University of Gloucestershire

System Design (CT4033), Computer Science

PEGASUS: Driverless Ride-Hailing System Report

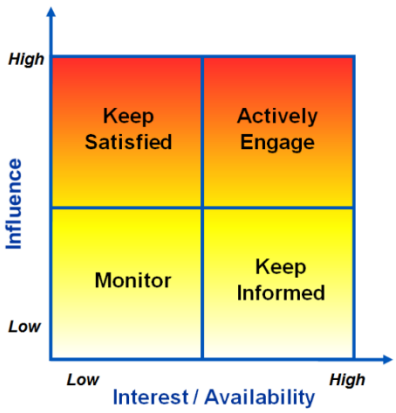
(Completed: 30th November 2023)

Introduction

Markwalter (2017) stated that there was a misconception that people did not want self-driving cars but according to a poll conducted by CTA Market Research in the journal, more than 60% of US consumers showed "a willingness in replacing their cars or trucks with a completely self-driving vehicle". The majority were young people from ages 18 to 35. Also, it inferred that the cars would be innovative and significant for future generations compared to the older generations who fear lack of control over driving. This driverless ride-hailing system which will be developed will involve the cars to be electrically powered, being eco-friendly. The intention of the system will be to pick up and drop customers to or as close to their destination if necessary. It will provide numerous benefits such as less land needed for parking, reducing road incidents and saving resources, time and money (Dang & Gupta, 2020). The system will be named Pegasus as it metaphorically compares the driverless cars to the mythical creature, providing a premium user experience.

Stakeholder Analysis

Using Jemilo (2016) slideshow on a managing framework on stakeholders for teams, programs and portfolios, it can help identify, analyse, prioritise and engage with stakeholders using the influence-interest framework.



The following questions were generated as a result:

Identifying, analysing, prioritising and engaging with stakeholders

- Are they an internal or external stakeholder?
- How impactful are they to Pegasus and why?
- Will they improve or hinder Pegasus in the future?
- How influential are they to provide changes to Pegasus?
- What interests do we have for the stakeholder?

Stakeholders

Customer

An external stakeholder that provides a significant impact to Pegasus as the intended users that the system aims to satisfy, producing profit and forming good customer satisfaction which leads to a good reputation as a reliable system (Benn, Abratt & O'Leary, 2016). Through profits, it will be useful for updating and maintaining resources along with covering other expenses related to Pegasus. This means that if there is little to zero profits generated by customers it could lead to a reduction of the system's maintenance, thus reducing performance. The customer has the capability to directly and indirectly improve and hinder Pegasus which is why they are prioritised as a major stakeholder (Jemilo, 2016). Out of all the stakeholders, they have the most influence over Pegasus because their collective decisions and trends formulate Pegasus and other stakeholder's decisions indirectly such as more customers using a certain car type so the car manufacturer may construct more of that car type.

The ideal customer

- Above age 18 with a BMI ranging from 18.5 to 40
- Not possessing a vehicle, inability to drive, preference for driverless cars
- Height under 6 foot 6 inches
- Able to pay within the price range (varies depending on distance of destination and car type)

Employee

An internal primary stakeholder required to make Pegasus stable and establishes its long-time survival as a system (Jemilo, 2016). Their frequent availability is required for internal processes within Pegasus which makes them impactful to the system in a positive light, however it could be said that major (or even minor) mistakes may hinder Pegasus from making progress so they will need to be organized and understand their roles within Pegasus to reduce the likelihood of failure. As an addition to supporting Pegasus, they boost customer satisfaction as they can revive a horrible user's experience with the driverless cars by engaging with customers by call, email, responding to reviews and queries, chatline.

The roles & responsibilities of an employee:

- **Staff** -> Dealing with customer service where they deal with complaints and reviews. For example, proving refunds, offering solutions during real time issues. Some are assigned to other sectors such as finance, IT, car engineering.

- **IT** -> Development, updating and maintenance of the Pegasus driverless car website and its mobile app. Other responsibilities include supporting and updating Pegasus databases.

- **Managers** -> Manages their sector they are assigned to (IT, worker, finance, etc).

All staff should to have at least a year of experience with relevant qualifications, understand their role and responsibilities well, accept policies and receive specific training based on their sector.

Car Manufacturer

Another external stakeholder and a vital supplier (Jemilo, 2016). The car manufacturer provides the main resource essential for Pegasus to become a ride-hailing system; cars. It could be said that they hold high impact and influence after the customer as any changes from them can improve or hinder Pegasus. The chosen car manufacturer should provide products and good services with various automobile types where vehicle parts are good quality for long-term use (Baek et al, 2007) and they should successfully collaborate with other stakeholders.

Technology Supplier

A supplier and an external stakeholder for Pegasus (Jemilo, 2016). If the car manufacturer doesn't provide the Pegasus cars with driverless functionality and other software programs automatically, they can be a minor back-up stakeholder. They would be impactful for delivering Pegasus it's unique niche of being driverless, so they are needed to implement artificial intelligence and other non-functional programs within Pegasus cars to generate a unique good user experience. Like the car manufacturer, the technology supplier should provide similar services.

Government

The government would be deemed as an external major-minor stakeholder. Initially, during planning, analysis and the testing phase of Pegasus their rules and regulations must be taken into account. Their requirements must be involved when we implement Pegasus into the public. Also, they will provide loans to fund Pegasus.

Fleet Management

Fleet management is responsible for the management, maintenance and organisation of Pegasus cars. As an external stakeholder that provides values when it comes to maintaining Pegasus cars during implementation. Interests in fleet management is high however influence is low compared to other stakeholders so they must be kept constantly informed (Jemilo, 2016). We should consider its reputation for its services but uniquely for fleet management, the communication with its clients and car insurance. It should also maintain cars to a standard-high quality such as appearance, recording condition of car and able to quickly transfer Pegasus cars to several locations (Powell & Topaloglu, 2005).

Terms, Facts & Business Rules

Terms	Facts	Business Rules
Pegasus -> driverless ride-hailing system	- Provide 0-9 buttons on side of front side door for customer to input - All Pegasus cars have a GPS location - All Pegasus cars come in 3 car models: PegasusMICRO (£2), PegasusMULTI (£10) and PegasusSTANDARD(£5) - The price range of Pegasus cars: £2 - £140 (1 – 100 miles) with additional with car type - All Pegasus cars process and respond to the commands “Go” and “Done”	- Pegasus car will only unlock door after it verifies 4-digit code from customer - Arriving cars’ location will be tracked by customer after order - Distances more than 100 miles and less than 1 mile are not valid for Pegasus cars

Customer -> a person/s who has made an order for Pegasus cars	- All customers have an automatic GPS location - All customers can post reviews about experience - All customers can post queries about issues relating to Pegasus	- The pick-up location set by customer must be a mile close to the customer - A customer must have an account on Pegasus website/app to order - Customers cannot make orders simultaneously, only one at a time - Only reviews can be edited - A customer cannot have no more than two accounts - A customer is given a 24-hour cooldown between reviews and queries

Employee -> a person who is working for Pegasus internally	- In general, staff can respond to customer reviews, queries, on call and email - Employees have an employee ID number	- Employees will only respond to customers during weekdays and weekends (9AM – 4PM) - All employees must follow security measures (change passwords, remember ID number)

Order -> providing payment for Pegasus services (Pegasus cars)	- Can involve several payment options such as PayPal, Debit Card, Google Pay and Apple Pay - If car is more than 30 minutes late, the customer is entitled to a 50% refund	- Customers must input relevant financial information for an order to go through - The 50% refund is only eligible three times per account - All order will be securely encrypted

Charging Hub -> an area where Pegasus cars will be fuelled up with electricity	- Charging hubs can fuel up to 5-10 Pegasus cars - Located at fleet management and some shopping centres	- Will only fuel Pegasus cars - Pegasus cars under 20% of its engine can be fuelled at the charging hubs

Scope of the Product & Business Events List

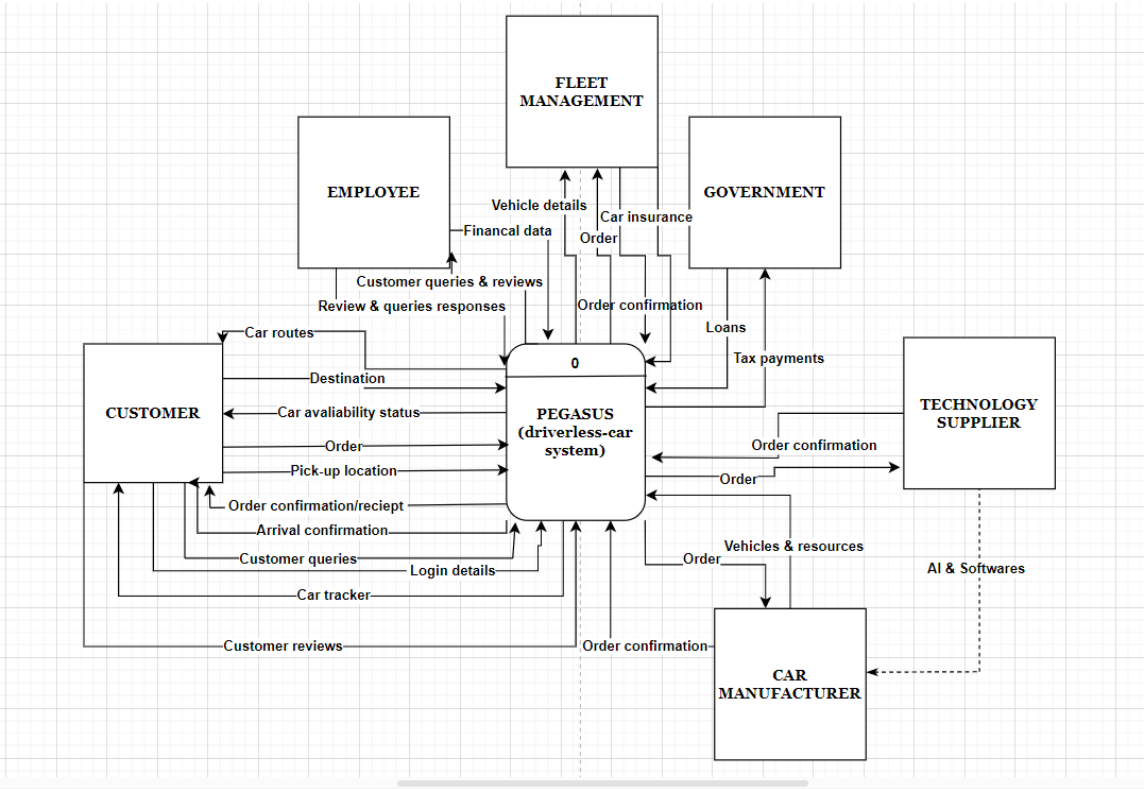


FIGURE 1 - Context Diagram (diagrams.net)

Customers can order a self-driving Pegasus car to pick them up from their current location and drop them off to their destination while providing a memorable and unique user experience only many can have with Pegasus.

Placing an order

Before an order is carried out, the customer's current GPS location is automatically tracked if permissions are allowed on, or they can manually input their pick-up location along with the destination location. Ordering is done using the website or the mobile app which is compatible with IOS and Android mobile devices. The customer chooses a car type: PegasusMICRO (Micro), PegasusSTANDARD (Hatchback) or PegasusMULTI (SUV). PegasusMICRO, fill in their payment option and inputs their relevant financial information.

Several routes will be generated, and a price will be shown for the user to select and pay including the car type selected. Prices may change according to holidays such as a rise in prices during the Christmas holiday.

Available driverless car confirmed
After the payment is successfully authorised, a randomly generated 4-digit pin is generated, will be told the commands for car and an available driverless car with an appropriate amount of fuel that can take the customer to their destination without any faults will be notified. A response with a confirmation notification to the customer occurs and drive to the customer's selected pick-up location. The user will be able to track the current location of the car as it moves. It should take no longer than 20 minutes to arrive.

Pick-up, journey & destination of car
If it is late, the customer is entitled to a 50% refund. The car should notify the customer of its arrival. If it has not been verified with the customer and it waits for more than 30 minutes, a £5 charge will be applied, and it will continue waiting at 30-minute intervals. Once the customer successfully verifies by inputting the 4-digit pin, the car will unlock the doors and trunk. It will stay at the location until the customer is inside and says the command "Go". Doors will be locked, and the car will start heading to destination. At the destination or as close as it can be, the car will unlock, allow the customer to exit and retrieve bags from the trunk. The customer should say "Done" and the car will drive for another pick-up or to a central charging hub if the amount of fuel is low. If a customer does not say this with no persons or animals in the car, it will drive away after 20 minutes.

Charging Hubs
A central charging hub will be an area with multiple charging stations to electrically charge the Pegasus cars. Melendez el at, (2020) has formed a central charging system for electric cars that Pegasus could mimic.

Holidays and Occasions
During holidays and special occasions, it is expected that Pegasus will be at its maximum performance such as on Christmas Day. Multiple Pegasus cars may be allowed to be parked on a street during these holidays however it is usually only one car allowed. As an extra, discounts and promotions will be offered.

Feasibility Study

Modern technologies available today are viable for us to deliver driverless functionality to automobiles by using sensors, detection systems and software necessary for machine learning however Pegasus could not be capable of full automation. Realistically, the cars will have to go through a long period of testing as they close into Level 5 automated driving (Society of Automotive Engineers, 2021) but it will most likely achieve Level 3 or 4 automated driving. However, we still have "a long way to go before we can have driverless cars in the street" so technologies can be improved to the point where all drawbacks for driverless cars are insignificant (Dang and Gupta, 2020). In 2016, Uber implemented self-driving cars and chose Uber users in Pittsburgh and later expanded in Arizona however they suspended the program after one of their vehicles was involved in a high-impact crash and

another incident which led to the death of a woman (American Library Association, 2019). Pegasus should follow the same methods which Uber performed by testing the cars within a small-populated town and record statistics.

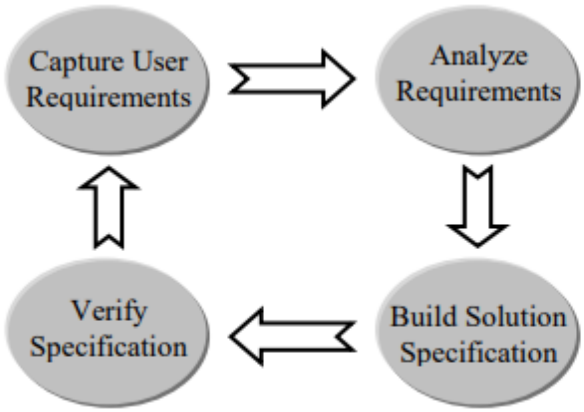
Some potential issues with driverless cars (Hansson, Belin & Lundgren, 2021):

- Risk of hacking from criminals or terrorists
- Risk of safety for some parts of road system (e.g. roundabouts)
- Responsibility for passengers? Pegasus? Other stakeholders?
- Effect on health of users & environment

The duration to build and launch the entirety of Pegasus is estimated to take some years with some hinderance including for the government to generate rules and regulations for full automated Pegasus cars along with Pegasus being compatible with those rules and regulations. Specific and good AI code and decisional making must be implemented to reduce decisional and recognition errors within Pegasus cars (Dang and Gupta, 2020).

Requirements

Using the RE Process Framework (Alcazar el at, 2000), all requirements are produced for Pegasus



Functional, Non-Functional & Data Requirements

ID	Category of requirement	Requirement	Description of requirement
01	Functional	Account Creation	Customer creates an account on the Pegasus app by inputting their full name, date of birth, home address, email address and password where data is stored in "Customer" database.

02	Functional	Route calculation	Routes are calculated, sent to customer as options and final route sent to available Pegasus car
03	Non-Functional	Automatic Route Switch	A route is automatically switched with another generated route by the Pegasus cars during real time
04	Non-Functional	Seat Warmers	Seat warmers enabled and disabled in Pegasus cars based on temperature of environment

Other functional and non-functional requirements include:

- Account Login [functional]
- Order Options [non-functional]
- Customer Notifications [functional]
- Discounts [non-functional]
- Electrically Fuelled Cars [functional]

Data must be collected to be converted into information to be used to improve and maintain Pegasus. As data grows, the databases must grow which can make the accuracy, completeness and timeless unknown (Wang el at, 1993). For example, the customer database would initially start like this:

Customer ID	First Name	Last Name	Date of Birth	Home Address	Email Address	Password
0001	Alex	Morris	18th September 2000	21 Klev Line, Moscow	alexmorris@gmail.com	H4qwepo-39

Conceptual Analysis

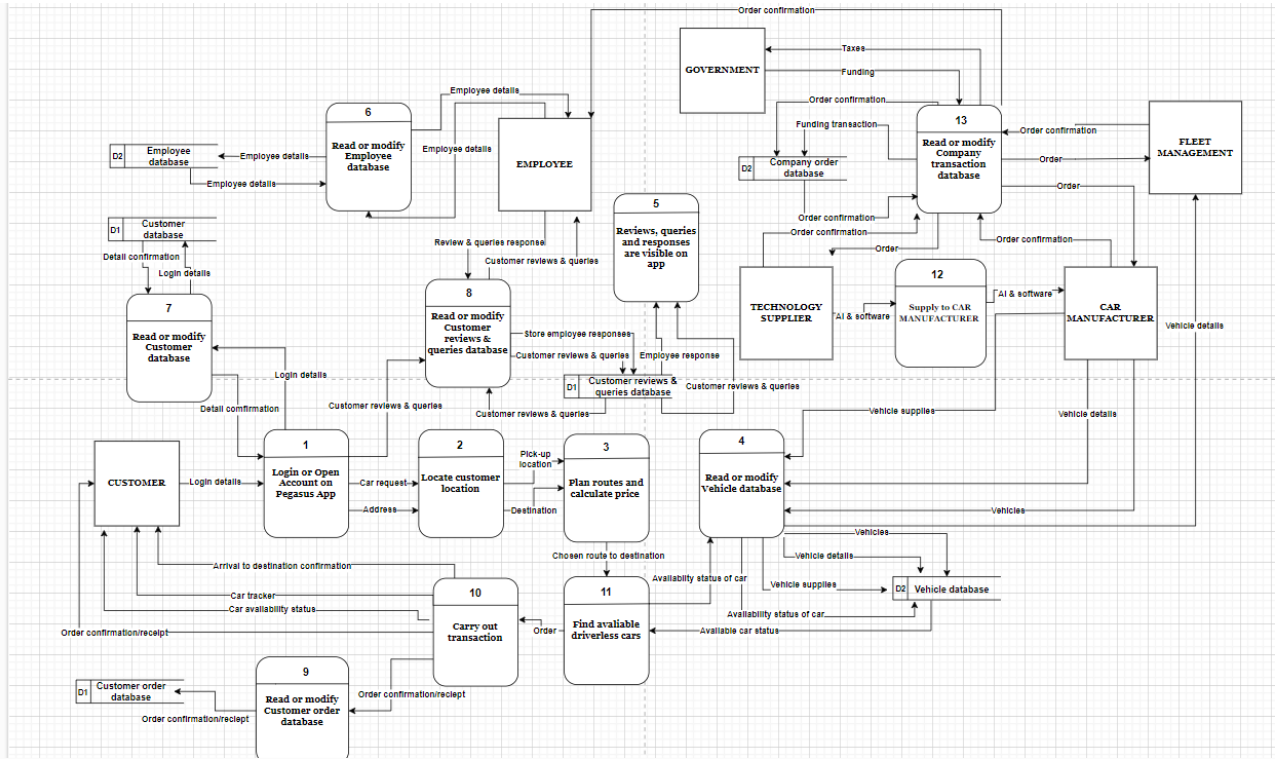


FIGURE 2 - Data Flow Diagram (diagrams.net)

Logical Data Modelling

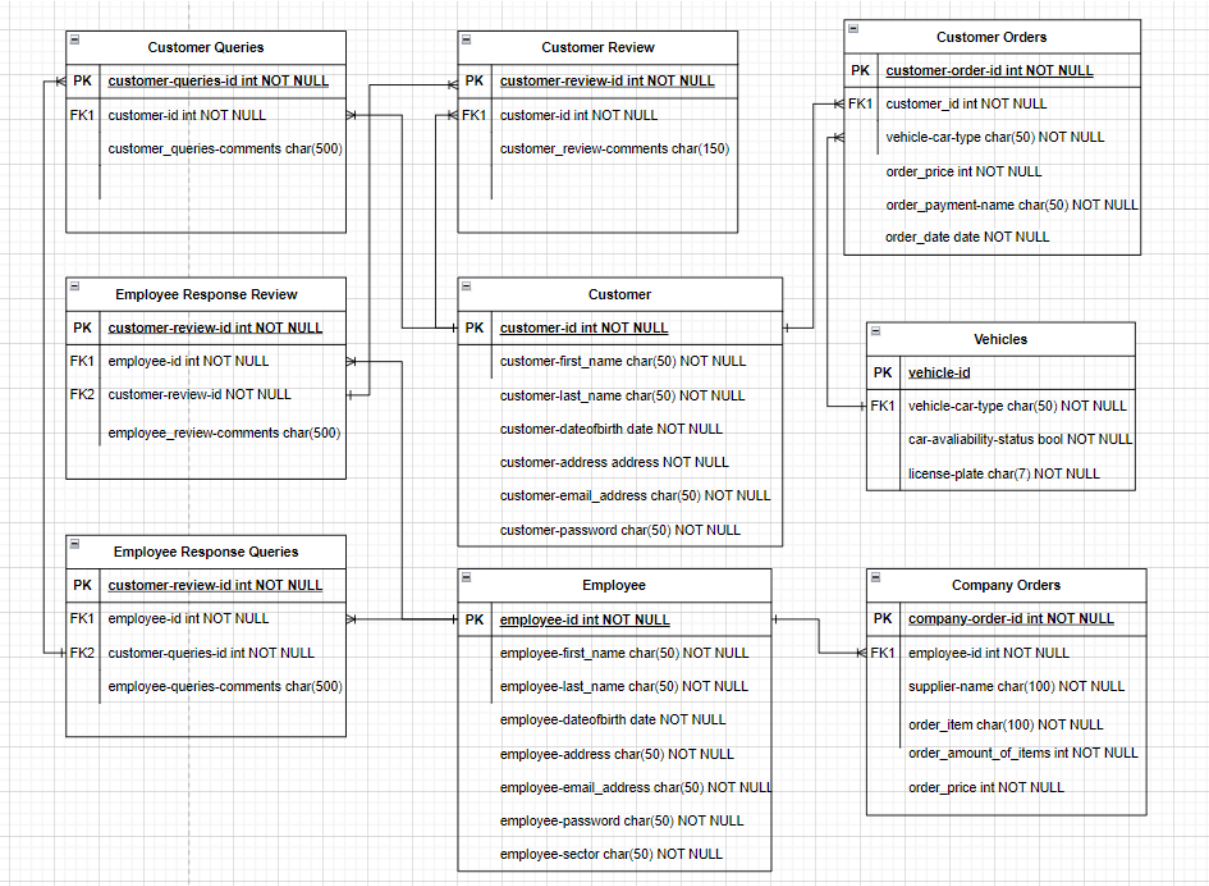


FIGURE 3 – Entity Relationship Diagram (diagrams.net)

Conclusion

In conclusion, this report identifies Pegasus' stakeholders, scope, user and data requirements and the modelling of all data involved.

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