The Guardian

Artificial Intelligence System for Roadside Assistance and Vehicle Maintenance

W.G.I.F. Jayasuriya

198756T

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DECLARATION

I declare that is thesis is my own work and has not been submitted in any form for another degree or diploma at any university or other institution of tertiary education. Information derived from the published or unpublished work of others has been acknowledged in the text and a list of references is given.

W.G.I.F.Jayasuriya.

UOM Verified Signature

Date: Signature of Student:

Supervised by:

Dr. Saminda Premarathne
Faculty of Information Technology
University of Moratuwa.

UOM Verified Signature

Date: 29/07/2022 Signature of Supervisor:

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I will forever be indebted to the love and support of my parents and wife throughout my life for the advancement of my career.

ABSTRACT

Artificial intelligence for roadside assistance and vehicle maintenance system develops for users with less mechanical knowledge. The main scope of this system is to provide technical or non-technical information without delay when requested by system users. The system enables users to connect to the system using the shorts message system (SMS) feature. The system consists of 4 subsystems: the short message gateway, NLP (Natural Language Processing), Chat-bot and Database Handler. When a user sends a question to the system, it sends directly to the natural language processing module to understand what the user is requesting. If the NLP is unable to handle the problem, the system sends those requests to the Chat-bot, which can communicate with the users to handle ambiguous issues and provide solutions to the users' problems. Existing systems for road assistance are more difficult in practice. They are more expensive to use, which means it costs more for the user to continue the service after the warranty period and they provide the service only to registered customers. Although service agents are almost always busy and need a high cell but a phone or other device to use those services. Hence, the shortcomings of existing systems lead to the development of an artificial intelligence system for roadside assistance. Furthermore, this research will help people doing research in the field of roadside assistance and also people who interest to perform their maintenance without the assistance of a third party.

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INTRODUCTION

1.1 Introduction

This chapter presents background of the project, problem statement, research question, aims and objectives, proposed solution, motivation, significance, scope and assumptions and limitations.

1.2 Background of the project

Early motorists were capable of doing minor repairs on their own, but as automobiles became more sophisticated with technology, it became more difficult to do so without proper knowledge. Thereby today most of the motorists tend to roadside assistance plan to protect their vehicles. Some automobile manufacturers offer free roadside assistance to their customers for a period of time after purchasing a new vehicle. Roadside assistance plan includes diagnosing and repairing the problem that caused the vehicle breakdown, car towing service, tire change service, petrol delivery, and dead battery service etc. In recent years, free roadside assistance applications have been developed with the proliferation of mobile phones and the advancement of mobile technology.

The study aims to develop a platform that assists vehicle breakdown and maintenance. The system provides information on hospitals, fuel stations, police stations, garages, towing companies, basic vehicle maintenance tips, and tricks, and explains the causes of car breakdowns. The project's main advantage is eliminating the need to visit a vehicle service provider for trivial matters and encouraging people to do their own vehicle maintenance.

1.3 Description

Vehicles are one of the greatest inventions of the 20th century and regardless of lifestyle, the place of residence, behaviors, or other factors, vehicles are very important in daily life. Currently, roadside assistance plans are more common in developed countries, but in

developing countries such as Sri Lanka, this service is not very popular, but Sri Lankan drivers also need this type of service.

Although The automakers are constantly conducting a lot of research and testing to add features to improve the driving experience and improve the performance of their products. In such cases, car users need to have sufficient knowledge to interact with these new technologies. Otherwise, users will have to contact the vehicle service provider for minor issues and spend more money.

Roadside assistance systems are popular in developed countries. In Sri Lanka, some companies offer roadside assistance to provide specialized professional services to their clients. With the proliferation of mobile phones and the advancement of mobile technology, many developers tend to develop free roadside assistance applications. When a vehicle breaks down on the road, the driver of the vehicle will notify the fault through the system or application, then the system will instruct a qualified mechanic and the mechanic will arrive at the location and repair it.

Considering Sri Lanka's existing roadside assistance system, most of them have failed, caused by the difficulty to reach remote areas, problems in assigning mechanics, and the effects of the corona virus.

1.4 Problem Statement

In 2019, the Sri Lankan vehicle population was 8,095,224. It indicates that most of the Sri Lankan people have their own vehicle. But sadly, most of them are being second-hand, low-quality or polluting vehicles. Accordingly, vehicle breakdown on the road has also increased relative to the vehicle population. Furthermore, the automotive industry today works with the new technology and produces the most innovative, safest, and most comfortable vehicles. With this advanced technology, the vehicle has been a larger smart device. Hence, vehicle owners should better understand of this new technology to operate and maintain the vehicle.

The COVID-19 virus has been swept whole around the world. To mitigate the spread of the virus workers have tended work from home (WFH) practices. In such a case the vehicles are

parked in the garage for a long time of the period without having proper maintenance or at least engine restart. This must be a cause for several mechanical problems.

As a consequence of the COVID-19 pandemic, the government has introduced practices of social alienation in people's daily lives, such as staying at home, avoiding crowded areas, physical distance from others, etc. As a result, drivers are reluctant to seek help from locals in the event of a car breakdown on the road. On the other hand, many drivers do not have the technical knowledge to fix basic car faults and should contact their auto repair service provider, even for minor vehicle repairs. In this pandemic, it is difficult to find the services of a car repair service provider. Because some service providers are not available, some refuse to provide the service and some are far from the point of failure. All this happens suddenly on the road and the driver panics for help. In such cases, fraudsters take advantage of it.

Considering all the above problems, it is important to create a solution that solves all of these problems at once. As a driver on the road, a car accident can happen anytime, anywhere and is beyond the driver's control. This research provides a convenient way to help the driver if he or she is involved in such a situation.

An Artificial intelligence system for roadside assistance and vehicle maintenance is a system that supports troubleshooting and vehicle maintenance anytime, anywhere. It provides reasonable knowledge for repairing minor car breakdowns and helps find the location of utility. In addition, the English literacy rate is only 22% of the Sri Lankan population over the age of 15. The adequacy of English should also be taken into account when developing the system. The uniqueness of this project focuses on the methods of artificial intelligence technology applied in roadside assistance. Artificial intelligence can communicate with humans using natural language processing technology. This project can save valuable time for vehicle users, reduce, or eliminate unnecessary bookings for service providers, and provide relevant information with minimal delay.

1.4.1 Research question

The research question for research can be identified as follows.

- How to develop a platform that assists users in vehicle breakdowns and maintenance anytime, anywhere?

- How to provide troubleshooting instructions to users with low mechanical knowledge?

- How to implement an intelligent system to identify various user questions and provide the most suitable answers?

- How to implement an intelligent system to work with low English literacy people?

1.5 Research aims and objectives

1.5.1 Research Aim

- ❖ Developing a platform to assist users with low English proficiency in a vehicle break down and vehicle maintenance.

1.5.2 Research objectives

Research objectives can be identified as follows.

- ❖ Implement a fully functional & quality roadside assistance system for user satisfaction
- ❖ Implement an intelligent system to work with low English literacy people.
- ❖ Provide mechanic instructions for low mechanical knowledge peoples.
- ❖ Provide non-mechanical information required in the event of a vehicle break down on the road.

1.6 Proposed Solution

This project develops a platform to assist vehicle breakdown and maintenance using artificial intelligence that can solve all the above problems. It Provides reasonable knowledge of minor mechanical failures, basic vehicle maintenance tips, and guidance on finding utility places. Although it eliminates the need to visit a vehicle service provider for trivial matters and to encourage people to do their own vehicle maintenance. The uniqueness of this project is the application of artificial intelligence in roadside assistance. Artificial intelligence can communicate with humans using natural language processing technology.

1.7 Motivation

The motivation for building this system is to make life easier for vehicle users. Vehicle users are free to ask questions about their vehicle at anytime, anywhere without worrying about their adequacy in English, and even trivial things eliminate the need to visit a vehicle service provider and encourage people to maintain their vehicle.

1.8 Significance of the project

The main advantage of using this system to support roadside breakdowns is, users can get a quick response compared to other aids and users can access the system at any time of the day, making it easy for them. The system is more manipulative than humans. The system is flexible because it is the quality of being able to practice and add new questions and answers relating to the relevant topics. The system is cost effective as it requires less manpower to solve user maintenance issues.

1.9 Scope of the project

This project can save people valuable time by reducing or eliminating unnecessary appointments with service providers, as well as providing relevant information with minimal delay. From the beginning of the project, analyze the incident of vehicle failure on the road and identified the basic maintenance and repair of the car that users can perform themselves. In order to gather the necessary information for the development of the system, a survey of

vehicle users was conducted. The survey statistics were used to develop the right system that will provide the information that users really need. Then analyze the existing roadside assistance system and identified the weakness of the existing system. In order to collect mechanical instructions for the database, a personal interview with a mechanic was conducted. In an effort to gather technical and non-technical information about the system, reviewed documents and research papers on the Internet, which helped to create a better system than the existing one.

When developing the system in countries like Sri Lanka, need to consider proficiency in English. Nowadays most of the new generation in Sri Lanka can read and understand the English, but some of them make mistakes in English spelling and grammar. When developing the system this problem also going to be considered.

Further, the system will help to the people who would like in the field of the road assistance and people who are willing to make their vehicle maintenance by themselves.

1.9.1 User scope

User scope can be identified as primary user scope and secondary user scope as follows.

- Primary User: Vehicle users

The user can use the system anywhere and anytime.

- Secondary User: Administrator

The administrator can add questions and answers to the SQL database, to make the system more reliable and efficient.

1.9.2 System scope

The system was developed using natural language processing (NLP) and the system provides the best suitable answer for the user questions (SMS). The system Chat-bot can handle user conversations.

1.10 Structure of the thesis

This thesis has five chapters. There is a brief description of each chapter in this figure.

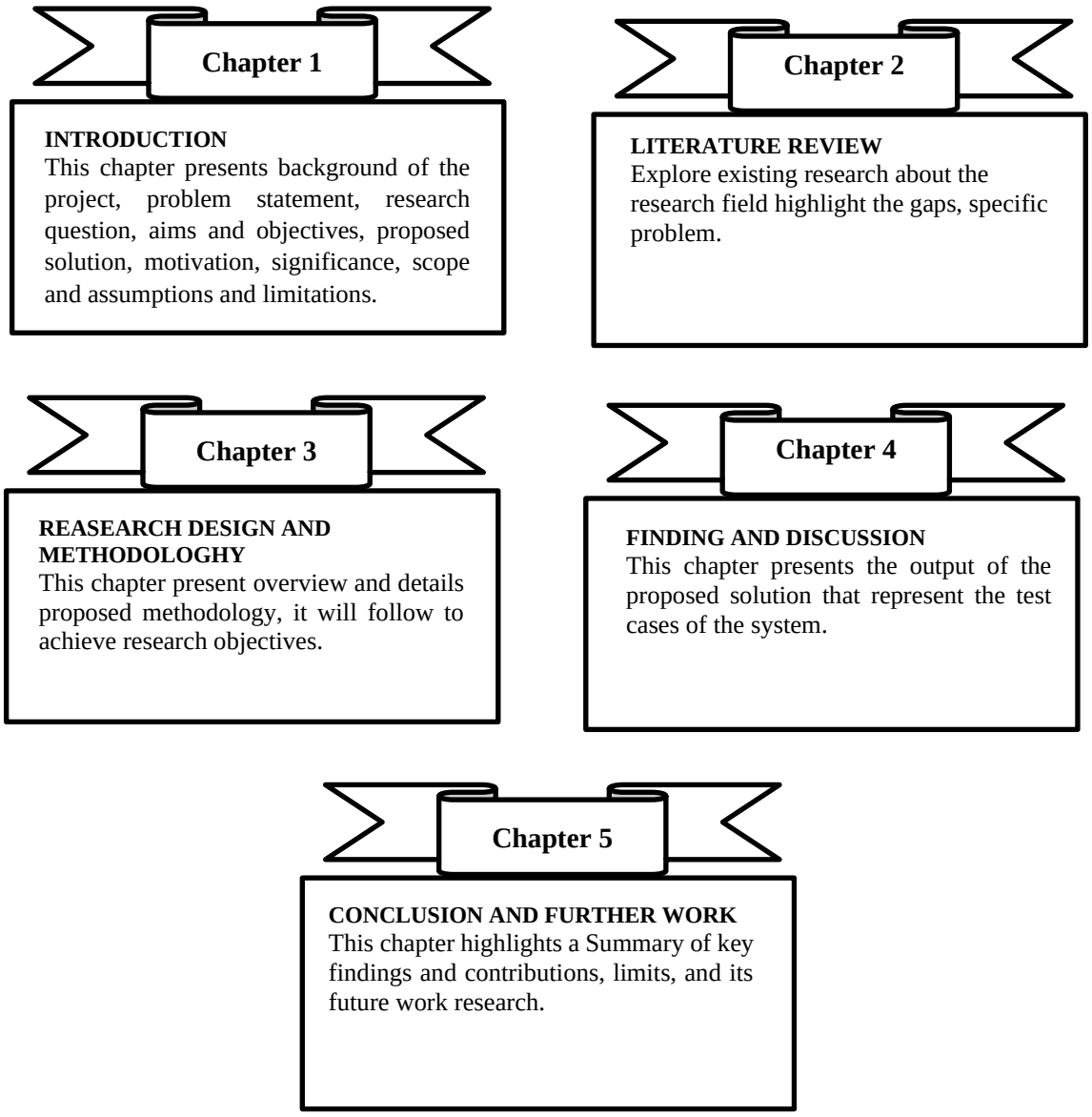


Figure 1 Structure of the thesis

1.11 Assumptions and Limitations

1.11.1 Assumptions

The main assumption of the project can be identified as follows.

- The system is capable of handling a large number of issues from different users simultaneously.

1.11.2 Limitations

The main limitation of the project can be identified as follows.

- The system may be less accurate and will not respond to the questions which are out of the questions in the SQL database.

1.12 Summary

This chapter included the background of the project, problem statement, research question, aims and objectives, proposed solution, motivation, significance, scope and assumptions and limitations. The next chapter will explore the existing research on the research area, highlighting the gaps, specific issue.

Chapter 2

LITERATURE REVIEW

2.1 Introduction

The previous chapter discussed the background of the project, problem statement, research question, aims and objectives, proposed solution, motivation, significance, scope and assumptions and limitations. This chapter includes the literature reviews, which provides a critical and detailed evaluation of previous studies. This is a summary of specific research areas, confirming the reasons for conducting this research.

2.2 Existing roadside assistance system

A Car Breakdown Service Station Locator System is a system which developed for the Android platform. When The vehicle breaks down on the highway or any other road, the driver can enter their information into the system with including the breakdown place, then the system automatically searches and show the nearby Car Repair Service Provider (CRSP) who registered with the system and their prices. This system is useful for drivers who do not have CRSP contact numbers. [3]

Khoo Jin, Ahmad and Kamal proposed a system that focuses on finding the nearest CRSP to the drivers, who haven't any engineer number in hand. The system determines the nearest CRSP then Displays a list of available CRSPs, and the user can choose one. [6]

On Road Vehicle Service Finder is an Android-based application that can work with any type of Android device (tablet or smartphone). This system is focused on helping users discover the nearby engineer and communicate with him through the application. The system has a mechanical portal, and the engineer can log into and search for available customer service requirements. The customer can submit a complaint or service request through the customer portal. Then the customer details send to the nearby engineers and the engineer can log in to the engineer portal and select the customer for service by calling the customer. Finally, the engineer will be directed to the customer's location via Google Maps. [2]

On-Road Vehicle Breakdown Assistance is an Android-based application that helps, users to find the nearest service provider (SP) by accessing the SP's area of expertise, contact information, images and ratings. A special feature of this application is the chat platform. The chat platform allows users to ask questions and other users and engineers to answer them. Users can also evaluate and comment on the engineers when the job is completed. [7]

Vehicle breakdown assistance is an application that can be used to find the closest engineer. This is the best solution for the driver seeking help remotely. The application mentions authorized engineers and the administrator monitored engineers based on the user feedback. It prohibited the engineer from charging users additional service charges. This application allows the user to pay for vehicle repairs at a reasonable price. [1]

Chat-bots: can they serve as natural language interfaces to QA corpus? Chat-bot is a program that allows people to converse with it in natural language, on a topic that incorporates the internal knowledge model of the chat-bot. From this article, the chat-bot is used as a question-and-answer interface, and the QA component TRE09 is used to automatically retrain the catboat's knowledge base. [5]

The approach in this project focuses on methods of artificial intelligent techniques to be applied to Roadside assistance. Artificial intelligent can communicate with humans by processing natural language using natural language processing techniques. Technically This system is based on short message service as well as natural language processing techniques. The capability of the system includes reply for the short message by processing natural language.

2.3 Summary

This chapter presented the existing research about the research field highlight the gaps, specific problem. The next chapter will present overview of proposed methodology, which follow to achieve research objectives.

Chapter 3

REASEARCH DESIGN AND METHODOLOGHY

3.1 Introduction

The previous chapter presented the literature reviews, which provides a critical and detailed evaluation of previous studies. This chapter presents overview of proposed methodology, which follow to achieve research objectives.

3.2 Research Description

The "Guardian" roadside support system lets the driver know how to make minor vehicle repairs at once. In the event of a problem, the driver should send a short message (SMS) to the system by informing the error which occurred. Then the system identifies the specific problem users send using the SQL database. In the next step, the system informs the driver of the steps to resolve the error. This section further explains how to handle customer requests and smooth it out by managing separate threads for each customer request message. The whole system has a main process module call "natural language processing" module. This section provides an overview of the natural language processing module.

3.2.1 Internal process of the NLP module

When a raw message is received from the SMS gateway module, the NLP module can understand the contents of typed or raw messages using the following mechanism.

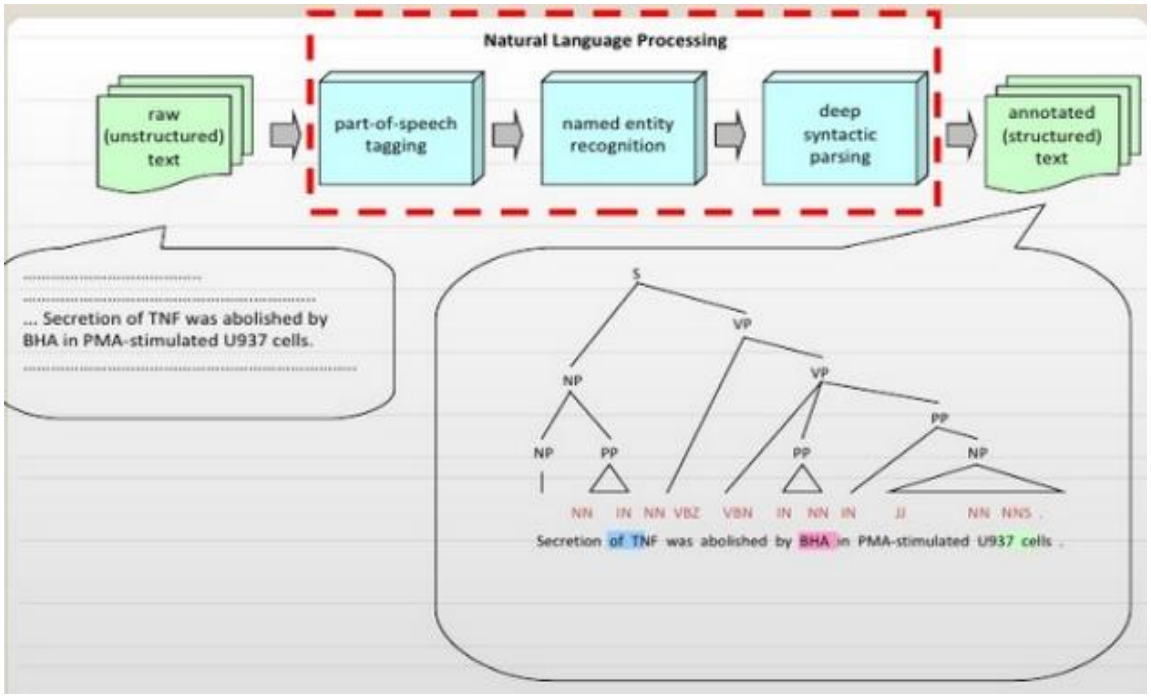
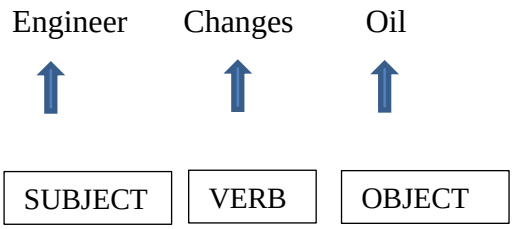


Figure 2 Internal process of the NLP module

In NLP module the large lexical database called “WordNet”. WordNet is a large database of English dictionaries. Nouns, verbs, adjectives, and verbs are grouped into sets of cognitive syn-sets, each of which expresses a different concept. The syn-sets interconnect by conceptual-semantic and lexical connections. The WordNet is free to download and publicly available. Each of the 117 000 syn-sets in WordNet is connected to other syn-sets through small "conceptual connections". The basic mechanism of the concept of a natural language processing model of this project is as below,

Basically, in this module identify the "Subject", "Verb", "Object" section of each sentence coming from the SMS gateway module. In this case a similar word presents some obstacles, as the SMS portal has to deal with a complex situation when similar words come from the NLP module. This module uses a hash algorithm to create a sequential list (% by percentage) to solve this problem.



Engineer	Changes	Oil
Engineer	Adjustments	Oil
Engineer	Conversions	Oil

After allocating weight to a sentence, the system automatically finds the appropriate solution from the SQL database. The system administrator updates and add new solutions to the system using the system admin panel. That solution message needs to be more precise and concise and meaningful.

The database integrates with the Microsoft O365 grammar and spell-checking module, this third-party module, automatically detects grammar and spelling errors in administrator-updated solution file files and helps users to correct their grammar and spelling errors when sending a message to the system.

If a solution is not found in the SQL database using the natural language processing concept, it will take the next best alternative solution and will automatically interpret that customer request a message to the next module called "CHATBOT". CHATBOT communicates with the customer and identify what customer need. There it will enhance the user-friendliness and accuracy of the entire system. System Architecture

3.2.2 High level system architecture

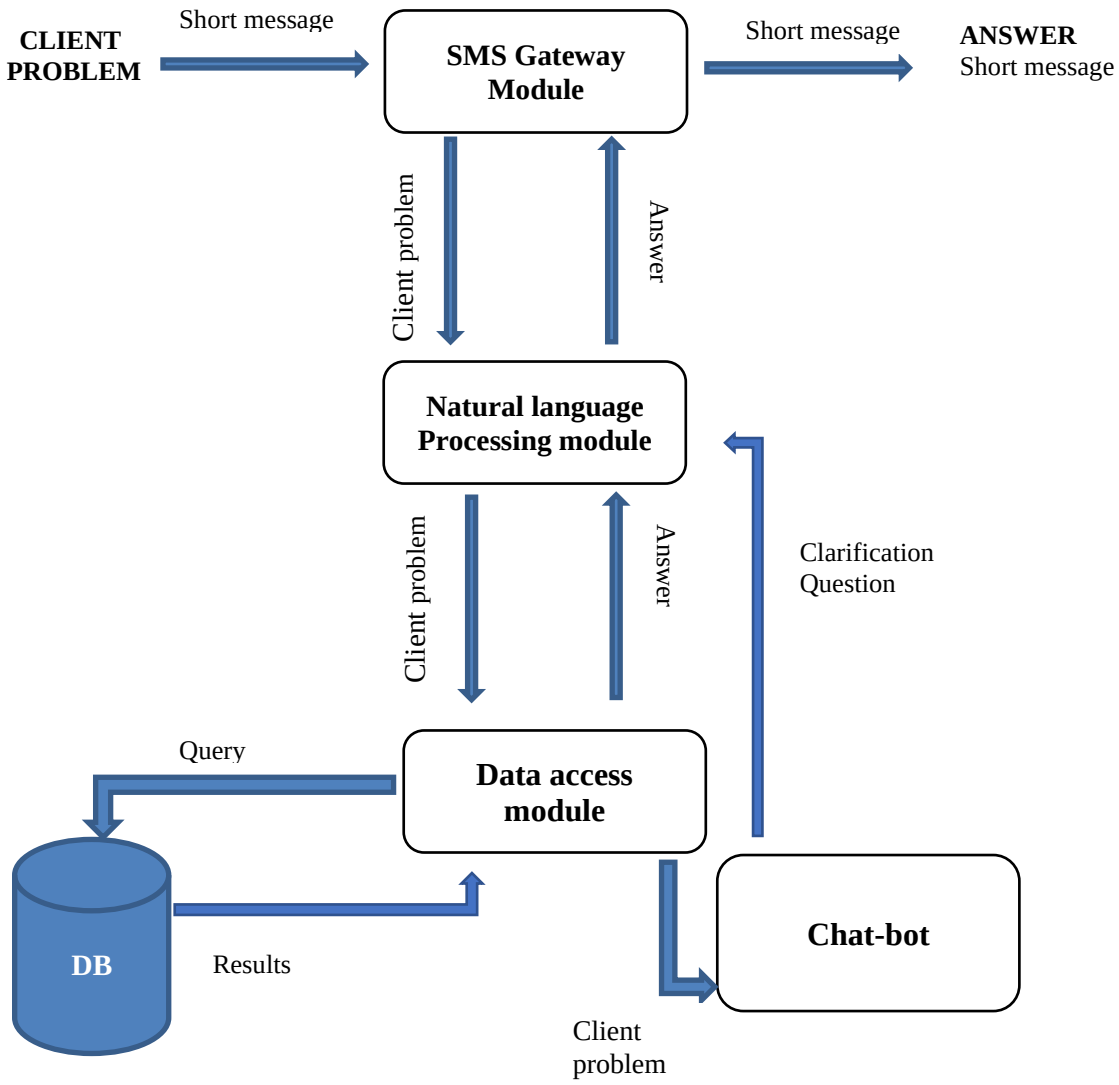


Figure 3 High level system architecture

3.2.3 Requirement Gathering

The process of requirements gathering of this project are collected through surveys and interviews. The requirements gathered by conducting a survey. According to this project, the target audience is the population of vehicle users. Therefore, in here used closed-ended questions that are used to determine the type of system that vehicle users really need. In the current state of Covid19, used Google Forms the research. The next step is to organize a private interview with several mechanical consultants and several AI experts to get a basic idea of what the process is Interview AI experts are systematically conducted to gather more up-to-date information on the use of our software tool, which makes a huge difference in the system.

Furthermore, study several research papers and gather more information about a past and present activities on regarding the research topic. In addition, it may help to know more about suitable technologies that can be used in different components of this system.

3.2.4 Analysis of Gathered Information

Following methods are used to analyses the survey data.

- Charts

  The chart is used to analyze the data collected from the survey. It is easy for anyone to understand and create. This chart helps to use the data in a more targeted and actionable way.

3.2.5 System approach

A review of the literature made by scholars around the world to identify similar applications and the survey findings are more useful for developing a better system. The following requirements must be met by the system.

- The system should be able to answer the client's questions with minimum delay.

- The client can be able to connect with the system at any time anywhere.
- The system should be able to understand different types of questions from users and provide the best solution.
- The system should be able to work with low English literacy people.

3.3 Designing the system

This system is designed to follow the Agile Unified Process (AUP) methodology. [4] By following Agile Unified Process (AUP) methodology, small and frequent releases and capable of addressing frequent changes in user needs and communicating with users and involving them in the development process.

3.3.1 Overview of the system

The system diagram is illustrated and the expected features to be developed in the system are as follows,

Figure 4 Overview of the system diagram

3.4 Project Methodology

The methodology used in this project is the Agile Unified Process (AUP) Because AUP emphases on fast iterations, small and frequent releases and capable of addressing the frequent changes in user needs and communicating with users and involving them in development process. AUP can offer a good opportunity to create a system where small changes can be made and tested.

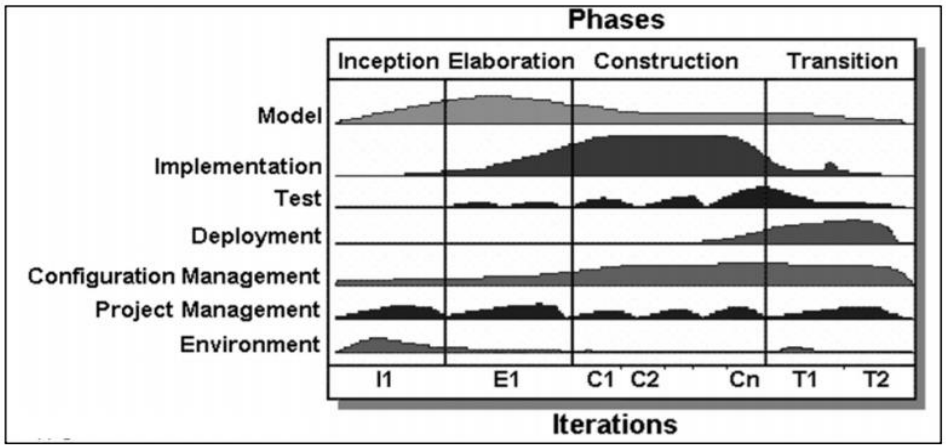


Figure 5 Disciplines of Agile Unified Process (AUP) in phases

3.4.1 Disciplines in AUP

Agile Unified Process AUP includes 7 disciplines such as models, implementations, tests, deployment, configuration management, project management and an environment. These seven disciplines are more useful for developers to conduct research in systematic way.

3.4.2 Model

This discipline requires developers to know a specific problem area to find out a feasible solution. [4]

3.4.3 Implementation

Once the developer has successfully completed the ***Model*** phase, the development team can proceed to ***implementation.*** In here, the model(s) are written into code. The code is then executed and tested using only one basic test level (unit test).

3.4.4 Tests

Once the code passes the first level, developers can run a wider range of tests. During the ***testing*** phase, developers perform objective evaluations to verify that the code is working properly, to identify bugs and errors, and to ensure that project requirements are met with code and software quality.

3.4.5 Deployment

Once the software has passed the test phase, it is ready for ***deployment***. At this stage, the developer plans to deliver the system to the end user.

3.4.6 Configuration management

It basically refers to the post-development moment where the team has access to the project artifacts. ***Configuration management*** helps keep track of changes and versions made to this project.

3.4.7 Project management

Project management is a slightly more comprehensive phase where developers manage risk, outsource work, track progress, coordinate with required parts and systems to ensure deliverables on time and on a budget.

3.4.8 Environment

The final stage of the agile unified process is the ***environment***. The primary purpose of this is to support collaboration between development teams by providing tools, standards, and guidelines as needed.

3.5 Development Methodology

In AUP development methodology can be identified four phases such as inception, elaboration, construction and transition.

3.5.1 Inception

The requirements of the project are identified in the inception phase. It's important to gather right requirements and organized them properly to ensure all required features are included in the system. In this phase, the important part of the project is done such as project background, problem definitions, project goals, etc.

3.5.2 Elaboration

Unified Modeling Language (UML) diagrams are used to specify the structure of the system. The information obtained from the diagram determines the actual operating process of the system. At this stage, the usage case, class, sequence, and function diagrams are used to better understand the basics of the actual system.

3.5.3 Construction

At this stage the project model is built and completed. Construction of the project works through a series of different tests. The construction stage identifies bugs and errors in the project and fix them. Product errors will be corrected and developers to monitor all system changes. At this stage a reliable system can be created.

3.5.4 Transition

This is the last phase in which the system is implemented for end users. All kinds of user feedback are collected to further improve the system. At this developer can undo the entire system and make changes. The system tests are performed several times before the system is release.

3.6 Unified Modelling Language (UML) Diagrams

UML diagrams are created to understand and maintain the system within the object of the project. With these diagrams, developers can get a knowledge of the processes that take place at the back of the system. Thereby for this research, 3 UML diagrams are crated. Those

created diagrams are as below.

- ❖ Class Diagram – (Appendix B)
- ❖ Use Case diagram – (Appendix C)
- ❖ Sequence diagram – (Appendix D)

3.7 Implementation

This section focuses on describing system functions. The system consists of four main subsystems,

3.7.1 System module

The system consists of four modules as follows,

- Short Message Gateway
- Natural Language Processor
- Chat-bot
- Database Handler

Short Message Gateway Module

In this module user communicate with the system via short messages. Messages will be received to message service gate way's inbox. Gate way reads short message content and it transfer to the natural language processing unit.

Natural Language Processor Module

Function of this module understands the user input correctly by using natural language processingtechniques and queries the database to find available answers. As an example, user input can be in different formats.

- How to change oil in a car?
- How to change oil in a vehicle?
- How to adjust oil in a car?

In this module it manipulates various user input and understand the meaning of user input and send input to the Database Handler Module to generate the query to get results from the database and send those results to the user as a short message via the short message gateway.

Chat-bots

This module automatically generates a question and send a short message to the user to understand the user question properly. If the user answers this question again this answer process of the Natural Language Processing section and tries to answer the specific question, if he did not understand or did not find the answer related to the question, he will send it back to this module to continue with the understanding and response process.

Database Access Module

This module is primarily responsible for performing transactions with the database, such as retrieving data from the database and updating the database. When the Natural Language Processing Unit clearly understands the user's input, these processed items are sent to this module to find a relevant answer to the question. If this section could not find an answer, this module informs it to the Natural Language Processing module.

3.8 Summary

This chapter presented the overview of proposed methodology, which follow to achieve research objectives. The next chapter will present the output of the proposed solution that represent the test cases of the system.

Chapter 4

FINDING AND DISCUSSION

4.1 Introduction

An overview of the proposed methodology followed to achieve the research objectives was presented in the previous chapter. This chapter presents the output of the proposed solution representing the test cases of the system.

4.2 Findings

The findings and discussion are used to get credible feedback from application users. This is done using the following methods:

- Survey

Before developing the system, requirements need to be gathered. Requirements collected by conducting a survey. According to the project, the target audience will be the vehicle user population. Therefore, closed questions are used here to determine the type of system that vehicle users actually need. In here used Google Forms for the survey. (Appendix A)

- Interview

In order to collect mechanical instructions for the database, a personal interview with a mechanic wasconducted. Due to the Covid-19 pandemic, the interview was conducted with social distance practices.

- Document Analysis

In an effort to gather technical and non-technical information about the system, reviewed documents and the research papers on the Internet, which helped to create a better system than the existing one.

4.3 Evidence

This section describes system behavior in terms of user input or system constraints. This process was performed using different test cases and the results were analyzed. The end result depends on the following test cases. Considering this result in this section, identify the system accuracy ratio, system limitations, and evidence of system vulnerabilities.

Test case 01

Test Case Description: The system provides the relevant solution when the customer provides a meaningful vehicle related problems with or without a minor grammatical error.

Precondition: Server in running mode and client send a short message to the system.

Test case	Sequence	Test Description	Input Value	Expected Result	Status	Actual Result
01	1.1	Customers provide meaningful vehicle related problem. **(Figure 5)**	SMS without any Grammar mistakes	Receive a correct solution SMS	Pass	Receive solution SMS
	1.2	Customer will Provide Vehicle Related Problem with Grammar mistakes.	SMS with any Grammar mistakes	Receive correct solution SMS	Pass	Receive correct solution SMS
	1.3	If sever loses the mobile connection while texting the customer. **(Figure 6)**	SMS without any Grammar mistakes	System stores the delayed Message in a SMS Queue.	Pass	System store delayed Message in a SMS Queue.
	1.4	Admin tries to clear recently stored SMS Queue. **(Figure 7)**	Press deletes button event	Clear all recently stored SMS Queue.	Pass	Clear all recently stored SMS Queue.
	1.5	Admin tries to Connect with mobile Connection (Figure 8)	Press Start Server Button	System will show “Connected” Label Bottom of the Interface	Pass	System will show “Connected” Label Bottom of the Interface

Table 1 Test case 01

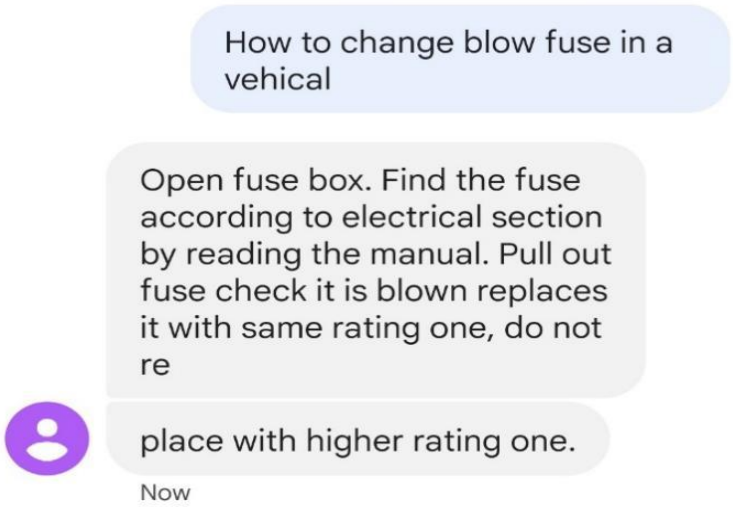


Figure 6 Test case 1.1

(When customers send a problem related to the vehicles fault, they receive a solution SMS)

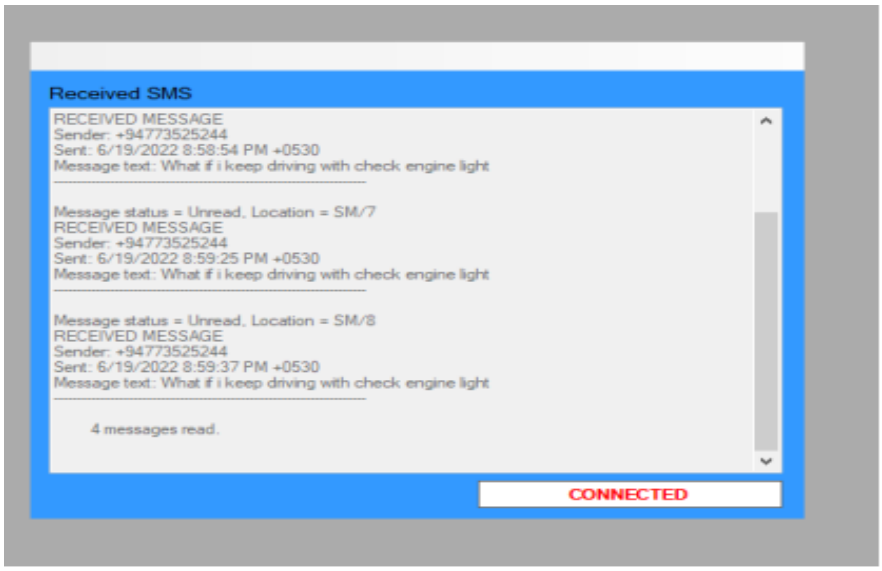


Figure 7 Test case 1.3
(If sever loses the mobile connection while customer is texting - System will store delayed Message in a SMS Queue.)

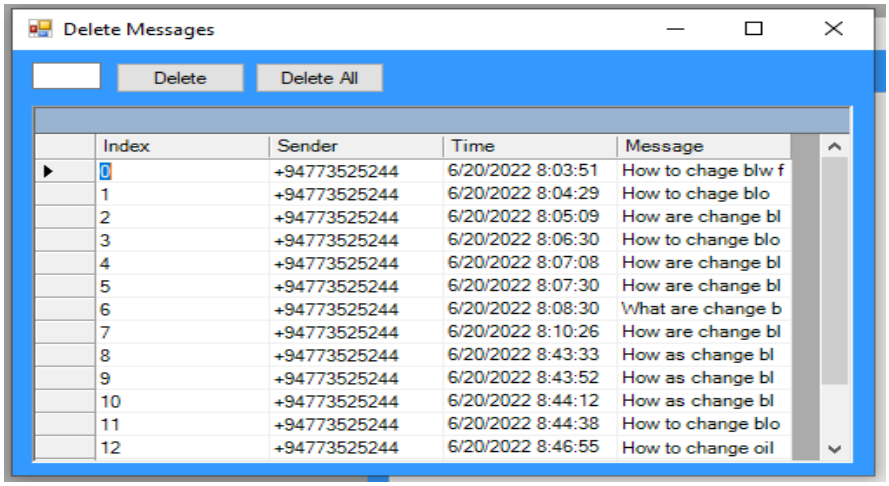


Figure 8 Test case 1.4

(Admin tries to clear recently stored SMS Queue - Clear all recently stored SMS Queue.)

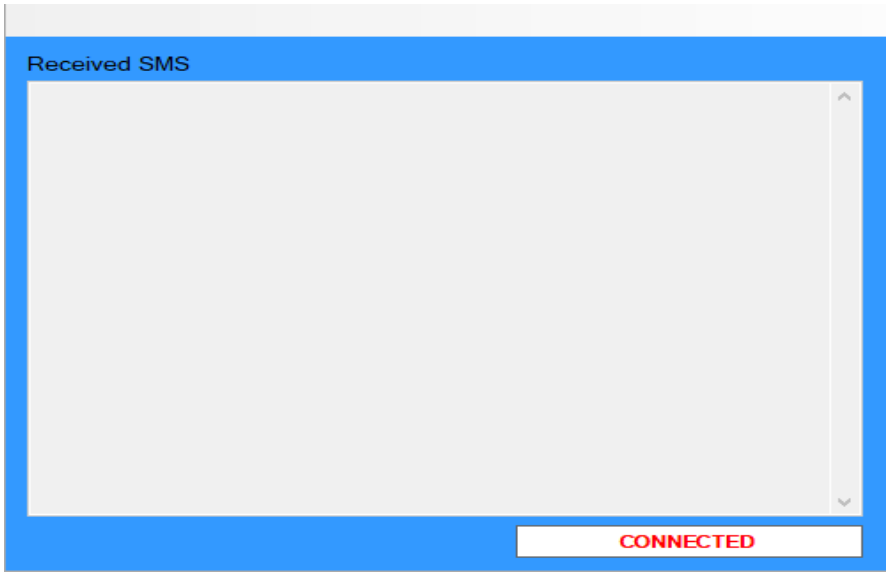


Figure 9 Test case 1.4

(Admin tries to Connect with mobile Connection - System will show “Connected” Label Bottom of the Interface)

Test case 02

Test Case Description: Identify and correct spelling errors in client SMS.

Precondition: Server in Running Mode

Test case	Sequence	Test Description	Input Value	Expected Result	Status	Actual Result
02	2.1	Identify and automatic Correct Spelling Mistakes.	Client's SMS.	User input without any spelling mistakes.	Pass	User input without any spelling mistakes.
	2.2	Identify and Correct Major Spelling Mistakes.	Client's SMS.	System provides user expected meaning	Fail	System provides a massage "I cannot understand. Please explain further".

Table 2 Test case 02

Test case 03

Test Case Description: Process the client's SMS by using Natural Language Processing techniques and string pattern matching techniques to understand the meaning of the client's SMS.

Precondition: Server in Running Mode and Client sends a Short Message to the System.

Test case	Sequence	Test Description	Input Value	Expected Result	Status	Actual Result
03	3.1	Retrieve information from the database by processing the client's SMS and sends to the client.	Client's SMS.	Retrieve correct instruction according to the user requirements and sends	Pass	Correct instruction according to the client's requirement.
	3.2	When User Input Filed is Empty Admin Try to Click Test Button.	Nil	Prompt Warning Message Box	Pass	Prompt Warning Message Box

Table 3 Test case 03

Test case 04

Test Case Description: Insert instruction to the database.

Precondition: User logged into the system.

Test case	Sequence	Test Description	Input Value	Expected Result	Status	Actual Result
04	4.1	Insert a new instruction to instruction list **(Figure 9)**	Instruction topic and Steps.	Successfully update the Instruction list.	Pass	Successfully update the Instruction list and pop up successfully updated message box.
	4.2	Insert Empty Test Filed and Empty Instructions List **(Figure 10)**	Nil	Prompt Waning Message	Pass	Prompt Waning Message
	4.3	Administrator tries to provide large no of data into instruction text area	Instruction with large data value	Prompt Message Box with "Maximum Character limit".	Fail	Nil
	4.4	Users send similar question to SQL database	Client's SMS.	Receive correct solution SMS	Pass	Receive correct solution SMS

Table 4 Test case 04

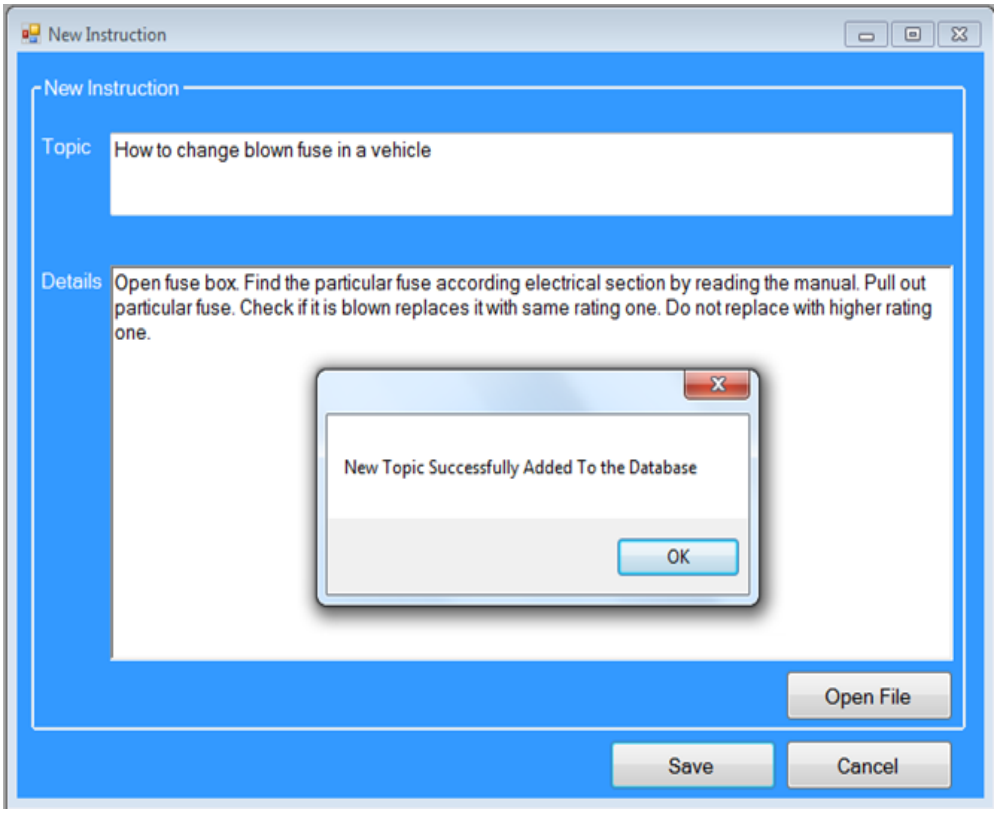


Figure 10 Test case 4.1
(Insert a new instruction to instruction list)

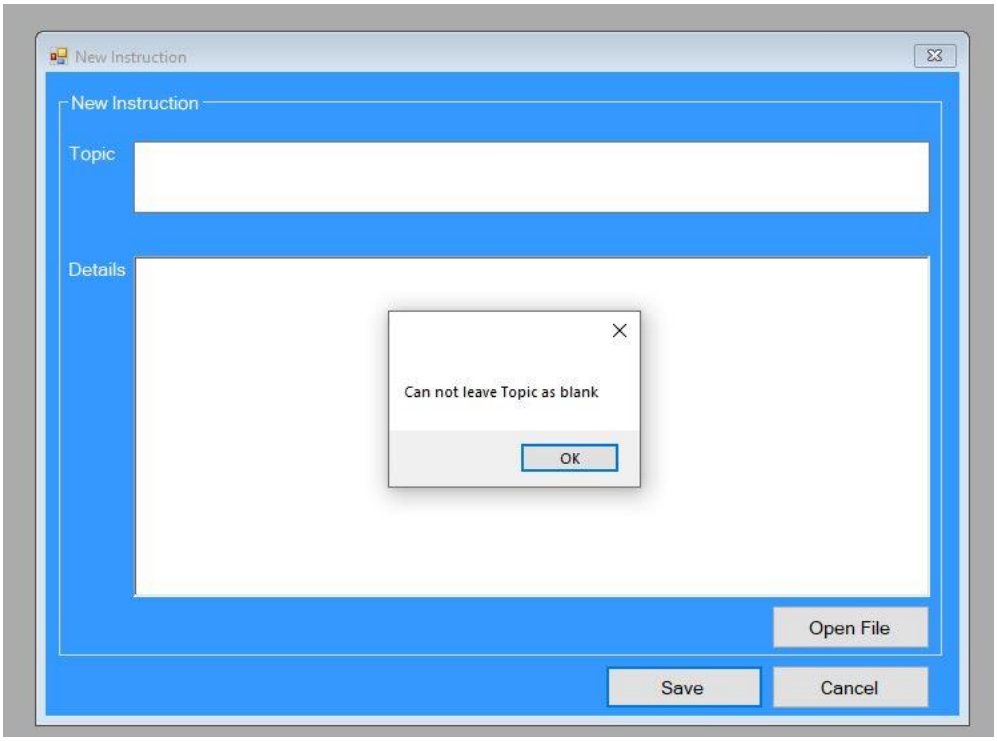


Figure 11 Test case 4.2

(Insert Empty Test Filed and Empty Instructions List)

4.4 Discussion

4.4.1 Reliability

The system can also detect spelling problems. So, the customer does not have to worry about their language proficiency. If the system normally reads through the Natural Language Processing Module and provides a solution from the SQL database but in case where cannot provide a solution from the natural language processing module, it provides solution by communicate through chat-bot. Users can also get reliable data on which they require.

4.4.2 Availability

The system available 24 * 7 hours a day and combined with two machines, the ability to combine two components in parallel is always far greater than the size of its individual components. The system automatically receives weekly database backups to increase system accessibility.

4.4.3 Security

The administrators are the only persons who will be able to log in to the system. The administrator should enter his username and password before logging to the system.

4.4.4 Maintainability

The system is developing from C #. The C # is Object-Oriented Programming Language and it should be easy to maintain. So, the developer can easily identify where the problem is and maintain it. Step-by-step system data (vehicle maintenance tip and tricks / location / police stations / hotels/ information) is updated.

4.4.5 Accuracy

The accuracy of the system will increase as a result of the support services provided by the system using 3 types of modules. At the component level, there are three alternative solutions known as NLP, Chat-bot and SMS. Basically, the NLP module is able to identify the "subject" "verb" "object" of the customer message. If the NLP module does not find a solution using the system, it will transfer to the Chat-bot module, so the system always tries to give the right result to its customers and always avoids sending wrong information to the customers. Its accuracy is essential to the type of software.
85% Test case Successful Rate

4.5 Summary

This chapter presented the output of the proposed solution representing the test cases of the system. The next chapter will highlight a summary of the main findings and contributions, limitations and its future research work.

Chapter 5

CONCLUSION AND FURTHER WORK

5.1 Introduction

The previous chapter presented the output of the proposed solution representing the test cases of the system. This chapter highlights a summary of the main findings and contributions, limitations and its future work research.

5.2 Importance of the Outcome

This system provides the driver with reasonable knowledge to correct the fault in the vehicle. It also provides solutions for simple mechanical faults such as tire punch, oil change, battery replacement, and broken light replacement. Such mechanical problems can be solved through this system. Although this system provides information to find the driver's utility locations on the road, such as Fuel stations, garages, police stations, hospitals or hotels. Using this information, the user can find locations in an unknown area. The user will connect to the system via short messages. It is useful for users because no need highly capable mobile devices. The system can provide mechanical instructions for educational purposes.

5.3 Limitation

The system cannot be capable to provide of providing solutions to the descriptive questions. The System only provides answer within stored information. Although system cannot correct heavily misspelled words. System Availability and response time depends on the network coverage. Also accessing cost depends on the GSM network provider. System provides access only via the English language and takes time to learn itself.

5.4 Future Work

In the future, it is possible to expand system capabilities to process the descriptive type of question. Also develop the system to communicate via multiple network providers, expand

system capabilities to get information from the Internet without limiting for stored information. Upgrade or modify AI module to reduce learning time and provide multi language support.

5.5 Conclusion

The system provides drivers with reasonable knowledge of how they correct an error in the vehicle. And it also provides solutions to simple mechanical errors like puncturing tires, changing oil, replacing a battery, and changing a broken light. And also, this system provides information to find nearby public service places on the road, such as gas stations, garages, police stations, hospitals or hotels. With this system, the user can easily find places in unknown area. Users connect to the system only through short messages. It is a bigger advantage for the user, because it is not necessary to have high-capacity mobile devices. The mechanical instructions provided by the system can also be retrieved for educational purposes. The system has the ability to provide the next best database alternative solution within seconds.

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GLOSSARY

NLP – Natural Language Process

Chat-Bot- Pattern matching

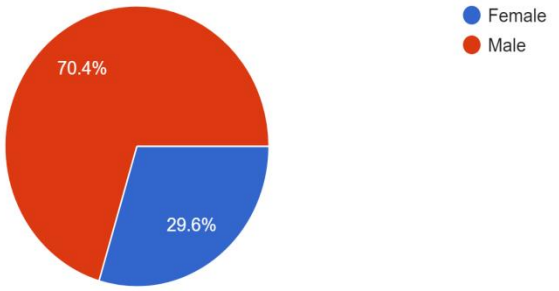
SMS – Short Message Service

APPENDIX A: Survey questions

Background information of participants

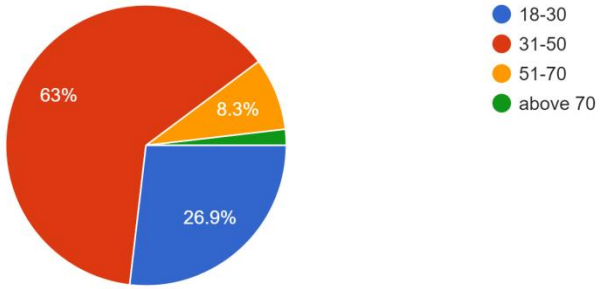
Q1. What is your gender?

108 responses



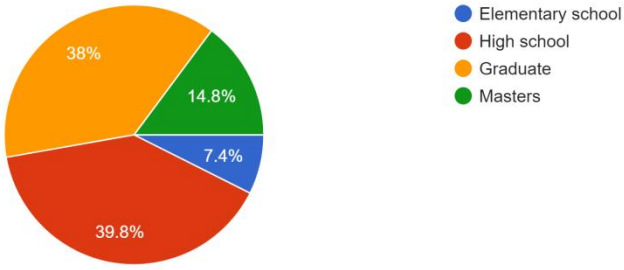
Q2. What is your age group?

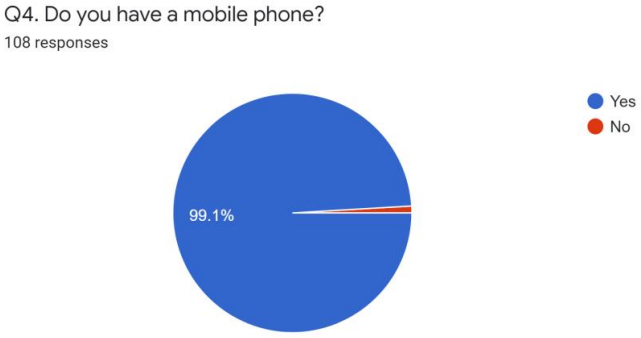
108 responses



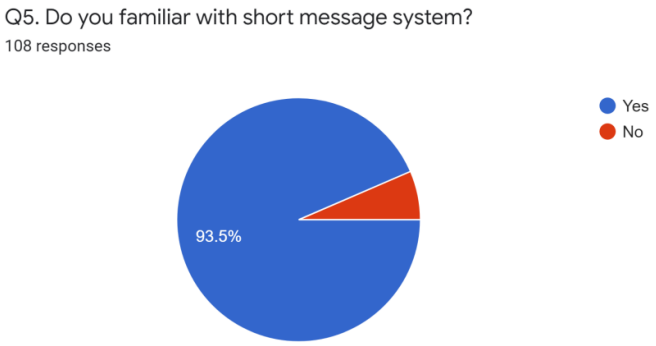
Q3. What is your highest level of education?

108 responses

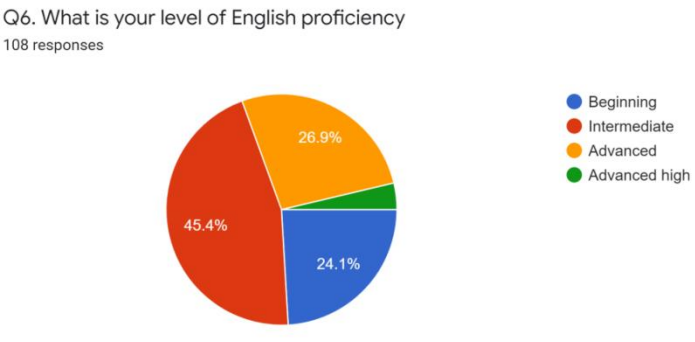




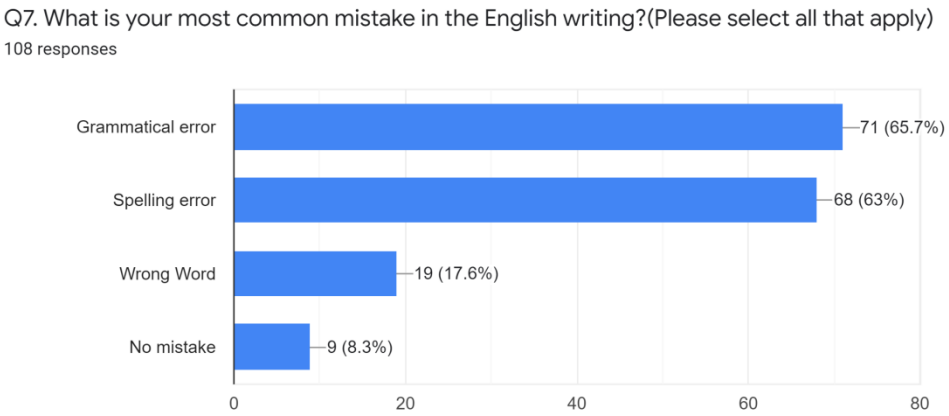
Based on the chart, 99.1% have mobile phone. This shows that most users have mobile phone and mobile based system is suitable for them.



Based on the chart, 93.4% surveyed are familiar with the Short Message System (SMS). This shows that SMS based system is more convenient for users.

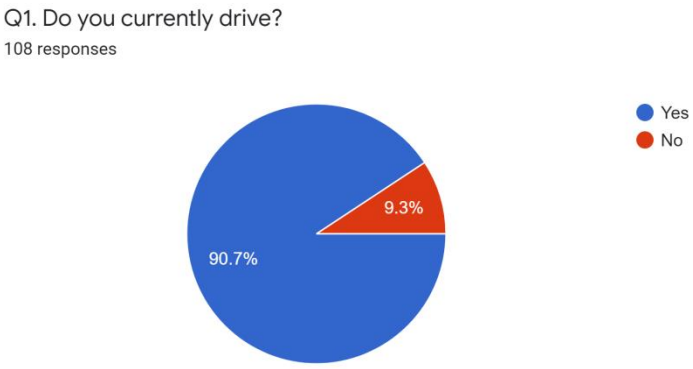


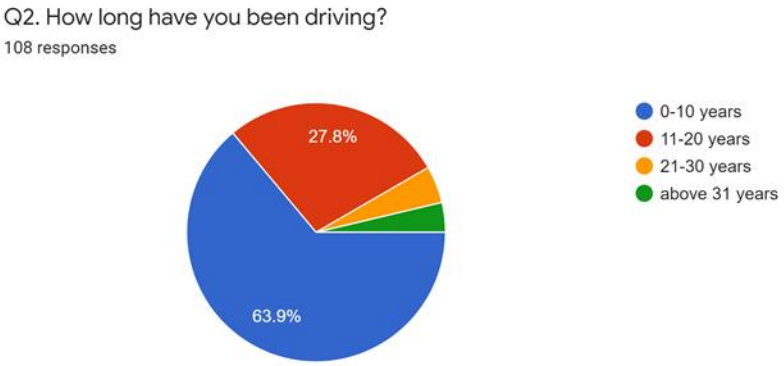
Based on the chart, 70% of the people surveyed have a basic and intermediate knowledge of English. This shows that the English language-based system is not a bigger problem for users.



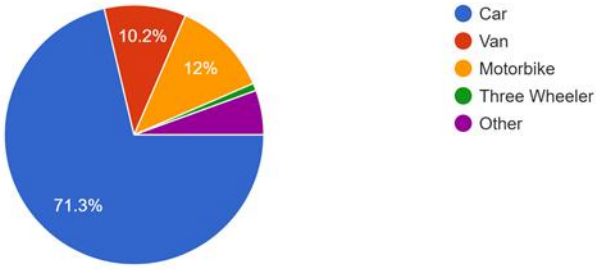
Based on the chart, 71% of those surveyed made grammatical and spelling mistakes. Developers should include a grammar correction method in the system, which will make it easier for users.

Mobility and driving behavior of participants

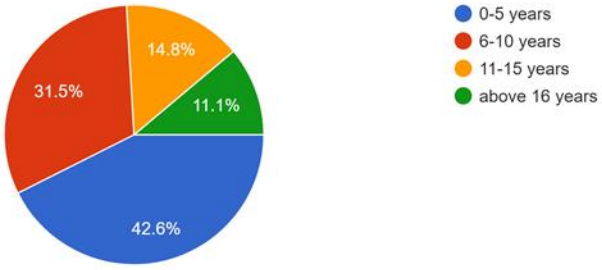




Q3. What type of vehicle's do you usually drive?
108 responses

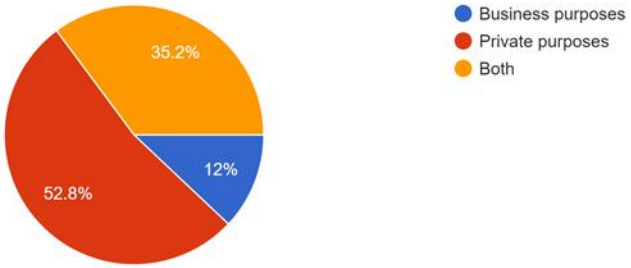


Q4. How old is the vehicle you drive?
108 responses

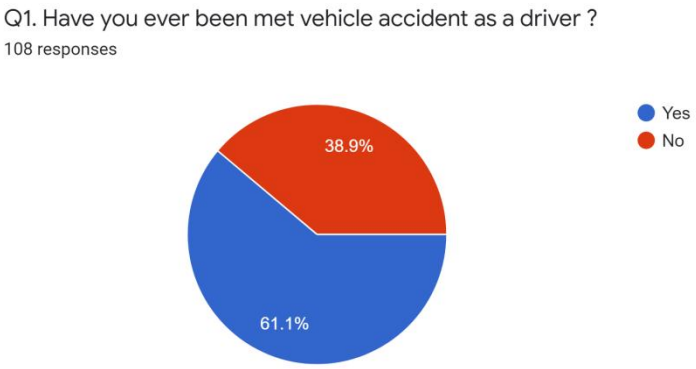


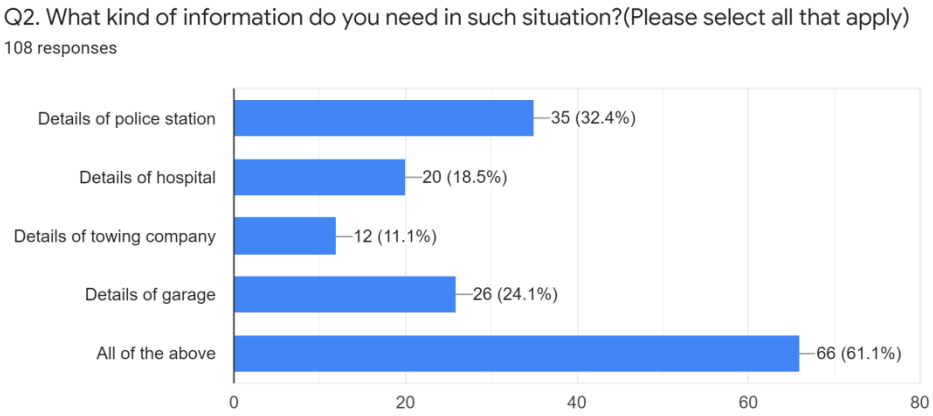
Based on the chart, more than 50% of the participants' vehicles are over 5 years old. This suggests that many users use older vehicles, which can result in car breakdowns on the road at any time.

Q5. What is your most common trip purposes?
108 responses



Information about vehicle accident



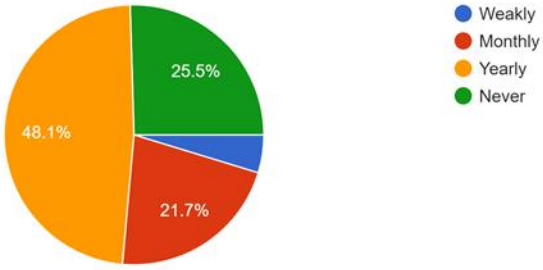


Based on the chart, more than 72% of those surveyed said it would be better to seek help from those who respond quickly when a vehicle crashes on the road. Developers should therefore consider developing a quick response system.

Information about Vehicle breakdowns

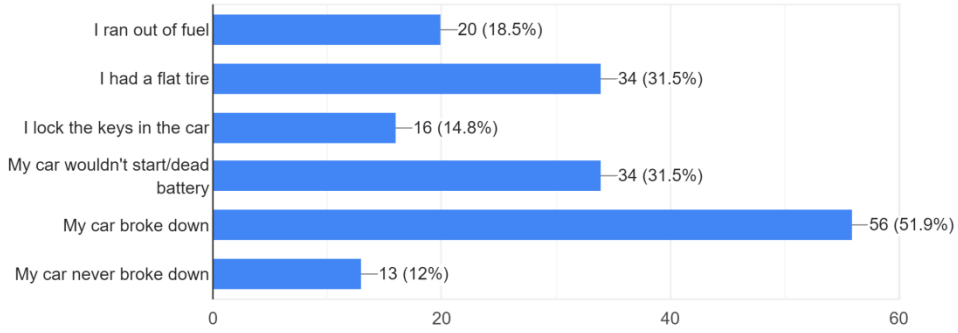
Q1. How often (on average) do you have car breakdown?

106 responses



Q2. Which of the following has ever happened to you?(Please select all that apply)

108 responses

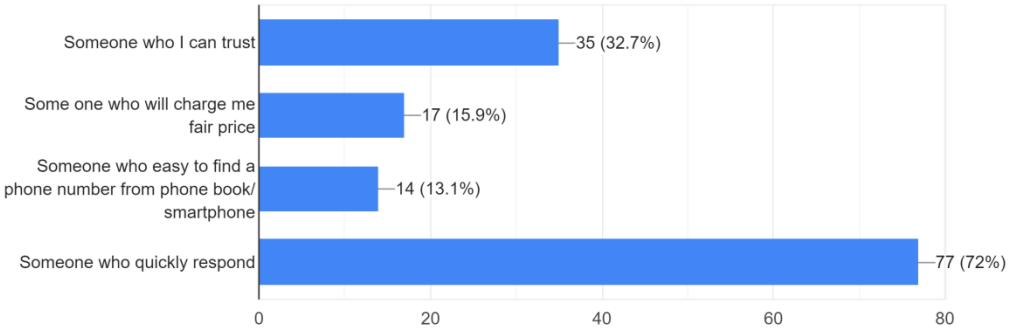


Q3. When your car breaks down, what do you do?

108 responses

Q3. When you need help with a car break down, what is the most important to you in choosing who to call help?

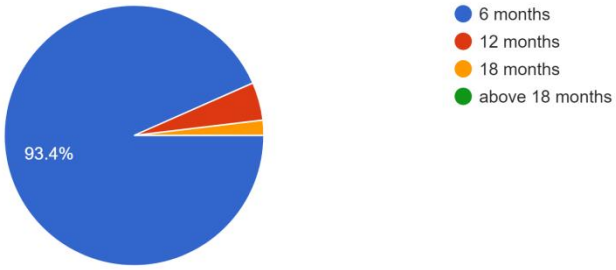
107 responses



Information about vehicle maintenance knowledge

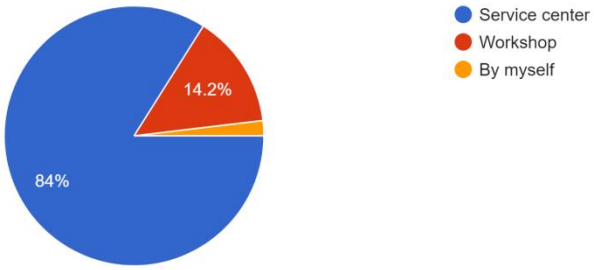
Q1. How often (on average) should you take your car for a service?

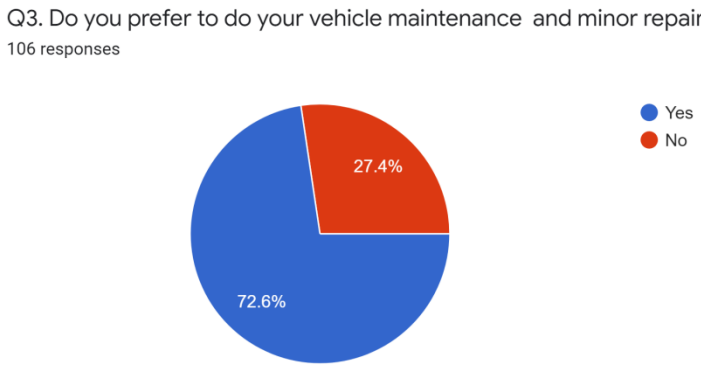
106 responses



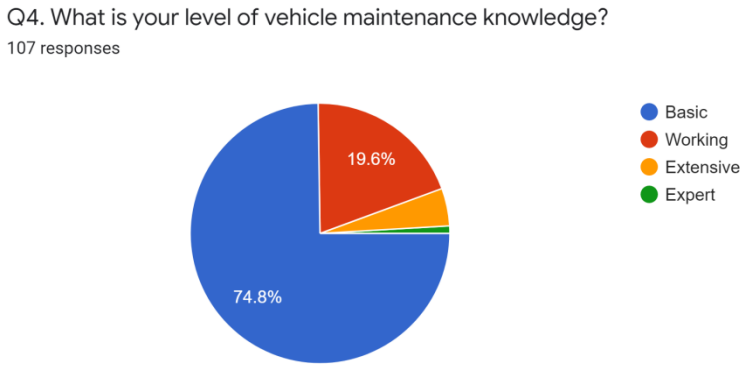
Q2. What is the option do you use for vehicle maintenance ?

106 responses



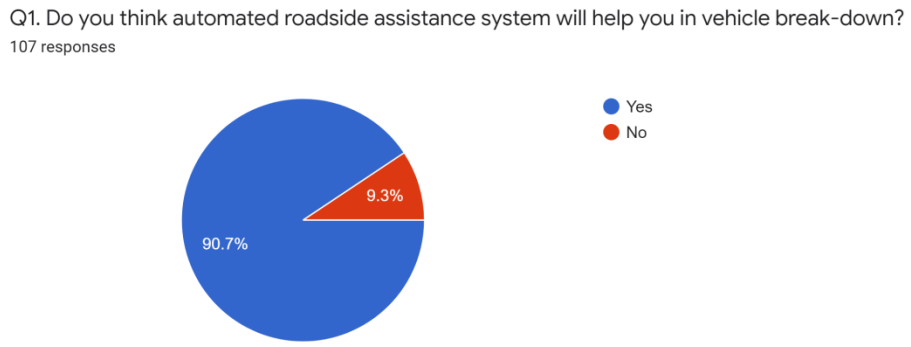


Based on the chart, more than 72% of the survey participants prefer to make minor repairs themselves. So, developers should consider developing a system that will help users make minor car repairs themselves.

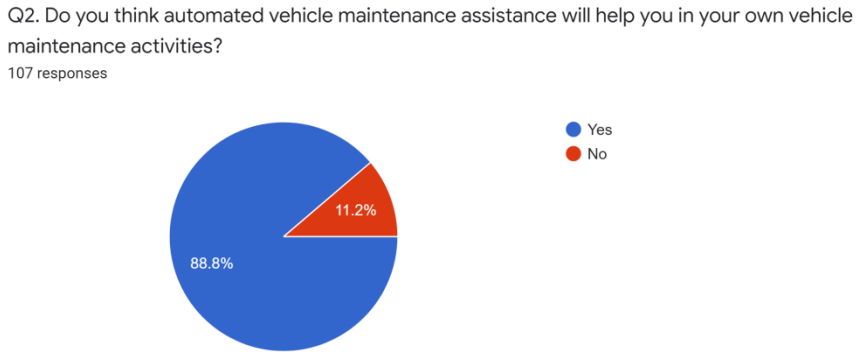


Based on the chart, more than 74% of the survey participants have a basic knowledge of vehicle maintenance. Developers should therefore consider developing a system that gives users a working knowledge of vehicle maintenance.

Information about the project



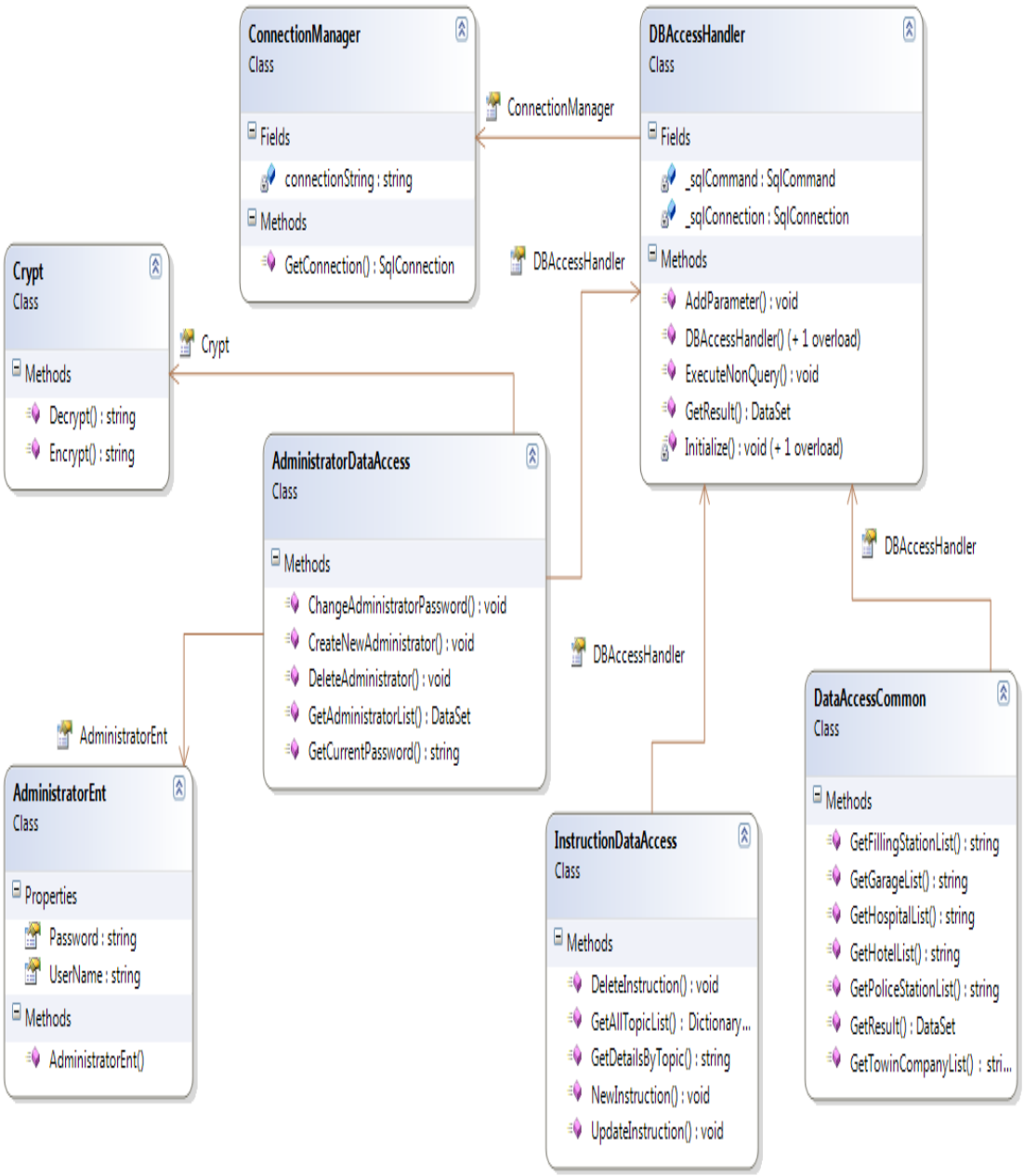
Based on the chart, more than 90% of respondents believe that an automated roadside support system can help them in a vehicle breakdown on road.



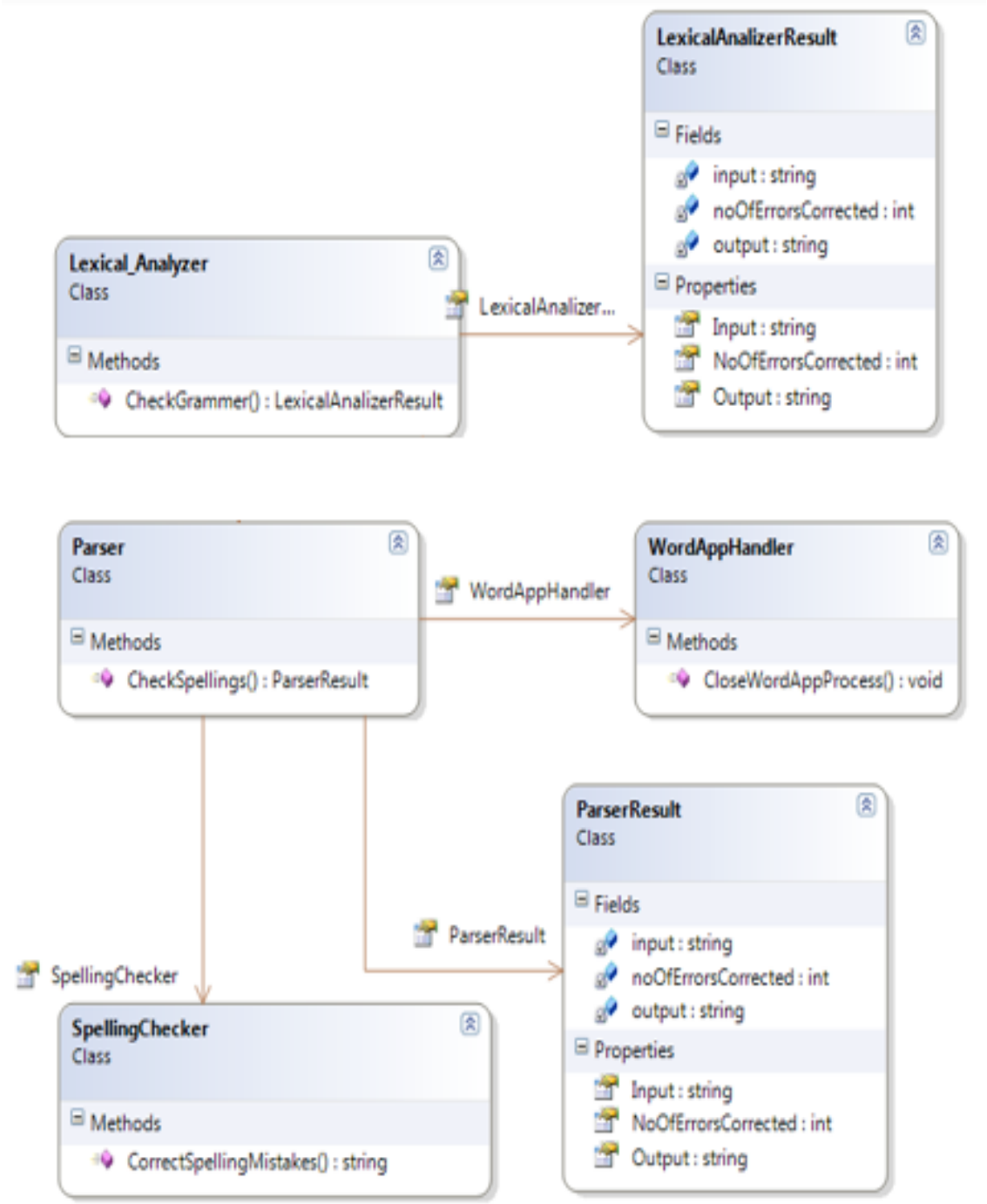
Based on the chart, more than 88% of respondents believe that an automated vehicle maintenance support system can help them in a vehicle breakdown.

APPENDIX B: Class Diagrams

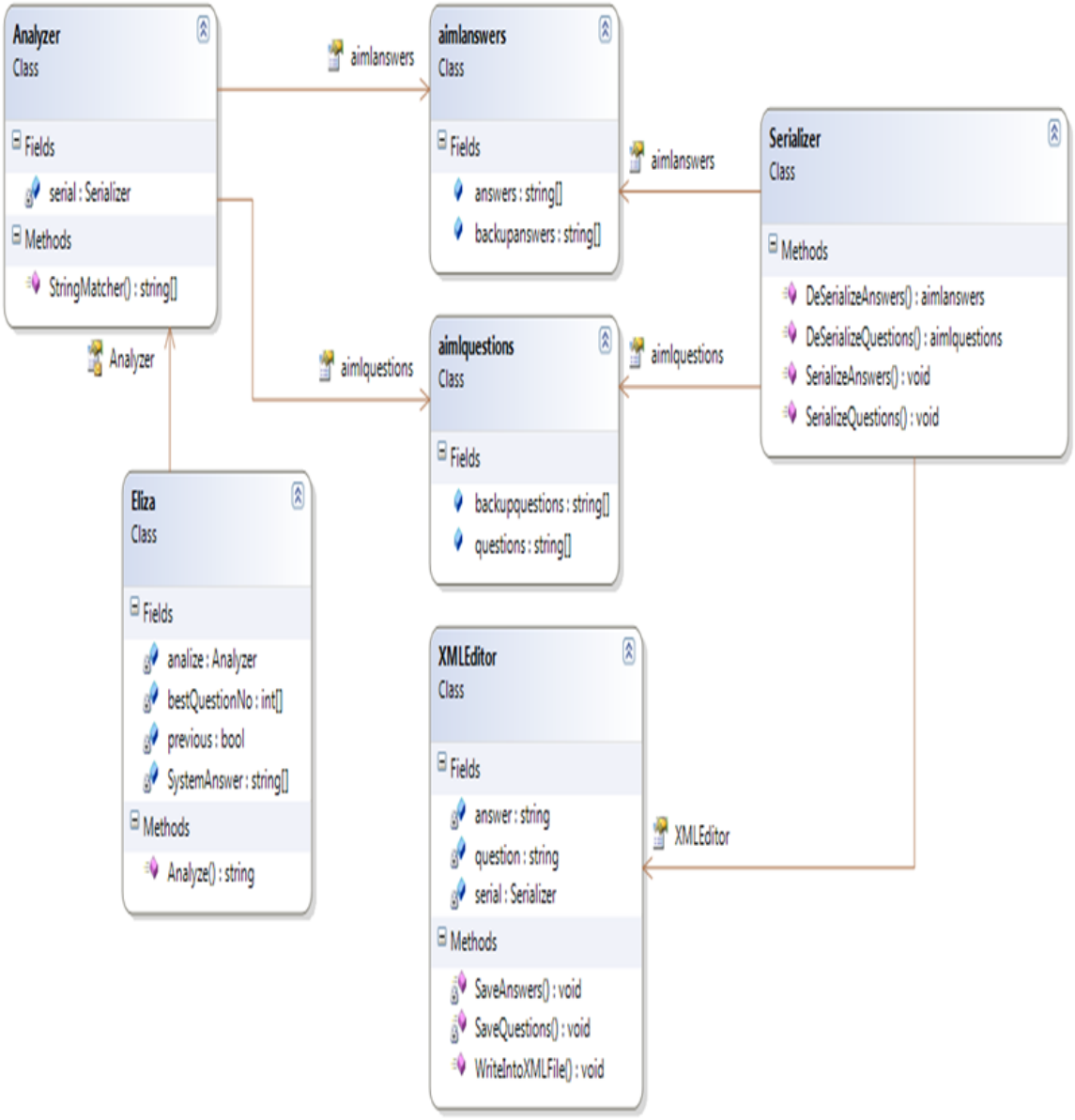
Class Diagram 1



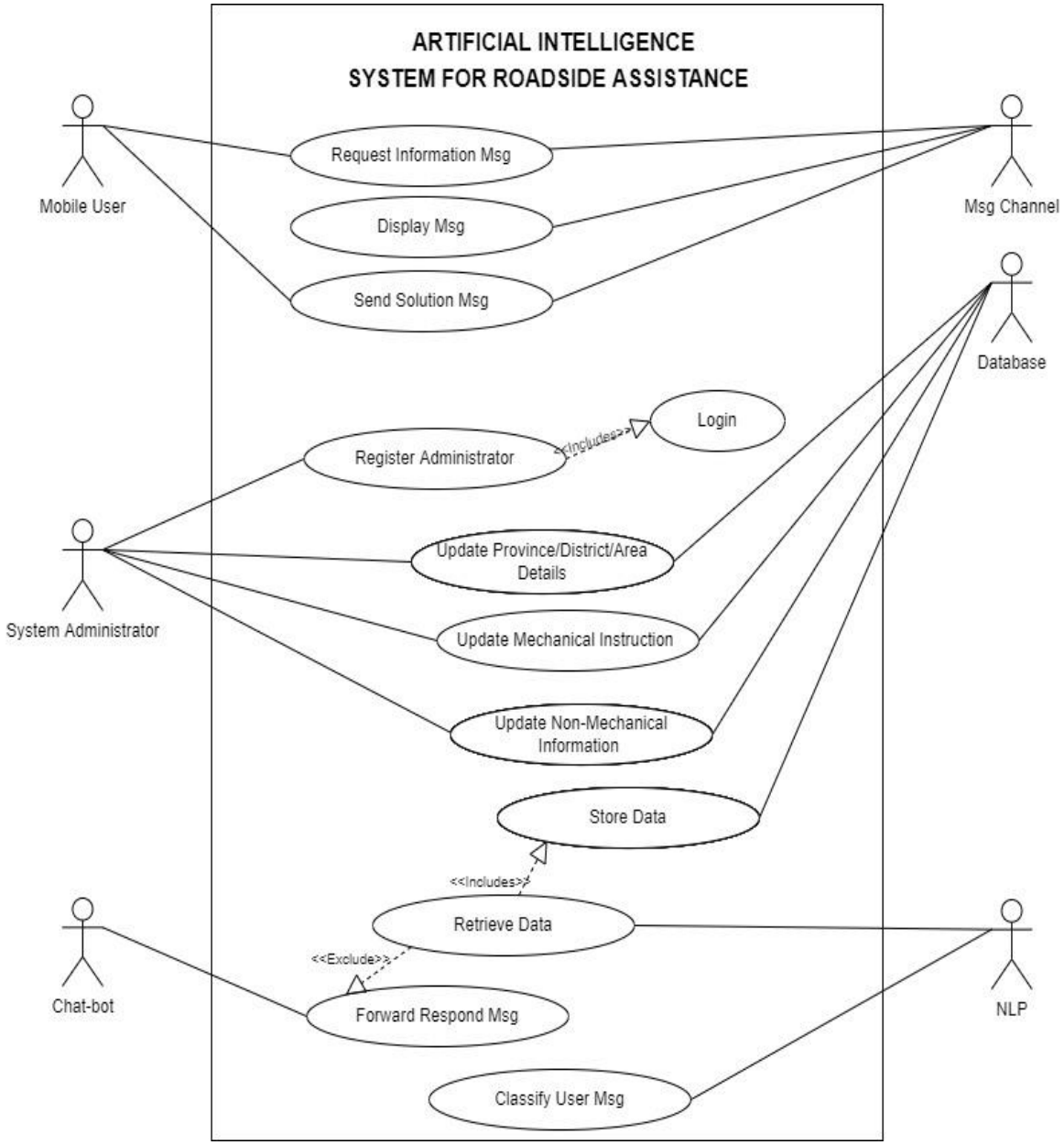
Class Diagram 2



Class Diagram 3



APPENDIX C: Use case Diagram



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Use Case scenario

1. Request Information

Use Case name	Request Information
Description	Allow user to get related information according to the problem
Actors	Mobile User
Pre-condition	System must be up and running
Main Success Scenarios	1.Send SMS to the system 2.System processes the natural language 3.Search Information in the database 4.Send information via SMS
Extensions	2a. Unclear problem 2b. Send another related question via SMS

Table 5 Use case - Request Information

2. Login

Use case Name	Login
Description	Allow user to access to the system by providing valid username and password.
Actors	Administrator
Pre-condition	System must be up and running
Main Success Scenarios	1. Enter Username 2. Enter Password 3. System validate the user 4. Prompt the main interface
Extensions	3a. User enter an invalid Username / Password 3b. Prompt an error message 3c. Press OK button 3d. Prompt the login interface

Table 6 Use case - Login

3. Update Province Details

Use Case name	Update Province Details
Description	Allow administrator to update details about provinces
Actors	Administrator
Pre-condition	User must be logged into the system
Main Success Scenarios	1. User Provide Required information 2. System validates the data 3.Prompt update complete message box
Extensions	2a. User enter invalid information 2b. Show error message 2c. Prompt Province update interface

Table 7: Use case - Update Province Details

4. Update District Details

Use Case name	Update District Details
Description	Allow administrator to update details about Districts
Actors	Administrator
Pre-condition	User must be logged into the system
Main Success Scenarios	1. User Provide Required information 2. System validates the data 3. Prompt update complete message box
Extensions	2a. User enter invalid information 2b. Show error message 2c. Prompt District update interface

Table 8 Use case - Update District Details

5. Update Area Details

Use Case name	Update Area Details
Description	Allow administrator to update details about Areas
Actors	Administrator
Pre-condition	User must be logged into the system
Update Mechanical Instructions	1. User Provide Required information 2. System validates the data 3. Prompt update complete message box
Extensions	2a. User enter invalid information 2b. Show error message 2c. Prompt Area update interface

Table 9: Use case - Update Area Details

6. Update Mechanical Instructions

Use Case name	Update Mechanical Instructions
Description	Allow administrator to Update Mechanical Instruction
Actors	Administrator
Pre-condition	User must be logged into the system
Main Success Scenarios	1. User Provide Required information 2. System validates the data 3. Prompt update complete message box
Extensions	2a. User enter invalid information 2b. Show error message 2c. Prompt Update Mechanical Instruction interface

Table 10 Use case - Update Mechanical Instructions

7. Update Troubleshooting Instructions

Use Case name	Update Troubleshooting Instructions
Description	Allow administrator to Update Troubleshooting Instructions
Actors	Administrator
Pre-condition	User must be logged into the system
Main Success Scenarios	1. User Provide Required information 2. System validates the data 3. Prompt update complete message box
Extensions	2a. User enter invalid information 2b. Show error message 2c. Prompt Update Troubleshooting Instruction interface

Table 11: Use case - Update Troubleshooting Instructions

8. Update Towing Company Details

Use Case name	Update Towing Company Details
Description	Allow administrator to Update Towing Company Details
Actors	Administrator
Pre-condition	User must be logged into the system
Main Success Scenarios	1. User Provide Required information 2. System validates the data 3. Prompt update complete message box
Extensions	2a. User enter invalid information 2b. Show error message 2c. Prompt Update Towing Company Details interface

Table 12 Use case - Update Towing Company Details

9. Update Garage Details

Use Case name	Update Garage Details
Description	Allow administrator to Update Garage Details
Actors	Administrator
Pre-condition	User must be logged into the system
Main Success Scenarios	1. User Provide Required information 2. System validates the data 3. Prompt update complete message box
Extensions	2a. User enter invalid information 2b. Show error message 2c. Prompt Update Garage Details interface

Table 13: Use case - Update Garage Details

10. Update Hospital Details

Use Case name	Update Hospital Details
Description	Allow administrator to Update Hospital Details
Actors	Administrator
Pre-condition	User must be logged into the system
Main Success Scenarios	1. User Provide Required information 2. System validates the data 3. Prompt update complete message box
Extensions	2a. User enter invalid information 2b. Show error message 2c. Prompt Update Hospital Details interface

Table 14: Use case - Update Hospital Details

11. 11. Update Police Station Details

Use Case name	Update Police Station Details
Description	Allow administrator to Update Police Station Details
Actors	Administrator
Pre-condition	User must be logged into the system
Main Success Scenarios	1. User Provide Required information 2. System validates the data 3. Prompt update complete message box
Extensions	2a. User enter invalid information 2b. Show error message 2c. Prompt Update Police Station Details interface

Table 15: Use case - Update Police Station Details

12. Update Filling Station Details

Use Case name	Update Filling Station Details
Description	Allow administrator to update details about provinces
Actors	Administrator
Pre-condition	User must be logged into the system
Main Success Scenarios	1.User Provide Required information 2.System validates the data 3.Prompt update complete message box
Extensions	2a. User enter invalid information 2b. Show error message 2c. Prompt Update Filling Stations Details interface

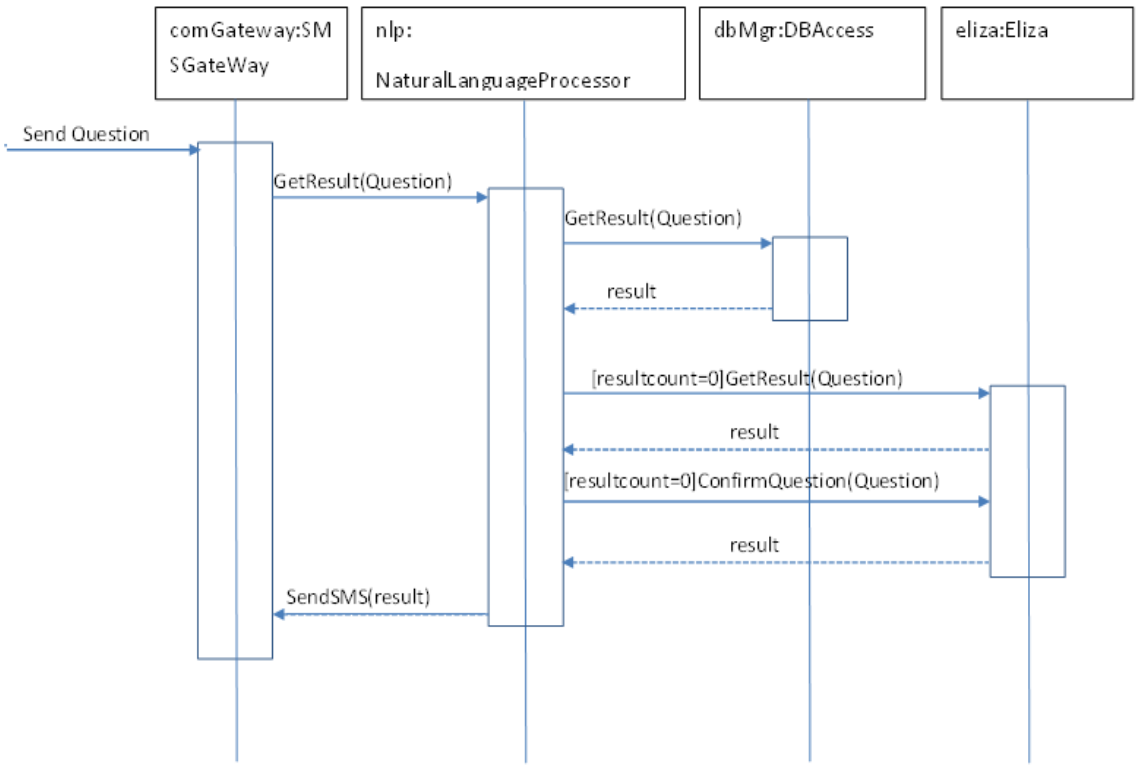
Table 16: Use case - Update Filling Station Details

13. Update Hotel Details

Use Case name	Update Hotel Details
Description	Allow administrator to update details about provinces
Actors	Administrator
Pre-condition	User must be logged into the system
Main Success Scenarios	1. User Provide Required information 2. System validates the data 3. Prompt update complete message box
Extensions	2a. User enter invalid information 2b. Show error message 2c. Prompt Update Hotel Details interface

Table 17 Use case - Update Hotel Details

APPENDIX D: Sequence Diagram



APPENDIX E: Algorithms

Natural Language Processing Algorithm

```
private void ProcessDetails(MessageEntity InitialMessage)
    {
       try
       {
          char[] splitedBy = { '.' };
          string[] sentences = InitialMessage.Message.Split(splitedBy);

          SentenceSimilarity semsim = new SentenceSimilarity();

          Dictionary<int, string> _topicList = new
InstructionDataAccess().GetAllTopicList();
          Dictionary<float, string> _similarity = new Dictionary<float, string>();
          Dictionary<float, string> _overallSimilarity = new Dictionary<float, string>();
          Dictionary<float, InstructionEntity> _detailsAccordingToTopicSimilarity = new
Dictionary<float, InstructionEntity>();

          if (sentences.Length == 1)
          {

               //Get most similar topics from database
               for (int i = 0; i < sentences.Length; i++)
               {
                  for (int j = 0; j < _topicList.Count; j++)
                  {
                     //Check if key exsist or not
                     if (!_similarity.ContainsKey(semsim.GetScore(sentences[i],
_topicList[j])))
                     {
                        //if not exsist add the key and the value
```

```
                        _similarity.Add(semsim.GetScore(sentences[i], _topicList[j]),
_topicList[j]);
                    }
                    else
                    {
                        //if it exsist check for the duplicate values
                        if (semsim.GetScore(_similarity[semsim.GetScore(sentences[i],
_topicList[j])], _topicList[j]) != 1)
                        {
                            _similarity.Add(semsim.GetScore(sentences[i], _topicList[j]) -
0.0001f, _topicList[j]);
                        }
                    }
                }
            }

            float _maxSimilarityIndex = _similarity.Keys.Max();

            if (_maxSimilarityIndex > 0.9)
            {
                //Send details according to the most similar topic via sms
                new Communication().SendSMS(new
InstructionDataAccess().GetDetailsByTopic(_similarity[_maxSimilarityIndex]),
InitialMessage.PhoneNumber);
            }
            else
            {
                //Send details to Eliza module and send reply via sms
                new Communication().SendSMS(eliza.Analyze(InitialMessage.Message),
InitialMessage.PhoneNumber);
            }

        }
    }
```

```
        catch (Exception)
        {
            MessageBox.Show("Error occured during the natural language process");
        }
    }
```

Primary sentence matching algorithm using XML data source

```
public String[] StringMatcher(String question)
    {
        String[] matcher = new String[3];
        aimlquestions aimlq = new aimlquestions();
        aimlq = serial.DeSerializeQuestions();
        String[] UserTokens = question.Split(' ');
        String[] SystemTokens;

        int currentCount = -1;
        int bestCount = -1;
        int bestQuestionNo = -1;

        for (int k = 0; k < aimlq.questions.Length; k++)
        {
            currentCount = -1;
            SystemTokens = aimlq.questions[k].Split(' ');

            for (int i = 0; i < UserTokens.Length; i++)
            {

                for (int j = 0; j < SystemTokens.Length; j++)
                {
                    if (UserTokens[i] == SystemTokens[j])
                    {
                        currentCount++;
                    }
```

```
            }

        }
        if (currentCount > bestCount)
        {
            bestCount = currentCount;
            bestQuestionNo = k;
        }
    }

    aimlanswers aimla= new aimlanswers();
    aimla=serial.DeSerializeAnswers();

    if (bestCount > -1)
    {
        matcher[0] = bestCount.ToString();
        matcher[1] = aimla.answers[bestQuestionNo];
        matcher[2] = aimlq.questions[bestQuestionNo];
        return matcher;
    }
    else
    {
        matcher[0] = bestCount.ToString();
        matcher[1] = "";
        matcher[2] = "";
        return matcher;
    }
}
```

APPENDIX F: Software and Hardware

- Microsoft Visual Studio 2022

This is Microsoft's Integrated Development Environment (IDE). It is used to develop computer programs, websites, web applications, web services and mobile applications. **[8]**
The .NET Framework 4.8 is compatible with applications built using previous versions of the .NET Framework, with the exception of a few changes made to improve security, standards compliance, accuracy, reliability, and performance.

- Microsoft SQL Server 2019

It is a relational database management system developed by Microsoft. [9]

- Microsoft Office 365

Provide grammar and spelling checking functions for .Net applications.

- iText

iText is a library that contains classes for creating and managing Portable Document Format (PDF) documents. Document operations include splitting, merging, and form. [10]

- WordNet 3.0

WordNET is a dictionary database with definition links between words in more than 200 languages.
In the field of natural language processing, there are various functions such as automated text sorting, emotion analysis and text summaries. These functions are based in part on the outline of the sentence and the meaning of the words in another context. The two different words may be similar in width. For example, the words "jogging" and "running" are partly different and partly similar. [11]

Hardware and Communication Requirements

- Dongles with Short Message Facility
- High-end Personal Computer

APPENDIX G: System Performance

Performance Necessities

- Performance requirements define acceptable response times for system functionality.
- The loading time of the user interface screen will not take more than two seconds.
- Login information must be verified within five seconds.
- System shall run using Object Relational Mapping database. Hence whole Database load into the Main Memory and Queries will return result within five seconds.