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COM583 - Assignment 1

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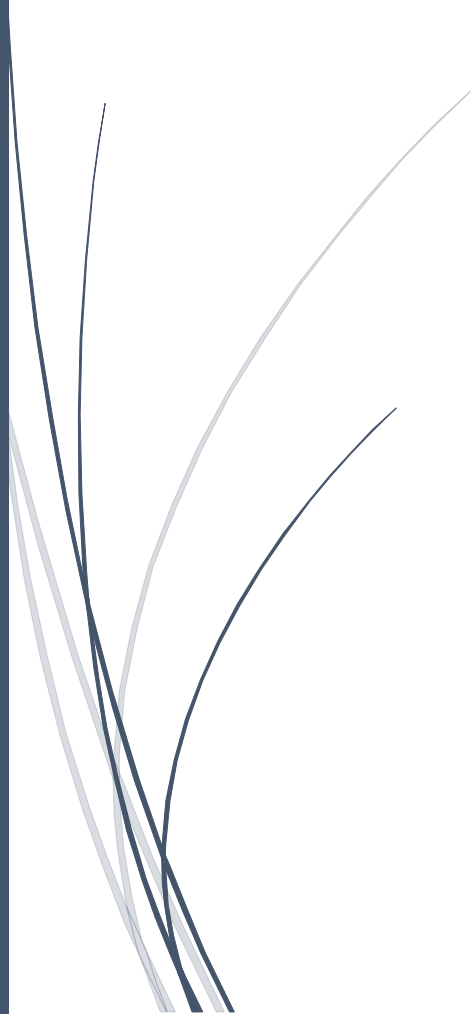

Contents

1. The Purpose of the Project

1.1 The User Business or Background of the Project Effort

Improving mobility whilst reducing traffic congestion, road collisions and air pollution is one of the key challenges faced by urban areas throughout the world. European Commission figures suggest that over 60% of European citizens live in urban areas and thus cities are struggling to handle movement of humans in an efficient, safe and environmental friendly manner. Therefore, this project was devised to help eradicate the issue through the implementation of new a public transport system that uses autonomous vehicles. All individuals, including children, elderly, and the disabled will be able to move around the city in a safe and timely manner, reducing the number private cars on the road and the level of CO2 emissions.

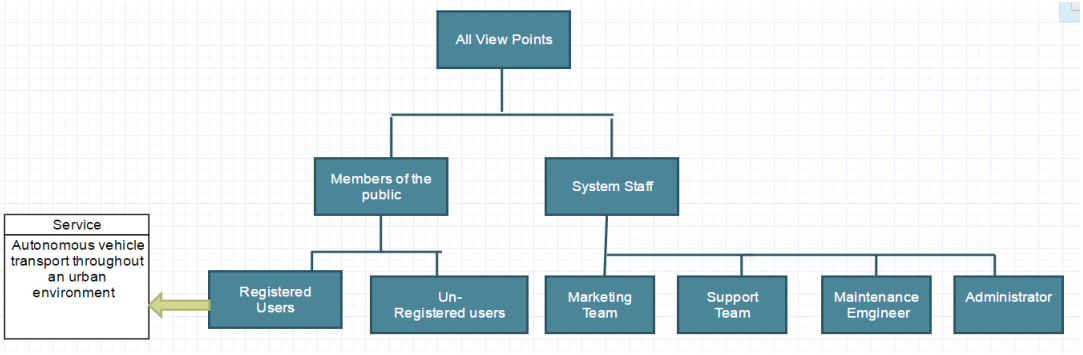

Figure 1-Viewpoont Hierarchy of Autonomous Vehicle System

VORD is an elicitation technique that was used to identify viewpoints that are concerned with the new systems. Once identified, the viewpoints were organised and structured into a hierarchy as illustrated above. The reason for using this approach is because it clearly separates out different perspectives of the system making it easier to identify conflicts and gain a better understanding of it. It also acts as guide for the engineers when they are designing the system as various views of the system are known. A drawback of using viewpoint however according Sommerville and Sawyer (1997), is that they are inflexible in that they do not account for changes in views. Interviewing the stakeholders is alternative technique that may have been used. However, as there are many stakeholders in the project and using VORD was more suitable option.

1.2 Goals of the Project

The PAM (Purpose, Advantage, Measure) approach is used below to explain the main goal of the project:

Purpose: Implement an entirely driverless public transport system using autonomous vehicles that humans can avail of to travel around urban areas in a safe, efficient and environmental friendly manner.

Advantage: The demand for private road vehicles will be reduced and the issues of heavy traffic congestion, road collisions and CO2 emissions will have lesser impact on the area.

Measure: A comparison of the levels of congestion, traffic collisions and CO2 emissions before and after the implementation of the transport system.

2. The Stakeholders

A power versus interest grid is used for the task of identifying and analysing stakeholders for the project. This technique was devised by Eden and Akernmann (1998) and it involves prioritising stakeholders in order of importance based on their interest and influence on the project. A quadrat is used to illustrate this information. The advantage is that because stakeholders are prioritised actions can be put in place to ensure that those who have the greatest influence on the project are kept the happiest. The Basic Stakeholder Analysis Technique is another approach which could have been used. This technique is described by Bryson (1995) and involves the creation of flip charts for each stakeholder to illustrate their expectations and whether these expectations are poor, fair or good. However, this approach does not consider the influence each stakeholder has on the project and for that reason it is not used for this project.

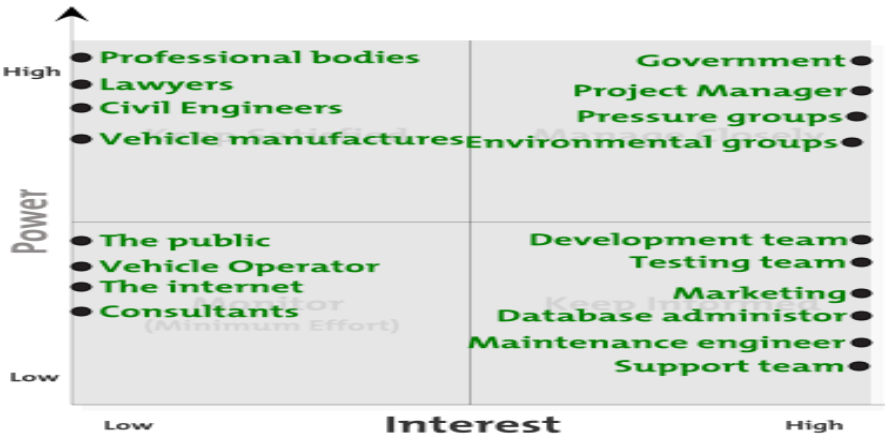

Figure 2- Stakeholder Analysis

3. Mandated Constraints

3.1 Solution Constraints

Description: The autonomous vehicles shall adapt the to the road network of the urban area which they are situated in. This involves acting accordingly when dealing with road traffic signals, junctions and other vehicles occupying the road.

Rational: Society will not accept autonomous vehicles if they are cannot operate in safe, law abiding manner.

3.2 Anticipated Workplace Environment

Weather conditions often change and autonomous vehicles must be able to deal with this. This includes the detection and reaction to brightness, darkness, rain and snow. The functional decomposition diagram below further explains how the vehicle must handle changing weather conditions.

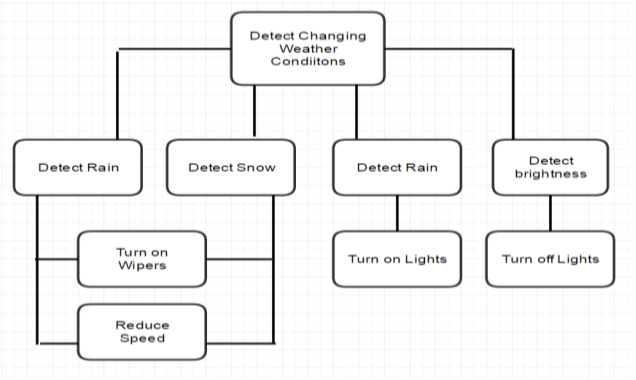

Figure 3-Functional Decomposition Diagram

Figure 2 illustrates that autonomous vehicle must be able to detect changing weather conditions, establish if the condition it is snow, rain, brightness or darkness and then act accordingly based on that condition. Functional decomposition diagrams are useful for breaking down a process into a hierarchical structure, allowing relationships between processes to be established. They model what the system does without going into extensive detail about how it does it. Function statements is an alternative external behavioural modelling technique which may have been used. However, function statements are composed of plan text and a diagram was more an elegant way of explaining how the vehicles should function in this scenario.

4. Relevant Facts and Assumptions

4.1 Assumptions

Roads won't be updated to accommodate autonomous vehicles. The vehicles will operate using the road structure currently in place and will obey the same laws as private cars/drivers.

5. The Scope of the Work

5.1 The Current Situation

Current transportation systems in most urban areas enables involves members of the public accessing an online ticket purchasing system where they can view timetables for the different forms of public transport and purchase tickets accordingly. Ticket booths are also available at most stations to provide an alternative method of buying tickets. When entering the vehicle, the passenger must verify payment of the service to the operator of the vehicle. They then wait on the vehicle until it reaches their desired location.

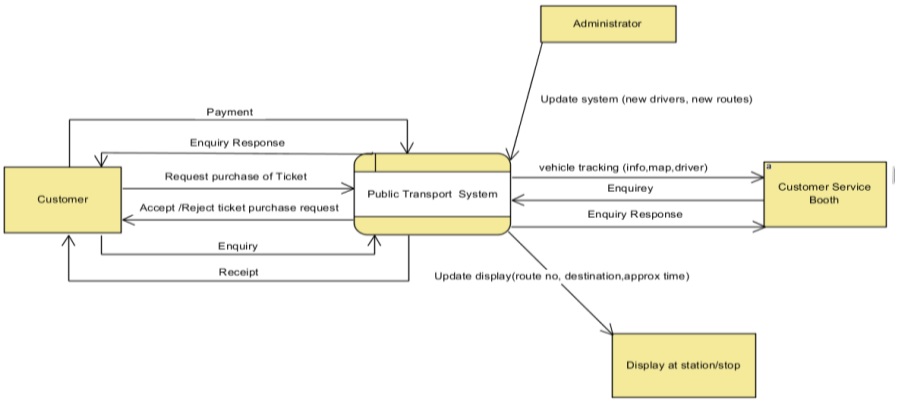

Figure 4- Context Diagram (Level 0 DFD)

5.2 The Context of the work

The Level-0 Data Flow above provides a high-level overview of the current transport system used in urban areas, showing the relationships between the system and its external entities. The arrows represent the flow of data through the system. The advantage of using a context diagram is that identifies the boundaries of the system in a way which can be easily understood by all the stakeholders in the project. However physical considerations are left out which may not suitable for those that require a more in-depth knowledge of the system. To overcome this shortcoming however a higher-level Data Flow diagram may be created, the level will depend on the amount of detail that is desired.

6. The Scope of the Product

The autonomous vehicle transport system will provide an alternative form of public transport and will initially operate alongside the current systems in place. Using a mobile application members of the public must register for use of the service and once registered, they will be able track the location of all autonomous vehicles operating within the area and make transportation requests. When making a request, the user will provide information regarding their current location and if they require disability facilitates or not. Each request is then handled by a central processing unit that will identify the most suitable autonomous vehicle in the system for the user. Once identified instructions are passed to the vehicle by the central processing unit, directing it to pick-up the user at a specific location. Upon entering the vehicle, the user keys in their desired destination using touch screen GPS system. This information is then mapped to the vehicle using cloud technology and it will begin to manoeuvre throughout the city until it reaches the desired destination. When a client's transportation request is confirmed they will be sent a unique identified number via text message. To enter the vehicle this number must first be typed into a keypad attached to the outside of the vehicle. This is to prevent users from availing of the service without prior booking.

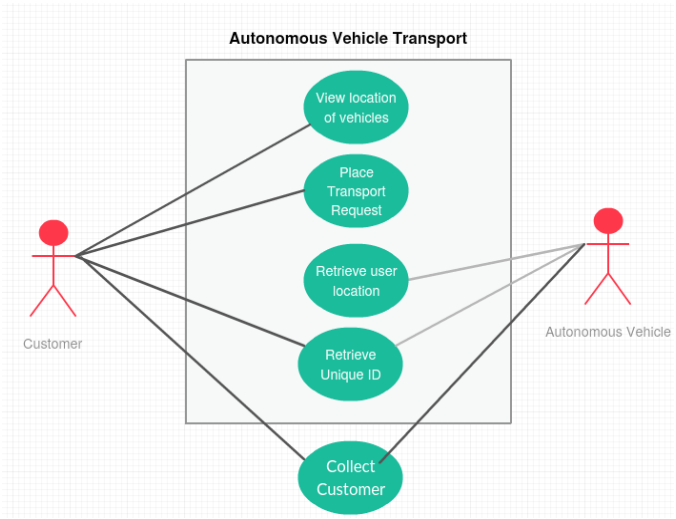

Figure 5-Use Case Diagram

The use case diagram above illustrates the different involvements the customer and the autonomous vehicle has with the central processing unit when the user makes a transport request. The advantage of using this diagram is that provides users of the document with an easily understood graphical representation of how this aspect of the system should work. An alternative technique which may have been used to model this process is Scenarios. Scenarios provide real- life examples of how the system is used and could have been adapted to the case of the user making a transport request. However, they are generated using plain text and diagram was more way elegant way of modelling how this aspect of system will work.

9. Functional Requirements and Non-Functional requirements

Req#	Requirement Type	Description	Rationale	Fit Creation
1	Functional	Autonomous vehicles in the system shall be able to communicate with other autonomous vehicles on the road.	To ensure the system and journey runs efficiently.	Vehicles can successfully transfer information and instructions to each other.
2	Functional	Autonomous vehicles in the system shall be able to accept locations and manoeuvre throughout the urban areas until these locations are reached.	To ensure vehicles can locate users and transport them to their desired destinations.	The vehicle successfully locates users and transports them to their desired destination.
3	Functional	Autonomous vehicles in the system shall detect and avoid all obstacles which are in within 5 meters of its surrounding area.	To prevent the vehicle colliding with other obstacles.	The vehicle stops immediately when an obstacle is within 5 meters of its surrounding area.
4	Functional	The control unit of the system shall send a unique pin number to a user upon a successful transportation request.	The requires this pin to enter the vehicle.	A text message containing the pin is received by the user within 30 seconds after confirmation.
5	Functional	The control unit of the system shall identify and instruct autonomous vehicles with disability features to perform the service to users who require the features.	Members of the public who have a disability can avail of the system.	When a user requests disability features a vehicle with these features is identified and dispatched.
6	Functional	Autonomous vehicles in the system shall allow access into the vehicle whenever a valid pin number is provided by the users.	Ensures that only the user who has made the transport request can avail of the system.	The door of the vehicle will immediately open upon input of a valid pin.
7	Performance	Autonomous vehicles in the system shall obey all road traffic signals.	To ensure safety of passengers and other objects in the surrounding area.	The vehicle shall detect changing signals and respond to them within 500 milliseconds.
8	Look and Feel	Autonomous vehicle in the system shall have a key pad attached to the outside of its passenger door.	User requires keypad to enter their unique pin.	Users are successfully able to enter their unique ids into the key pad

Req#	Requirement Type	Description	Rationale	Fit Creation
9	Usability	Autonomous vehicle in the system shall make it easy for users to move in and out off.	To ensure users receive an efficient service	Doors immediately open when the users enters a valid pin into the keypad.
10	Legal	Autonomous vehicle in the system shall obey road laws within the area they are operating in.	To protect passengers and other objects in its surrounding environment.	All laws are abided by the vehicle.

Vlore requirements shell was used to assist with the task of discovering functional and non - functional requirements. The key information on the snow cards was extracted and placed into the table above. The requirements are expressed using structured language to ensure that they precise, unambiguous and are interpreted by users of the document the same way. Natural language may also have been used, however it is more suitable when writing requirements that will be viewed end users who have less technical knowledge of the system.

Part 2 - Requirements Engineering Process

Scope: This report outlines a plan for feasibility study, requirements elicitation and analysis, requirements documentation, requirements management and provides a discussion of the lifecycle for system. Note that the project should be completed within 6 months and that the project budget is £4 million GPB. 3 assistants will available to complete the task.

10. Feasibility Study

The feasibility study of the autonomous car transport system will be focus on answering the following four questions and If the answer to any of these questions is ‘no’ then the project will not go ahead.

1. Is the protect Technically Feasible?

The capability of autonomous vehicles to operate within urban areas has been previously investigated and research into the results of these investigation will occur. If the results are positive more in depth research into artificial intelligence will be made and all available technology in the field will be noted. A comparison of current technology against the technology required for the proposed system will then occur, checks will also be made to

ensure the technology can be acquired and that is reliable when adapted to the system. Assistant 1 will be responsible for gathering this information.

2. Is the project Schedule Feasible?

Assistant two will conduct closed interviews with each of the engineers to gather information about their current skills and expertise and if they have any prior experience working with artificial intelligence. Based on the information a decision will be made on whether the schedule of 6 months is practicable. At this stage a decision to hire additional engineers who have the required expertise will be made.

3. Is the project Operational Feasible?

I will identify all key project stakeholders using the power versus interest grid defined within the requirements specification and arrange an open interview with each of them. The aim of the interviews will be to determine if the key stakeholders fully support the project, how end users feel about the project and evaluate whether the system will work.

4. Is the project Economic Feasible?

The team will investigate the costs of the system, including hardware/software costs, implementation costs and maintenance costs. The total cost will be then weighed against the £4 million budget to and a decision will be made on whether it is economically feasible.

11. Elicitation and Requirement Analysis

If the project is deemed feasible the next stage will involve requirements elicitation and analysis. This will involve a lot of interaction with stakeholders. The overall aim is to gain a full understanding of current public transport systems, the problems with these systems and what all functionality and services the new autonomous vehicle system should provide. A number elicitation techniques will be used. These are explained below:

Interview: An informal closed interview with users of the current transport systems shall be organised. During this interview, several pre-defined questions will be asked to gain background information about the current system and the problems associated with it, some these questions asked in the interview will include:

1. How often do you avail of the transport system currently in place?
2. How reliable or unreliable is the current system?

3. What aspects of the current system could be improved?

Ethnography: To Identify further requirements an analyst will be sent to a public transport station to observe the workings of the system and to make notes on it. The benefit of this is that helps to discover implicit requirements that that reflect the actual ways that people work (Sommerville, 2016). The information gathered by the analyst will then be reviewed and requirements will be established based on this review.

12. Requirement Validation

Once all requirements have been identified they will then be reviewed and analysed. During this analysis, each requirement will be checked to ensure that it is realistic, has no conflicts and that it is valid in terms of the functionality that it offers. On competition of this task test cases will be generated for key requirements to further ensure their validity.

13.Requirements Management

A database system will be used to assist with requirements management. The requirements will be held within a data store, to which only the project manager and software engineers will have access to and each requirement will be assigned a unique id so that they can be easily identified and retrieved. Using this unique id relationships between requirements will be also recorded for traceability purposes. This is important during requirement changes as the impact of the change on other requirements can be monitored. The following steps explain the process for handling requirement changes. Note that only key stakeholders will be able to request requirement changes and the project manager and software engineers will be the key individuals involved in the change.

1. A changed request is made by a key stakeholder.
2. A risk analysis will be carried out for the change.
3. Estimates for cost and time for the changed will be established.
4. The importance of the change is established based on the overall impact it will have on the product.

Depending on the outcome of the steps a decision will be made by the project manager on whether to accept the change request or not.

13. Development Lifecycle

The life cycle process which will be used for the project is the iterative approach. The reason for using this process is because the project is a safety-critical system that involves specialised technologies such as artificial intelligence and by building the system incrementally each feature can be fully and tested and verified before moving onto the next. The waterfall approach would also cater for this, however, unlike waterfall, the iterative approach provides a certain degree flexibility when handling requirement changes and incorporating new requirements into the system. This is important because the specialised technology used in the production of autonomous vehicles is relatively new to the world and as we do not yet fully understand all its capabilities it is likely requirements will constantly change throughout the project. In addition to that, the end users of the system are members of the public which is a large spread of individuals and to meet their needs it is likely that many additional requirements will need be incorporated into the system.

Using an agile methodology would provide the desired flexibility for handling requirement changes, however it is unsuitable for this project as it does not provide a standard template making it difficult to estimate effort required to complete the project. In addition to that the project involves working with advanced technology and as many of the engineers have little experience working with this technology they will be incapable of making the quick decisions that are required in the agile process.

Prototyping would be a useful methodology to use for the development of the project as it would enable end-users to get involved in the project and they will have a better understanding of the product, allowing them easily identify deficiencies in the system which can then be recertified. However, the issue with using prototyping for this project is that the autonomous vehicle transport system is safety-critical and using a prototype may put the health of users at risk.

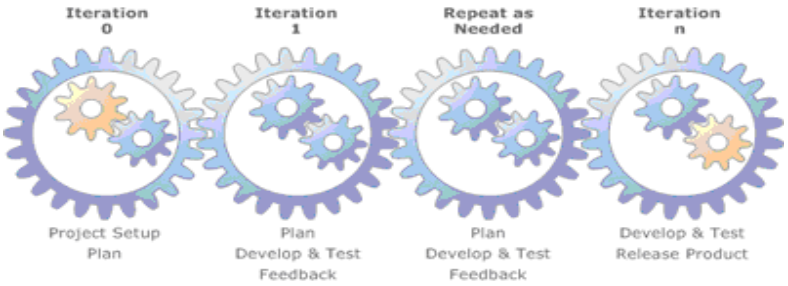

Figure 6- Iterative Lifecycle Process

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