M., & Kesting, A. (2013). *Traffic Flow Dynamics: Data, Models and Simulation.* Retrieved from https://books.google.com.ph/books?id=sWiUjVAGTVgC&printsec=frontcover&dq=traffic+simulator&hl=en&sa=X&redir_esc=y#v=onepage&q=traffic%20simulator&f=false

Yang, Q., Slavin, H., Stefansson, K., Rabinowicz, A., Olsberg, S., LaClair, M., & Brandon, J. (2013, July 9). *U.S. Patent No.* 11/614,617. U.S.

Zhao, Y., Wagh, A., Hou, Y., Hulme, K., Qiao, C., & Sadek, W. A. (2014, June). *Integrated Traffic- Driving-Networking Simulator for the Design of Connected Vehicle Applications: Eco-Signal Case Study.* Retrieved from https://www.researchgate.net/profile/Yunjie_Zhao/publication/271937865_Integrated_TrafficDrivingNetworking_Simulator_for_the_Design_of_Connected_Vehicle_Applications_EcoSignal_Case_Study/links/5644ff3408a ef646e6cc0f2a.pdf

APPENDIX A

Transmittal Letter - Dean

October 5, 2016

MOMA D. ORTEGA
Dean of College of Computer Studies
University of Cebu - Banilad Campus

Dear Madam:

Good Day!

We, the 4th year students of Bachelor of Science in Information Technology of University of Cebu - Banilad Campus are presently conducting a Capstone Project entitled "Traffic Sim: A Traffic Modeling Application". The aforementioned activity is a year-long pre-requisite for graduation which requires intensive research beyond the four corners of the school.

In line with this, we humbly ask your consent to allow us to visit and conduct an interview in a government agency specifically CCTO (Cebu City Transportation Office). We believe this interview would strengthen the foundation of our thesis.

We are hoping for your positive consideration of this request.

Respectfully yours,

Agapay, Jochelle D.
Project Manager

Noted by:

Mr. Eric Ortega
Adviser

Recommended by:

Ms. Moma D. Ortega
Dean, College of Computer Studies

APPENDIX B

Transmittal Letter - CCTO

October 4, 2016

RAFAEL CHRISTOPHER L. YAP
Executive Director of CCTO Board Office
CCTO Board Office
2nd Floor, Ramos Public Market
F.Ramos St., Cebu City

CCTO
Cebu City Transportation Office
RECEIVED
J. Lizy 10-7-16
10:49 AM

Dear Sir:

Good Day!

We, the 4th year students of Bachelor of Science in Information Technology of University of Cebu - Banilad Campus are presently conducting a Capstone Project entitled "Traffic Sim: A Traffic Modeling Application". The aforementioned activity is a year-long pre-requisite for graduation which requires intensive research beyond the four corners of the school.

In line with this, we humbly ask your good office to allow us to conduct a personal interview with you with regards to traffic. We believe this interview would strengthen the foundation of our thesis. Rest assured that the information gathered shall be highly kept confidential for your security and safety.

We are hoping for your positive consideration of this request.

Respectfully yours,

Agapay, Jochelle D.
Project Manager

Noted by:

Mr. Eric Ortega
Adviser

Recommended by:

Ms. Mona D. Ortega
Dean, College of Computer Studies

Approved by:

Atty. Rafael Christopher L. Yap
Executive Director of CCTO Board Office

Finished

APPENDIX C

Censor's Certificate

University of Cebu
College of Computer Studies
Cebu City

Date: November 11, 2016

CENSOR'S CERTIFICATE

This is to certify that the undersigned has reviewed and went through all the pages of the proposed project study/ research manuscript titled "Traffic Sim: A traffic modeling application" as against the set of structural rules that govern the composition of sentences, phrases, and words in the English language as well as the technical terms, syntax (format, etc.) and semantics appropriate for the Information Technology and Computing fields.

Signed:

MS. MIRIAM FLORES
Grammarian

Conforme:

JOCHELLE D. AGAPAY
Project Manager

Noted:

MR. ERIC ORTEGA
Adviser

CURRICULUM VITAE

PERSONAL DATA

NAME: Jochelle D. Agapay

DATE OF BIRTH: January 29, 1996

ADDRESS: AS. Fortuna Street, Banilad, Mandaue City, Cebu

GENDER: Female

CIVIL STATUS: Single

RELIGION: Roman Catholic

CONTACT NUMBER: 505-3069

EDUCATIONAL BACKGROUND

COLLEGE:	Bachelor of Science in Information Technology
	University of Cebu – Banilad Campus
	Banilad, Cebu City
	School Year 2013 – Present
HIGH SCHOOL:	Mandaue City Comprehensive National High School
	Plaridel St. Reclamation Area, Mandaue City
	School Year 2008 - 2012
ELEMENTARY:	Banilad Elementary School
	St. Therese Drive, Banilad, Mandaue City
	School Year 2002 – 2008

PERSONAL DATA

NAME: Janice C. Bornea

DATE OF BIRTH: June 6, 1997

ADDRESS: Cubacub, Mandaue City

GENDER: Female

CIVIL STATUS: Single

RELIGION: Roman Catholic

CONTACT NUMBER: 09434115872

EDUCATIONAL BACKGROUND

COLLEGE:	Bachelor of Science in Information Technology
	University of Cebu – Banilad Campus
	Banilad, Cebu City
	School Year 2013 – Present
HIGH SCHOOL:	San Isidro Parish School
	Borbajo St., Talamban, Cebu City
	School Year 2009 - 2013
ELEMENTARY:	Talamban Elementary School
	Talamban, Cebu City
	School Year 2003 – 2009

PERSONAL DATA

NAME: Ephrem Anthony Q. Geotoro

DATE OF BIRTH: June 9, 1997

ADDRESS: Sto. Nino II, Lower Casili, Consolacion Cebu

GENDER: Male

CIVIL STATUS: Single

RELIGION: Roman Catholic

CONTACT NUMBER: 09335779997

EDUCATIONAL BACKGROUND

COLLEGE:	Bachelor of Science in Information Technology
	University of Cebu – Banilad Campus
	Banilad, Cebu City
	School Year 2013 – Present
HIGH SCHOOL:	Saint Louis College-Cebu
	Sudlon, Maguikay, Mandaue City
	School Year 2009 - 2013
ELEMENTARY:	Consolacion Central School
	Poblacion Occidental, Consolacion, Cebu
	School Year 2003 – 2009

PERSONAL DATA

NAME: Jam Tinber A. Medequillo

DATE OF BIRTH: December 1, 1996

ADDRESS: #9 Sitio Tapoco Pit-Os, Cebu City

GENDER: Male

CIVIL STATUS: Single

RELIGION: Born Again Christian

CONTACT NUMBER: 09239821114

EDUCATIONAL BACKGROUND

COLLEGE:	Bachelor of Science in Information Technology
	University of Cebu – Banilad Campus
	Banilad, Cebu City
	School Year 2013 – Present
HIGH SCHOOL:	Pit-Os National High School
	Pit-Os, Cebu City
	School Year 2009 - 2013
ELEMENTARY:	Talamban Elementary School
	Talamban, Cebu City
	School Year 2003 – 2009

PERSONAL DATA

NAME: Kenny Jay L. Pepito

DATE OF BIRTH: December 20, 1996

ADDRESS: Bacayan, Cebu City

GENDER: Male

CIVIL STATUS: Single

RELIGION: Born Again Christian

CONTACT NUMBER: 09331502729

EDUCATIONAL BACKGROUND

COLLEGE:	Bachelor of Science in Information Technology University of Cebu – Banilad Campus Banilad, Cebu City School Year 2013 – Present
HIGH SCHOOL:	Agsungot National High School Agsungot, Cebu City School Year 2009 - 2013
ELEMENTARY:	Agsungot Elementary School Agsungot, Cebu City School Year 2003 – 2009