Project Alcoy

Smart Sustainable Public Transportation
2017-2018

Smart Sustainable Cities

University of Applied Sciences Utrecht
Polytechnic University of Valencia
Municipality of Alcoy

Timo van Bergen, Elske Borneman
Jasper Merkens, Teemu Nässi,
Luuk Peeters, Sara Puusaari,

Coordinated by;
Martijn Rietbergen,
Pedro J. Ramiro Zafra,
Manolo Llorca
Preface

For the minor ‘Smart Sustainable Cities’ of the ESSENCE program of the University of Applied Sciences Utrecht, a project group of six international students will carry out a project for the Municipality of Alcoy. The project consist of a research into the public transport system in this city. This project took place in the University of Applied Sciences Utrecht and on location in Alcoy, Spain.

Our thanks goes to Martijn Rietbergen for guiding this project. During the field research, Pedro Ramiro and Manolo Llorca have accompanied us, thank you for this.

Utrecht, 30th of January 2018
# Table of content

Preface .................................................................................................................. 1  
Table of content .................................................................................................... 2  
Summary ................................................................................................................. 5  
1. Introduction ......................................................................................................... 6  
2. Methodology ....................................................................................................... 8  
3. Stakeholders ...................................................................................................... 9  
4. Alcoy .................................................................................................................. 11  
  4.1 Alcoy on sustainability and infrastructure ....................................................... 11  
  4.2 Alcoy on public transportation .................................................................... 12  
  4.3 Insights .......................................................................................................... 14  
    4.3.1 Insights questionnaire .......................................................................... 14  
    4.3.2 Insights Vectalia .................................................................................. 14  
    4.3.3 Insights municipality of Alcoy .............................................................. 15  
    4.3.4 Project group’s insights ...................................................................... 15  
5. Options ............................................................................................................... 16  
  5.1 Hybrid buses ................................................................................................. 16  
  5.2 Ecological way of driving ............................................................................. 16  
  5.3 Make specific timetables per bus stop .......................................................... 16  
  5.4 Improving app with GPS following system .................................................. 16  
  5.4 Make city centre hard to drive ..................................................................... 17  
  5.5 Speed cameras .............................................................................................. 17  
  5.6 Incentives ....................................................................................................... 17  
  5.7 Connection with industrial / expanding bus lines ....................................... 18  
  5.8 Marketing straight to target groups ............................................................... 18  
  5.9 More frequency of buses ............................................................................. 18  
  5.10 Improve bus stops ...................................................................................... 18  
  5.11 Cheaper bus tickets .................................................................................... 18  
  5.12 Make transfers between bus lines .............................................................. 18  
  5.13 Improve current bus lines ......................................................................... 19  
  5.14 Speed Bumps .............................................................................................. 19  
  5.15 Reduce parking spots ................................................................................ 19  
  5.16 Car free city centre .................................................................................... 19  
  5.17 Lower speed limits ..................................................................................... 19  
  5.18 Pay more for parking ............................................................................... 19  
  5.19 Green waves for the traffic light system .................................................... 20  

Final Report – Public Transport Alcoy
10.3.1 Solution ............................................................................................................................................. 36
10.3.2 Cost and investment .......................................................................................................................... 36
10.3.3 Advice ................................................................................................................................................ 36
11. Timeline .................................................................................................................................................... 37
12. Conclusion .................................................................................................................................................. 39
Recommendation ............................................................................................................................................. 40
Literature list ................................................................................................................................................. 41
I. Appendix 1: Current daily bus users ........................................................................................................ 42
Summary

In this qualitative research it was investigated how to make the public transport more attractive in Alcoy to stimulate the amount of daily users.

The research was done by first doing a desk research on general information about public transport, smart sustainable cities, the current problems with the public transport and their corresponding solutions. After this a 3 week field research in Alcoy was performed to conduct information about Alcoy. This field research included a questionnaire with 131 responses, geographical research, technical research and an economical research about the current public transport system of Alcoy and what could be improved. Furthermore, a meeting was organized with the bus company Vectalia and the municipality of Alcoy.

Based on the insights acquired from the questionnaire, bus company Vectalia and our own experiences, brainstorm techniques and research was done to generate options to solve these problems. The following insights were found; not all the areas are connected to a bus line, inhabitants are disturbed by the noise and CO₂ pollution, tickets are too expensive, the need for a ticketing system, inhabitants want to know how late the bus exactly arrives, inhabitants are not motivated to use public transportation.

A list of all possible options to solve the problems based on the insights was made. All the different 25 options were ranked by certain criteria in a selection matrix, a selection of 9 options were made to work out further.

The 9 options that were worked out further are the improvement of current bus lines, better connection with certain areas, incentives for busses, marketing straight to target groups, improvements of bus stops, specific timetables per bus stops, free Wi-Fi, improving application real traffic time system and a ticketing system.

Based on this research of the nine solutions a timeline was made to show when to implement the different solutions, since some are more important than others.
1. Introduction

The purpose of this project is to generate new ideas for city of Alcoy on how to make the public transport system more efficient and attractive. The ideas have been generate from the insights and problems that have been found as a result of the questionnaire made by the project group.

An efficient public transport system (PTS) is one of the most important part on the smart city concept. Alcoy has a PTS that consist of four bus lines from Monday until Friday, during the weekend a fifth bus line is operating. The operating company, Vectalia, has nine buses driving each day on these routes. Referring to the insights made out of the project groups questionnaire and the group members their own experiences, the PTS does not work in the most effective way. For example, the timetables of the buses are hard to understand, the frequency and range of the bus connection are not wide enough and most of the bus stops require modern upgrades to keep up with today’s standards. Therefore, the project group wants to improve and make the PTS more efficient in Alcoy. Based on this, the following research question is generated.

How can the public transportation system (PTS) become more attractive and sustainable so that 15% of the inhabitants will use this instead of non-sustainable means of transport?

1. Technological. Alcoy’s goal to reduce 20% of its CO₂ emissions in 2020 will serve as a guide for this project on this topic.
   I. Which technologies do the bus company uses currently?
   II. What kind of smart solutions are available to make the PTS more attractive?
   III. Can technology make the public transport more attractive?

2. Economical. To give advice about the investment costs, different information is needed.
   This is collected by the following questions.
   I. What are the costs of the available smart solutions
   II. Find out how the project group is able to calculate the return of investment.

3. Social
   I. What is the people opinion about the current public transport?
   II. Why do the people do not use the public transport?
   III. How can we change people’s habits of public transport?
   IV. What kind of people uses the public transport currently?
   V. Investigate different types of target groups.

   I. What are the interest points in the city?
   II. Where do people want to travel?
   III. What are the most used bus stops nowadays?
   IV. What is the total amount of daily users?
   V. How much more public transport users is needed to achieve the goal?
   VI. What are the current public transport connections between bus lines?
The goal of the project is to make the public transport of Alcoy more attractive. When the public transport becomes more attractive, the city of Alcoy will become more smart and sustainable, because the private car usage of inhabitants will be reduced. This results in less pollution, more open spaces and a good transport system to travel through Alcoy.

The project has been carry out with a view of sustainable development and thinking of three different perspectives (PPP), which has been learned during the courses; People (Social Design), Planet (Physical Transition) and Profit (Entrepreneur).

The boundaries of the project can be explained with different subjects, which are Social, Demographic, Economic and Technological.

For the social aspect, the group wants to find solutions for the public transport and how people’s habits can be changed. The inhabitants see their cars as a status symbol. The project group has to find a solution to motivate people for using the public transportation system.

For the geographic aspect, the expectation is that a lot of benefit can be gained by changing the transport, according to the targets groups. For example: Alcoy has various industrial working areas, their employees are living in the city centre. Those people travel by car because the buses do not reach those working areas. If this can be changed, this will be beneficial for the project on geographic aspect.

The economic side of the project involves cost and investment. It also includes new marketing strategies.

For the technological aspect, it is mostly focused on new technologies that can be implemented that can improve the PTS.
2. Methodology
The research of the project is done first by doing desk research. This happened in November of 2017. In December 2017 the project group went to Alcoy for field research. In January 2018 the project was finished in Utrecht.

The desk research generated other projects and information about Alcoy. This information was about the amount of inhabitants, geographic appearance of the city and the building style. The desk research generated literature about smart sustainable cities. It also provided literature about public transport. The project done last year was also part of the desk research.

The field research was done by a questionnaire. By using Google Forms, a questionnaire about the way of moving within Alcoy, traffic in the city centre, safety in the streets and where people want to travel was generated. This questionnaire had 131 attendees.

Further field research was during the project weeks in Alcoy, the project group spoke to the Municipality of Alcoy and the Universitat Politecnica de Valencia. The project group also had a meeting with Vectalia, the operating bus company in Alcoy. This meeting was with Andres Pinate, an employee of the marketing department of Vectalia.

To show what Alcoy looks like now, the project group took pictures of the different districts of Alcoy.

To create suitable options for the solutions, research was combined with brainstorm techniques (learned in the methodology phase of this minor). Techniques as mind mapping and hot-potato method created twenty-five different options. To select the best options, the method of the selection matrix was used. This method is a method where every option is graded towards several criteria that can have its influence towards that option.

After the trip to Spain, the project group worked in Utrecht. Here the project group did research on the solutions. This resulted into deliverables.
3. Stakeholders

Since there will be more options that can be executed to increase the public transportation users, the stakeholders can differ per project that will be executed. There are four stakeholders that will be responsible to execute some of the options. The bus company Vectalia, the bus stop company Impursa, the municipality of Alcoy and the government are all the parties that are responsible to execute the necessary projects. All of their interests are to increase the daily public transportation users. Vectalia wants to make profit by this, Impursa wants to show as much advertisement as possible to make profit and the municipality and the government wants to stimulate sustainable means of transportation.

The municipality of Alcoy, autonomous community of Valencia and the government of Spain are the parties that give approval for the results and is ultimately responsible for the execution in most cases. Their interests are to make most of those options a success to increase the amount of public transport users.

The parties that can play a supportive role in most of the projects are the public transport operators (PTO’s), infrastructure companies and software companies. The PTO’s their main interest is increase their daily users and their goal is to make more profit. The goal of the infrastructure companies and software companies are only to make profit.

The consulting parties exist of the ESSENCE project team and the EU. The ESSENCE project interest is to consult the municipality of Alcoy and the bus company to present options on what the bus company and municipality could do to improve their daily public transport users. The EU has co-financed an organization called civitas.eu that provides a lot of information and research on mobility solutions (e.g. smart ticketing), which can be asked for consult.

The parties that should be informed about ongoing projects are the sport clubs, schools and universities, companies from industrial areas and the shops in the city. The shops in the city have contrary interests in regard of the public transport, because Inhabitants are less likely to be able to park in front of the shops, but a better public transportation might also increase the daily customers. Sport clubs, schools and universities and the companies from industrial areas might be able to help promote the public transportation and are also dependent on the possibility of a good connection with the public transport.

The stakeholders interests and relationships with each other are described by the RASCI model in figure 3.1.

**Responsible:** Municipality of Alcoy, Vectalia, Government of Spain  
**Accountable:** Autonomous community of Valencia, Government of Spain and the municipality of Alcoy.  
**Support:** PTO’s (Vectalia bus company and Renfe railway company), Infrastructure company, Software company, Bus stop company (Impursa)  
**Consulted:** Essence project team, Public transport system consultancy’s (e.g. civitas.eu)  
**Informed:** Sport clubs, Schools and universities, companies from industrial area’s and shops in the city.
Figure 3.1 Stakeholder analysis
4. Alcoy

Alcoy is an industrial city located in East coast of Spain. It belongs to the Valencian community and province of Alicante. Alcoy is located in a mountainous area in a valley, it is around 560 meters above the sea level and there are few small rivers going through the city. The population contains around 60,000 inhabitants and has a size of around 130 km² (Wikipedia, Alcoy, 2016). There are lot of students living in Alcoy, because of the Alcoy campus of Universitat Politècnica de Valencia, which is a technical university. The economy of Alcoy thrives on the manufacturing industry related to textile, paper, food and metal (alcoi.org, 2018). There is a train connection to Valencia (105 km North East from Alcoy) and a bus connection to Alicante (54 km South from Alcoy).

There are two big natural parks in the area of Alcoy. Especially in summer time tourists come to visit those natural parks, which makes Alcoy touristic during the summer. It also has a cultural centre with few museums, churches and traditional events.

![Figure 4.1, City of Alcoy](image)

4.1 Alcoy on sustainability and infrastructure

The general goal of Alcoy is to implement smart city structure, capable to improve the quality of life of the citizens, the environment and the economy (Alcoy M. o., sd). The city has a lot of projects going on about mobility, economy, tourism, energy, efficiency and environment, which some of them are already done to make Alcoy a better place for people to live. For example, there is a website, where people can share their own ideas about smart and sustainable solutions. Information about electrical car charging points and more information about sustainability can be found. (Alcoy M. o., sd).

There are still a lot of improvements possible in Alcoy to get a more smart and sustainable city. The infrastructure is very challenging and a few small rivers going through the city and divides Alcoy in parts. This makes it hard to implement some smart and sustainable solutions in the city.
Alcoy is located in a very mountainous area, this causes problems especially for planning mobility. Streets of the city are designed for cars, with narrow sidewalks and lot of parking spots. Houses are very close to each other, so there is no room for wider streets or sidewalks. The current situation for pedestrians and possible cyclist are very dangerous. It is not safe to walk on narrow sidewalks, when cars drive too fast without caring about speed limits. The culture of transport in Alcoy is that people use their own cars every single trip, regarding the distance.

There are two main roads in city centre of Alcoy. Those roads are both one-way streets. The main street, avenue l’Alameda, which leads to North-West Alcoy, has four lanes included a bus lane. Two car lanes and parking lane on the left side of the street.

The first problem of the street shown in figure 4.4, is that the cars drive too fast, because there are two lanes. This speeding behaviour is dangerous for the pedestrians. Another problem is that the motorists use the bus lane to park their cars, this creates dangerous situations with the buses. The buses must always turn aside for the parked cars.

Besides the current parking lane, this street has a underground parking area. One floor of this parking area is half full and the other floor is closed, because there are no cars parked.

The other main street, Carrer Na saurian d’Entaca, which leads south-west of Alcoy, is a three-lane wide street. Those lanes includes two car lanes and one lane for parked cars. This street does not have a bus lane.

4.2 Alcoy on public transportation
The project group focuses on public transportation to make Alcoy more sustainable by reducing emission and private car users. The public transportation is mostly used by elderly people. The average number of the PTS users is 4.140 per day (appendix 1), which is around seven percent of Alcoy’s inhabitants. The public transport costs €0,80 for one ticket, which can be used for getting on the bus.

An new application of Alcoy bus is still in progress, but the current overview looks good. The routes section is under construction.
Currently, not every part of the city can be reached with public transportation. This makes it impossible to go to work in industrial areas for the employees. Also, the university is very hard to reach with bus and it takes much more time to get there compared to private car or even by walk. Timetables are very unclear and hard to understand. There are QR-codes in bus stops that are linked with the timetables and can be checked with bus application. Most of the times the QR-codes are broken or ripped off.

Elderly people do not commonly have a smart phone to check the application. Timetables are not specific, they just give approximately time when the bus arrives at the bus stop. With unclear timetables it is very hard to plan your journey, which makes travelling with public transportation inconvenient.

Average frequency of the buses is now every twenty minutes, this is too rare for some lines. One-way bus lines makes big detours which makes travelling sometimes long and not efficient.
4.3 Insights
In this paragraph the generated insights will be discussed. The insights that are gained are from a questionnaire, a meeting with Vectalia, the municipality of Alcoy and the project group.

4.3.1 Insights questionnaire
The questionnaire was answered by 131 attendees. The attendees were divided in different groups of ages and professions, which gave comprehensive results for the questionnaire. To figure out the current situation and different possible problems in Alcoy, the questionnaire was made. With the questionnaire the project group find out, what the habits of inhabitants are of the public transportation. Project group shared the link for the questionnaire with teachers at the university, Spanish students and employees of the municipality. Project group also interviewed people face to face in public places. Few of the most important graphs are shown below. Insights from the questionnaire are that people use their own car mostly to travel from one place to another. Still people find the current traffic situation in the city centre disturbing because of the noise and CO₂ pollution. People who are using the public transportation think that the system works, but tickets are too expensive in their opinion. There are still a few industrial areas in Alcoy where people would like to travel with buses, but there is no bus connection available.

4.3.2 Insights Vectalia
Vectalia is the operating company for bus transport in Alcoy. The company itself is operating in Spain and France. In Spain, it is mostly operating in cities for local transportation. It also has buses for driving through the whole country. In France the company only operating in long distance bus trips.

In Alcoy, Vectalia drives 500.000 km/year. There are 36 employees working in this department, this includes drivers, human resources, administrative and maintenance. There are twelve buses that are available in Alcoy, which of them nine buses are driving, three busses are for back-up. The target group on which Vectalia is focussing on in Alcoy is students younger than eighteen. This group is 30% of their customers.

One of the plans that Vectalia has for Alcoy is Yupi, this is an application that makes smart paying available in the bus.
Vectalia is also planning on getting new buses. These buses are innovative according to the current buses. The average age of the buses that are operating right now is eight years. The estimated lifespan of a bus is twelve years.

Vectalia is also willing to change the current bus routes and bus stops. Vectalia does not have influence on that. The bus stops are part of Impursa, the company that is in charge of the bus stops. They do the maintenance, advertising at and building of bus stops. The bus route is depending on the city council. They are responsible for the change in route (Vectalia, 2018) (Pinate, 2017).

4.3.3 Insights municipality of Alcoy
The municipality of Alcoy wants to improve city’s sustainability and smart solutions. They already have projects going on about mobility, economy, tourism, energy, efficiency and environment. The municipality puts lot of effort in those projects and it is really motivated for getting Alcoy more smart and sustainable. (Alcoy M. o., sd)

4.3.4 Project group’s insights
The project groups insights are based on the questionnaire, desk research, meeting with Vectalia and three-week field research trip in Spain. The project group found out that most people are not motivated to use public transport in Alcoy. The private car is a status symbol for inhabitants.

The project group detected multiple problems within Alcoy, those problems are; non- sustainable vehicles, timetables are not clear, habits and needs of the citizens, range of the buses, cars are faster than buses, city infrastructure, the application, traffic in city centre, pollution of city centre, buses are not attractive and the ticketing system.
5. Options

In this chapter the generated options are shortly described. These options came out the problems that were found in the insights. These insights were based on the questionnaire, meetings and research. The options arose from idea and brainstorm sessions.

5.1 Hybrid buses

If the buses will be improved to a more sustainable version, for example hybrid or electrical buses, the amount of emissions will reduce. With this option, the municipality attacks the sustainable part of the problem, but it will not affect the goal of increasing daily users.

Another disadvantage is the investments costs. Vectalia uses twelve buses in Alcoy to drive. If the buses are changed to hybrid buses, it must be cost-effective. This will not be effective with the current daily users, so not worth it to invest in.

5.2 Ecological way of driving

In Belgium, an initiator called “BBLV” learns bus drivers to drive in a more ecological way. For example; by switching to a higher gear sooner, optimum use of the fuel will be made. This reduces the amount of emissions in a city. The advantage of this solution is that the total emissions are reduced because the bus drivers deal more consciously with the situation.

The disadvantage is that this solution does not get the residents to use the bus more often. This solution only attacks the problem of total amount of emissions in the city.

5.3 Make specific timetables per bus stop

The timetables are not clear right now. When people arrive at the bus stop, there aren’t any timetables. The only way of knowing when the bus arrives is by using the application. There are some bus stops with a real-time schedule, but this is only available in a few bus stops. To make the public transport more reliable and more attractive, there should be a specific timetable at every bus stop, because every bus drives his own route and the time of arrival can be estimated pretty well the time schedule can be specific. When a bus is delayed, the customers have to wait the time that the bus is delayed. At this moment the customers is told that the bus can arrive ten minutes before and ten minutes after the time mentioned in the app. When these times also are written down in the bus stop, people can rely more on the timetable of the bus.

5.4 Improving app with GPS following system

The problem for the people now is that in most of the bus stops there is no information of the current location of the bus. This could be improved in the bus stop or in the app. By letting people track the life-location of the bus or giving an exact indication of when the bus is arriving to the stop people wouldn’t have to wait at the bus stop and wouldn’t feel like they are wasting time. By having this knowledge the passenger satisfaction will rise and there will be a reduction in customer complains. If passengers can learn about a delay before they arrive at the bus stop, they can make different decisions and think about alternative routes or modes.

The public transportation users of the Netherlands are able to download an app called “9292OV”. This app provides information about the different public transport methods in the Netherlands. For example, a user wants to go from home to school. The app provides the way of walking to the nearest bus stop, the exact time of the bus arriving at that bus stop and the length of the route. If the users has to change from bus, the app will give the user the necessary information.
This solution could work in Alcoy. From the questionnaire, several people have indicated that there is too little information about the buses available. The buses drive in an interval of mainly 30 minutes, but the exact time is not shown in the different bus stops. This solution provides every different public transport user of the necessary information.

This solution will persuade people to use public transportation every day instead of going by car.

By implementing this system it would not only help the passenger but would also be an advantage for the bus company itself because it can research the timetables better and improve it till the most accurate version which contains the least amount of delays as possible.

5.4 Make city centre hard to drive

By making the city centre harder to drive, private cars can be reduced, which leads to less traffic and a safer environment in city centre. The goal of this solution is to make driving difficult in city centre, which is supposed to make that people don’t want to use their own cars in city centre. The other main goal is to make public transportation faster compared to private cars. This solution makes public transportation more attractive and efficient compared to using their own car. Also, it makes city centre attractive too and reduce air-and noise pollution.

There are many ways to make city centre hard to drive with own car. The few most effective ways are to set driving forbids and make part of streets in city centre one ways. By making traffic lights non-advantage for private cars makes driving in the city centre annoying. Also, speed cameras, speed bumps, tolls in city area and lower speed limits makes driving more hard in city centre.

At the moment it is very easy to drive in city centre and unfortunately it is also easy to drive even dangerously fast. Taking account in sustainability, current system needs to be improved more for public transportation system. Currently public transportation doesn’t get attention as it should get and it is too easy to use private cars in the city.

5.5 Speed cameras

The problem in the central of Alcoy is that the drivers can drive with their car faster that the speed limits allow. There isn’t any obstacles or speed control around the city to monitor or fine the citizens who drives too fast. One of the solutions is to add speed cameras to the city image. Adding cameras, change the street image so that the city is more difficult to drive, affects people’s behaviour and the way of thinking. And the city is also able to fine drivers, which brings more profit to the municipality and lowers the driving speed.

5.6 Incentives

Attraction of more customers to use the public transport can be accomplished by incentives. Vectalia already uses some incentives. For example to attract more young people, they made a competition. The customers had a personal card, whereby in every age class there was a gift to win to the customer who made use of the bus the most. This types of incentives will improve the use of the bus.

Another incentive is for example to have a car free Sunday. This will make the use of the public transport or walking into the city centre more attractive. By making the city centre car free, it will be a bit harder to come to the city centre for people, but when they are there, the shopping and moving inside the city centre will be way more attractive.

The public transport also can be made more attractive to give away free tickets. This incentive will stimulate people to use the bus, because it’s free. When they can use the public transport free, they will see the advantages of the public transport and will make use of it another time when they have
to pay for the ticket. There are for example experiments in Sweden, which has increased the users of public transportation by this method.

These types of incentives will improve the bus usage. There are a lot of incentives to come up with. Every part of the public transport usage can be improved by incentives.

5.7 Connection with industrial / expanding bus lines
From the field research it can be concluded that the bus lines has to be improved. The range of the bus lines is not big enough currently. People of Alcoy uses the car to go to work and the buses do stop before the industrial districts of Alcoy. This means that these areas have a lot of busy car roads. Industrial areas as La Beniata, Industrial NORD and Baixes are not able to be reached by the public transport. This is why the people who work in those districts are forced to go to work by car. When the buses will move more into the industrial districts, the workers can choose to make use of the bus instead of the car.

5.8 Marketing straight to target groups
The marketing is not really dedicated towards one target group. When there will be more specific marketing on several target groups, it will be easier to generate more customers from one target group. The marketing can be via social media to connect to the younger customers. The older people can be reached by mail and billboards. This type of using marketing will be specific towards the target groups.

5.9 More frequency of buses
By adding more frequency for buses, it is easier to use buses and connections are better. Currently, average frequency for buses in Alcoy is 20 min. People can plan their schedule better when connections are better it doesn’t take so much time to travel with public transportation if it’s needed to change bus in some point of journey.

5.10 Improve bus stops
The current bus stops have a lack in comfort and information. The bus stops will need to get upgraded to the needs of the customers. In the current situation waiting for the bus is not a pleasant experience, by changing the environment for example by giving better shelter, entertainment or more information this could change the whole setting.

5.11 Cheaper bus tickets
The experiments of the bus company already showed that cheaper prices will increase the amount of travellers, also in the interviews 54% of the responders thought the prices where to high. By lowering the price of the ticket the profit would get lower but if this will increase the amount of travellers enough it would be better to the city of Alcoy. Also, there is an option for group tickets, which are cheaper compared to normal tickets. Buses are running anyway so these kinds of systems are easy to implement.

This seems like an easy solution but will bring a lot of consequences for the financial perspective, also the municipality cannot change the prices by itself but will need to discuss this with Vectalia.

5.12 Make transfers between bus lines
At this moment the bus lines in Alcoy are separated. When customers want to transfer from one bus line to the other bus line, they have to find the other bus line and have to wait until that bus is coming. At this moment there isn’t a good place where people can wait for another bus line. It is also
not clear for customers which line they have to take for their destination if they are not on the final bus line yet.

5.13 Improve current bus lines
Separate bus lanes and priority rules in favour of buses could make public transportation more attractive and efficient. Other examples of advantages are green waves for traffic light, separate traffic light for buses and streets where only buses can drive.

The goal of the advantages for buses is to make them faster than private cars and more easy to move in the city centre. Also, advantages help bus drivers to drive more safely and it makes the whole use of public transportation safer.

There are no advantages for public transportation in Alcoy now, except for few bus lanes in the main streets.

5.14 Speed Bumps
This solution has also been influenced by the centre speeding problem. Adding obstacles to the street image change behaviour and the way of thinking in long run. We want to install speed bumps to the roads to force drivers to slow down in the city centre. In the two of the one-way main roads, cars can drive almost as fast as they want and that make it faster to citizens to use their own car instead of choosing the public transport.

5.15 Reduce parking spots
By reducing parking spots in city centre the number of cars driving in the city centre can be reduced. When it’s harder to get a parking spot in the city centre people probably will leave their cars in home and stars using public transportation to get in the city.

Also, by making sidewalks wider by reducing parking spots it is going to be more safe to walk in city centre, because at the moment there are streets in the city centre, where the sidewalks are very narrow. When streets get wider by reducing of parking spots, bus lanes can be improved and more bus lines can be made.

5.16 Car free city centre
In the Alcoy city centre there is a lot of car traffic. A solution will be to make a car free city centre so that the cars have to drive around the centre, while the buses can pass the city centre. With this solution, different problems will be tackled.

5.17 Lower speed limits
Lowering the speed limits in the city central would increase the safety, since the result of the research shown that citizens of Alcoy don’t find the central area safe enough. The solution also would make the driving to the city central harder and slower. In the bus lines buses might be able to drive faster that the cars. This solution has also impact to people habits and minds.

5.18 Pay more for parking
The central of Alcoy is full of parking places along the roads and in the parking garages. The parking fee need to be paid only in the central and in the other areas it is free on charge. Adding parking fees and making it higher costs make it more expensive to drive with your car and that might increase the users of public transport.
5.19 Green waves for the traffic light system
A green wave in traffic means that a driver can drive through several traffic lights. This is only possible when he/she keeps to a certain constant speed. The traffic lights (in the green wave) are linked to each other and adjusted to the average driving speed. This is normally not only done for the convenience of the driver, but mainly done for safety.

By giving the bus green traffic lights it would bring a lot of advantages for the company. Due to the constant speed that can be driven, time (braking) and energy (acceleration) are saved. Also the driving comfort of the travellers and bus driver would be increased.

5.20 Information boards about current emissions
To make people aware of the pollution they produce, an information board about the amount of emission will be confronting. With this matter people will think about their usage of polluting machines. When they will know that they are the one that can change the amount of pollution, they maybe will use different types of vehicles and machines.

5.21 Make public transport more comfortable.
These days people are looking for comfort and they choose the most comfortable way. In Alcoy it is more comfortable to use your car so that the public transport system. The chairs are not sitting well and the indoor climate could also be improved. This could improve the attractiveness of the public transport a lot.

5.22 Free Wi-Fi
By giving the people the ability to use their time more efficient and useful, by having Wi-Fi people will be able the reply to their email or text messages, while otherwise they would have to drive their car and have to focus on the traffic. It would be an opportunity to safe time instead of wasting time to transport.

5.23 Ticketing system
The current prices of the bus are all the same. When customers buy a ticket, they only pay to enter the bus. If they only drive only for one bus stop, they pay the same amount as customers who drive the whole bus line.

With the ticketing system, customers have to check-in on the bus when they get on the bus and they have to check-out of the bus when they leave the bus. This system provides that customers have to pay for the distance of the travel, instead of getting on the bus. When customers forget to check-out, they will pay the price for the travel until the final destination of the bus line. This system makes it more straight for the customers.
6. Selection Matrix

To make an considered choice between twenty-three different solution options, a selection matrix is used in this project. In the row, the solution is described and considered against 14 different criteria. This criterion each have their own maximum of points that a solution can get. To make a difference between requirements and wishes between the stakeholders (focused on the municipality of Alcoy) a difference has been made in the total number of points to be obtained. For requirements, the total amount of points to obtain is 5, for wishes is it 3 points. This difference has to do with the importance between requirements and wishes.

Table 6.1 Criterion

<table>
<thead>
<tr>
<th>Criterion</th>
<th>Explanation</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Reduces emissions</td>
<td>This is a consequence of the requirements (2,6,11) of the project.</td>
</tr>
<tr>
<td>2. Increase daily bus users</td>
<td>A requirement given from the municipality and is the guideline of the project.</td>
</tr>
<tr>
<td>3. Cheap to implement</td>
<td>A wish of the municipality. This criterion influenced this end solution.</td>
</tr>
<tr>
<td>4. Short term solution</td>
<td>This criterion has been drawn up by the project group. Since the municipality wants to receive a timeline of the solutions, this must be tested on the options.</td>
</tr>
<tr>
<td>5. Long term solution</td>
<td>Since the municipality wants to receive a timeline of the solutions, this must be tested on the options.</td>
</tr>
<tr>
<td>6. Reduce private cars</td>
<td>A requirement given from the municipality and is the guideline of the project.</td>
</tr>
<tr>
<td>7. Reduce pollution (air and noise)</td>
<td>The questionnaire concluded that the residents do not like the pollution in Alcoy.</td>
</tr>
<tr>
<td>8. Makes public transport more user-friendly</td>
<td>This criterion has been drawn up in order to influence the target group.</td>
</tr>
<tr>
<td>9. Changes peoples habits</td>
<td>The previous project concluded that the habits of the residents must be changed. This is a guiding criterion for the project on social aspects.</td>
</tr>
<tr>
<td>10. Possible in Alcoy</td>
<td>Because the solution is placed in Alcoy, this must be tested.</td>
</tr>
<tr>
<td>11. Necessary</td>
<td>Because the solution is placed in Alcoy, this must be tested.</td>
</tr>
<tr>
<td>12. Maintenance</td>
<td>A lot of maintenance means a lot of costs for Vectalia and the municipality.</td>
</tr>
<tr>
<td>13. Socially responsible</td>
<td>The previous project concluded that the habits of the residents must be changed. This is a guiding criterion for the project on social aspects.</td>
</tr>
<tr>
<td>14. Able to collect data</td>
<td>At the beginning of the project, Alcoy indicated that it would like to take measurements with the end product in the future. (Where do people move, etc.)</td>
</tr>
</tbody>
</table>

The wishes have a maximum of three credit points. The option will not receive points any not relevant to the project and could get three points if the solution is very relevant. One or two points can be given between them.

Requirements can obtain five points if highly relevant and obtain zero points if not relevant.
After testing each option against the criterion, nine solutions have ended above 60%. This 60% is calculated after completing the selection matrix and is used as a guide for the solutions. The eight solutions are merged in four categories and will be developed into deeper developed solutions.

Underneath you find a list of solutions the project group will work on.

1. Reduces emissions
2. Increase daily bus users
3. Short term solution
4. Long term solution
5. Reduce private cars
6. Reduces pollution, air and noise
7. Make PT more user-friendly
8. Change people’s habits
9. Possible in Alcoy
10. Necessary
11. Socially responsible
12. Able to collect data

<table>
<thead>
<tr>
<th>Solutions</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
<th>9</th>
<th>10</th>
<th>11</th>
<th>12</th>
<th>13</th>
<th>14</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Hybrid buses</td>
<td>4</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>3</td>
<td>2</td>
<td>2</td>
<td>1</td>
<td>0</td>
<td>3</td>
<td>3</td>
<td>1</td>
<td>1</td>
<td>2</td>
<td>22</td>
</tr>
<tr>
<td>2. Ecological way of driving</td>
<td>3</td>
<td>1</td>
<td>3</td>
<td>3</td>
<td>0</td>
<td>2</td>
<td>2</td>
<td>1</td>
<td>0</td>
<td>3</td>
<td>4</td>
<td>3</td>
<td>1</td>
<td>0</td>
<td>24</td>
</tr>
<tr>
<td>3. Make specific timetables per bus stop</td>
<td>0</td>
<td>5</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>0</td>
<td>3</td>
<td>1</td>
<td>3</td>
<td>5</td>
<td>3</td>
<td>3</td>
<td>0</td>
<td>31</td>
</tr>
<tr>
<td>4. Improving app with GPS following system</td>
<td>0</td>
<td>5</td>
<td>1</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>0</td>
<td>3</td>
<td>2</td>
<td>3</td>
<td>5</td>
<td>1</td>
<td>3</td>
<td>3</td>
<td>32</td>
</tr>
<tr>
<td>5. Make city center hard to drive</td>
<td>3</td>
<td>3</td>
<td>0</td>
<td>1</td>
<td>3</td>
<td>5</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>4</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>27</td>
</tr>
<tr>
<td>6. Speed cameras</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>0</td>
<td>2</td>
<td>3</td>
<td>3</td>
<td>1</td>
<td>0</td>
<td>3</td>
<td>21</td>
</tr>
<tr>
<td>7. Incentives</td>
<td>1</td>
<td>4</td>
<td>2</td>
<td>3</td>
<td>3</td>
<td>2</td>
<td>1</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>4</td>
<td>3</td>
<td>3</td>
<td>1</td>
<td>36</td>
</tr>
<tr>
<td>8. Connection with industrial/expanding bus lines</td>
<td>3</td>
<td>5</td>
<td>1</td>
<td>1</td>
<td>3</td>
<td>3</td>
<td>2</td>
<td>2</td>
<td>1</td>
<td>3</td>
<td>5</td>
<td>1</td>
<td>2</td>
<td>0</td>
<td>32</td>
</tr>
<tr>
<td>Marketing straight to target groups</td>
<td>2</td>
<td>3</td>
<td>2</td>
<td>3</td>
<td>3</td>
<td>2</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>2</td>
<td>1</td>
<td>0</td>
<td>33</td>
</tr>
<tr>
<td>10. More frequency for buses</td>
<td>0</td>
<td>4</td>
<td>2</td>
<td>2</td>
<td>3</td>
<td>3</td>
<td>0</td>
<td>2</td>
<td>1</td>
<td>3</td>
<td>4</td>
<td>1</td>
<td>3</td>
<td>1</td>
<td>29</td>
</tr>
<tr>
<td>11. Improve bus stops</td>
<td>0</td>
<td>4</td>
<td>2</td>
<td>1</td>
<td>3</td>
<td>3</td>
<td>0</td>
<td>3</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>2</td>
<td>3</td>
<td>3</td>
<td>32</td>
</tr>
<tr>
<td>12. Cheaper bus tickets</td>
<td>1</td>
<td>4</td>
<td>3</td>
<td>3</td>
<td>1</td>
<td>3</td>
<td>1</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>1</td>
<td>3</td>
<td>3</td>
<td>1</td>
<td>30</td>
</tr>
<tr>
<td>13. Make new connections (between busines)</td>
<td>1</td>
<td>3</td>
<td>1</td>
<td>1</td>
<td>3</td>
<td>3</td>
<td>1</td>
<td>3</td>
<td>2</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>2</td>
<td>0</td>
<td>29</td>
</tr>
<tr>
<td>14. Speed bumps</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>1</td>
<td>2</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>3</td>
<td>0</td>
<td>3</td>
<td>0</td>
<td>0</td>
<td>11</td>
</tr>
<tr>
<td>15. Reduce parking spots</td>
<td>1</td>
<td>2</td>
<td>2</td>
<td>1</td>
<td>1</td>
<td>4</td>
<td>1</td>
<td>2</td>
<td>1</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>0</td>
<td>23</td>
</tr>
<tr>
<td>16. Car free city centre</td>
<td>3</td>
<td>5</td>
<td>0</td>
<td>0</td>
<td>3</td>
<td>5</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>27</td>
</tr>
<tr>
<td>17. Pay more for parking</td>
<td>1</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>0</td>
<td>3</td>
<td>1</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>2</td>
<td>2</td>
<td>0</td>
<td>1</td>
<td>24</td>
</tr>
<tr>
<td>18. Lower speed limits</td>
<td>1</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>1</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>0</td>
<td>0</td>
<td>27</td>
</tr>
<tr>
<td>19. Green waves for the traffic light system</td>
<td>3</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>2</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>3</td>
<td>1</td>
<td>1</td>
<td>3</td>
<td>3</td>
<td>20</td>
</tr>
<tr>
<td>20. Information boards about current emissions</td>
<td>1</td>
<td>1</td>
<td>2</td>
<td>2</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>1</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>0</td>
<td>22</td>
</tr>
<tr>
<td>21. Make busses more comfortable</td>
<td>0</td>
<td>3</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>2</td>
<td>0</td>
<td>3</td>
<td>1</td>
<td>3</td>
<td>2</td>
<td>2</td>
<td>3</td>
<td>0</td>
<td>21</td>
</tr>
<tr>
<td>22. Free Wi-Fi</td>
<td>0</td>
<td>5</td>
<td>2</td>
<td>3</td>
<td>3</td>
<td>0</td>
<td>3</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>2</td>
<td>3</td>
<td>3</td>
<td>0</td>
<td>34</td>
</tr>
<tr>
<td>23. Ticketing system</td>
<td>0</td>
<td>4</td>
<td>1</td>
<td>1</td>
<td>3</td>
<td>2</td>
<td>1</td>
<td>3</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>2</td>
<td>3</td>
<td>3</td>
<td>32</td>
</tr>
</tbody>
</table>

Figure 6.1 Selection Matrix

After testing each option against the criterion, nine solutions have ended above 60%. This 60% is calculated after completing the selection matrix and is used as a guide for the solutions. The eight solutions are merged in four categories and will be developed into deeper developed solutions.

Underneath you find a list of solutions the project group will work on.

1. Connection with industrial/expanding bus lines
2. Incentives
3. Marketing straight to target groups
4. Improve bus stops
5. Make specific timetables per bus stop
6. Free Wi-Fi
7. Improving app with GPS following system
8. Ticketing System
7. Improving current bus lines

During the field research, a problem occurred that has to be solved before taking other solutions in mind. The questionnaire and field research concluded that the buses do not reached the industrial areas of Alcoy. These areas are: Poligon industrial La Beniata, Poligon industrial Cotes Baixes and Poligon Industrial Nord. It is striking that no bus stops at the train station of Alcoy. To reach the industrial areas and the train station, it was decided to divert the buses to those areas.

If more people use the bus, the bus will also have to drive more often. In this chapter this will be calculated and an advice will be drawn up.

Another problem that causes fewer people to use the bus is that the car is faster than the bus. To attack this problem, the main street has to change towards a street that will slow the cars and speed up the buses.

7.1 Expanding bus lines to industrial areas.

The current situation of the infrastructure of the buses is described in ‘chapter 4: Alcoy’. To reach the Poligon industrial La Beniata, bus line 1 can be divert to this area. The diversion will be about 2 kilometres and will drive around the Parc de Cantagallet. Eight new bus stops can be placed in the Poligon Industrial La Beniata.

To reach the Poligon industrial Cotes Baixes, bus line 3 will be extended to this area. This diversion will be about 2,5 kilometres and five new bus stops can be placed on the street named ‘Poligon Cotes Baixes’.

The last areas that are not able to reach are the train station and the industrial area Poligon industrial Nord. To change the route from bus line 4 with a distance of 1,5 kilometre will be able to reach both spots. Three new bus stops will be placed in this diversion, one of them in 50 metres from the train station.

![Figure 7.1 Suggestion of the new bus infrastructure](image-url)
To make this possible, seventeen new bus stops can be placed in Alcoy (more information can be found in chapter 9). In figure 7.1, the new bus map is shown.

### 7.2 Frequency of the busses

In the appendix I, the current daily users of the public transport of Alcoy are shown. The current daily users are 6.9% of the total population of Alcoy. When this will be raised to 15%, the frequency of the busses has to be changed.

Currently, an average amount of 4,140 people uses the bus daily. When 15% of the population uses the buses daily, the total daily users will be around 9,000 people. Since the number of users will double, it would be logical if the buses run twice as often. However, the number of seats of different busses also affects the frequency.

An example of the frequency calculation is given: bus line 1 will be raised to 1,320 daily users. This means that there are twenty-nine users instead of twenty-seven. Because the buses that are used on this line have eighty-eight places, it will not be necessary to drive this bus more often. This does not apply to every line.

Table 7.1 gives an overview of the new suggestion of frequencies of the buses.

<table>
<thead>
<tr>
<th>Line</th>
<th>Colour</th>
<th>Current frequency</th>
<th>New Frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bus 1</td>
<td>Blue</td>
<td>Once in 20 minutes</td>
<td>Once in 20 minutes</td>
</tr>
<tr>
<td>Bus 2</td>
<td>Green</td>
<td>Once in 20 minutes</td>
<td>Once in 20 minutes</td>
</tr>
<tr>
<td>Bus 3</td>
<td>Red</td>
<td>Once in 20 / 30 minutes</td>
<td>Once in 20 minutes</td>
</tr>
<tr>
<td>Bus 4</td>
<td>Purple</td>
<td>Once in 35 minutes</td>
<td>Once in 20 minutes</td>
</tr>
</tbody>
</table>

Table 7.1 New frequencies

These new frequencies are important if Vectalia continues to drive with the same buses. The usual frequencies can be used if Vectalia decides to drive with larger buses on line 3 and line 4. This can even be applied only at peak hours. Another possibility is to drive the larger buses only during peak hours.

#### 7.3 Cost and investment

When the bus lines are extended to reach more areas, the investment can be calculated per driven kilometre per bus. For this investment, the total extra costs per month of all the buses will be calculated. The total extra distance the busses will drive is 5 kilometres and the total frequency of all the buses is currently forty-six for bus line 1, forty-four for bus line 3 and twenty-four for bus line 4 (Alcoi.vectalia, 2018). This concluded in a total amount of 214 kilometre a day (only workdays). With the use of costs indicators (CROW, Kostenkengetallen regionaal openbaarvervoer, 2015) for public transportation, an estimation can be calculated. This is shown in table 7.2.

<table>
<thead>
<tr>
<th>Costs factor</th>
<th>Costs</th>
<th>Total per month</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Maintenance</td>
<td>0,25 €/km</td>
<td>€ 1.070,00</td>
</tr>
<tr>
<td>2. Fuel</td>
<td>0,40 €/km</td>
<td>€ 1.712,00</td>
</tr>
<tr>
<td>3. Extra salary (Busdriver, planner, mechanic)</td>
<td></td>
<td>€ 108</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td></td>
<td><strong>€2.890</strong></td>
</tr>
<tr>
<td>4. Optional: New bus</td>
<td>€250.000</td>
<td></td>
</tr>
<tr>
<td>5. Optional: Storage bus</td>
<td>€3.000/year</td>
<td></td>
</tr>
<tr>
<td>6. Optional: New bus driver</td>
<td>€50.000/year</td>
<td></td>
</tr>
<tr>
<td>7. Optional: Taxes bus</td>
<td>€788/year</td>
<td></td>
</tr>
</tbody>
</table>

Table 7.2 Costs of investment
7.4 Infrastructure of l’Alameda
A problem according to the field research is that the cars are faster than the buses. This will allow the residents to use the car more often than the bus. In ‘chapter 4: Alcoy’ it is described that one of the main streets l’Alameda stimulates this problem. This street is a four lane street with one lane for parked cars, two lanes for driving vehicles and one bus lane.

One of the problems in the street is that the cars drive too fast, in the middle of Alcoy. Another problem is that the bus lane is used by motorists to park their cars, which creates dangerous situation for the buses. An underground parking area, placed in the street, is not entirely in use. One layer is half full and another layer is closed because of the minimum use.

7.5 Advice of infrastructure
The aim to change the infrastructure of the main streets of Alcoy is to slow down the cars and speed up the buses. This will lead to more people using the bus instead of the car. This two main streets can be stimulating the public transport and will guarantee safety for pedestrians.

Our suggestion is to change the infrastructure of the avenue l’Alameda. The first step is to remove the parking spots. The cars can be parked in the free underground parking what causes the people who use the car for groceries and other shopping activities to park there. This ensures that this group of travellers does not travel further on this road, which means less road users. The removed parking spots will be changed into wider sidewalks.

Currently, the bus lane is used by cars to park on this lane, to buy something quickly. By separating this avenue with a demarcation this will no longer be possible. These solutions ensures that the cars reduce speed and the buses can run faster. These solutions are long term solutions, but there are powerful when implemented in Alcoy. The solution is shown in figure 7.2.

![Figure 7.2 Sketch of 'new' l’Alameda](image)

7.6 Cost and investment
Along the street the parking places are changed to a wider sidewalk. A separation is also being built between the bus lane and the lane for cars. To estimate the cost of this investment, indicators are used. These indicators (Bouwkosten, 2018) are average costs of changing streets including, demolition materials and salary etc.

<table>
<thead>
<tr>
<th>Adjustment (lxm)</th>
<th>Costs</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Parking spots into sidewalk (1500m x 2m)</td>
<td>10.78 €/m</td>
<td>€ 32.160</td>
</tr>
<tr>
<td>2 Separation bus line (1500m)</td>
<td>83.01 €/m</td>
<td>€ 124.515</td>
</tr>
</tbody>
</table>

| Total                        | € 156.675 |

*Table 7.3 Cost of investment*
8. Incentives
To generate more customers, Vectalia is working on some incentives. These incentives can be a very focused incentive for one target group, or can be an incentive for the whole company.

8.1 Competition for age groups
In 2015 Vectalia had an incentive to gain more young customers. They made a competition of six different age categories. All the users of the bus had their own card, so the system would know which customer made use of the bus. It also counted the amount of bus trips. Every category would have a winner, the categories sat between eight years old and twenty-seven years old. The winner per category was the customer who made the most use of the bus in Alcoy. By doing this competition, the amount of young users increased and the young customers became more aware of the use of the bus (Vectalia, 2018).

8.2 Car free Sundays
Another possible incentive is the car free Sunday. In a rapport of the municipality of Amsterdam, they say that the inhabitants of several districts in Amsterdam are positive about the car free Sunday; 71% is positive, 13% is negative. This research was completed in 2009, the thoughts of the inhabitants was not to change much from the year before (Onderzoekstatistiek, 2018). This data are generated from Dutch inhabitants. The estimated percentages in Spain would be 10% less positive inhabitants and 10% more negative inhabitants.

The idea of the car free Sunday is that the city centre will be car free. This makes the bus usage way more attractive, because people cannot enter the city centre by car. The other option is walking, but for a lot of people is walking to far away or they can’t walk because they are too old. The city centre will be more attractive to shop when there won’t drive any cars. This makes the city centre more attractable for the inhabitants, this stimulates the use of the bus as well.

8.3 Free tickets
The people in Alcoy won’t use the bus that much. They have a bad thought about it, because of the previous years. They think that the public transport in Alcoy is working very bad (5,4%, or bad 12,3%). This 17,7% of the 131 responders, so 23 in total, will not get in the bus. By giving free tickets for one day or for an age group that barely uses the bus, they can use the bus and see that it is a user-friendly way of transport (Alcoy I. o., 2017).

When people get free tickets, they make use of the bus. They can use the bus on one day, this results into more use of the bus on other days, for example make us of the bus to go to school or shop (CROW, Behavioral change in Worcestershire, 2018).

8.4 Bus ticket in combination with event
To make the bus more attractive, Vectalia can work together with several companies. For example the football club or the theatre. When they offer bus tickets for a reduced price in combination with a ticket for an event like football or a theatre, people have the choose to spend less and use the public transport. This will keep the inhabitants from using the private car and will make the bus use higher. It also promotes the cultural activities.
8.5 Marketing straight to the target group

The marketing is not really dedicated towards one target group. When there will be more specific marketing on several target groups, it will be easier to generate more customers from one target group. The marketing can be by social media to connect to the younger customers. The older people can be reached by mail and billboards. This type of using marketing will be specific towards the target groups.

The bus use has to be increased. The total amount of customers of the bus in 2016 was 1,510,975. To get the 15% usage of the bus from the inhabitants, the amount of bus users has to increase 4,860 people per day, this is shown in appendix I. To gain more customers, marketing can help. Especially in the months where less people use the bus, marketing can provide more customers. Also the periods when the schools are open, the businesses are working and the people are not on holiday, the marketing can be straight towards target groups. When the marketing is straight to children from the elementary school, this has to happen in the period that the elementary school is open. This is the same for the other groups. The only difference is how to contact the different target groups. For this social marketing it is necessary to analyse the target group and especially their view on the problem. When we know this, we can focus on the intervention that is necessary to change the habits of this target group (CROW, Behavioral change in Worcestershire, 2018).

The marketing has to be set up towards the needs of the target group. They needs are different, but the basic reasons to use the product or service are this three:

1. Satisfy basic needs
2. Solve problems
3. Make themselves feel good

One of this basic reasons is more important for the product or service than the other. This results into different target groups. These target groups can be divided into age, gender, education, income, marital status, ethnic and/or religious background or family life cycle. For all different groups there are different methods to sell the product or service (Balance, sd).

In figure 8.1 the amount of influence of a company to its organisation, industry and total market is shown. This is the same for Vectalia and for the Municipality of Alcoy. The amount of influence is in total control when it is in the micro surroundings of the company. The influence will reduce when the meso surroundings are looked at and the influence is zero when the company wants to control the macro surroundings (plan, 2018).

![Figure 8.1 Influence of a company](image)
9. Improve bus stops and time schedule

Urban city images are full of signs of public transport, one of the first things people will tell you when you ask them about New York are the typical yellow cabs, for London this would be double red buses. Subways, trams and buses, are the basic things to see when you are walking through any city. Nowadays you will see buses driving in rural areas and sparsely populated areas. The expectations of the customer of the bus stops are getting higher. They expect and require a good provided service, people do not want to wait for their bus without a shelter that provides protection for the rain or the roaring sun, or without a bench for in case you want to rest your legs. In this busy world people do not want to wait for public transport. Companies and municipalities who provide the public transport should be able to offer smart solutions to show the passenger’s time table for the coming and going busses.

In the city of Alcoy has four bus lines driving and on Sundays there is fifth one driving to the cemetery area. So there are many bus stops, some of them are in workable conditions and some of them are missing important elements to make them part of a user friendly public transportation system.

The pole stops are often located to narrow streets where there is no room for shelters. The poles are positioned so that they are in the same direction with the road and therefore are really difficult to notice if you do not know where they are located. A solution could to in rotate the pole ninety degrees so is easier to spot.

Unfortunately, you often had to be disappointed, because the schedules were torn up. This results that some parts are missing and that makes it impossible to the right timetable.
9.1 Bus stop suggestion

Bus stops are an important part of public transportation. People spend time on bus stops when they are using public transportation when they wait buses and on bus transfers. The project group’s goal is to make bus stops in Alcoy attractive, so the bus stops create a cosy, relaxing and safe feeling for the people while waiting for bus. All the bus stops should recognize from the same kind of same symbol or style.

Public transportation is more attractive for the people when bus stops are interesting and there is nice to wait buses. Also, it is important too, that in the bust stops are electronic timetables and real-time information boards for delays etc. With bus stop improvement, the amount of people using public transportation is plausible increasing. To come up with new designs it is good to look at solutions that are already in the market or futuristic ideas.

Figure 9.3 Different bus stop designs
9.2 New bus stops

New bus stops should be attractive and give real time information about time schedules, delays etc. Bus stops could have different kind of themes, but they should have one recognizable thing (sign or something) that people, especially people that are unknown to the city can recognize them. There are many options to make bus stops attractive and cozy and all around the world there are many good examples about high quality and attractive bus stops. Taking in account the smart and sustainable aspect of this project, it is also possible to add this into the bus stations. This means that bus stops could have green roofs, water collectors, solar panels, plants, (fake) grass on the ground, real-time information boards, electronic screens, a place where you can see news or other videos, trash/ash bins, e-books, comfy benches and so on.

Figure 9.4, Smart bus stop

In the picture above you see a good example of a smart bus stop.

In the picture at the right you see a sketch of what a new bus stop could look like.

Figure 9.5, New bus stop design sketch
9.3 Bus stops on narrow streets
In Alcoy there are many narrow streets with narrow sidewalks where are bus lines. These streets are hard to implement bus stops and especially for pedestrian’s safety. The street in front of a bus stop should be painted with, for example yellow paint and mark out the area of a bus stop. There are options to put a bus stop with shelter in narrow sidewalks, but it will be harder to implement because people still need to be able to pass easily without having to walk on the street. In the picture below you find two sketches of possible solutions for narrow streets.

![Figure 9.6 New bus stop design for narrow streets.](image)

9.4 Current bus stop improvement
There are a few bus stops with shelters and real-time information boards already in Alcoy. However, those bus stops should be improved smarter and with greenery. To save the costs, it does not make any sense if those bus stops would tear down. The best solution is to renovate those bus stops and upgrade them with greenery or smart solutions.

9.5 Improve time schedule
The time schedule in the bus stops could need some improvements, they are hard to understand because the timetable is universal for the whole line, instead of specified for each stop. They only show time when the bus is leaving from the first and the last bus stop. The stops do not have any real-time information boards, only glued timetables on the board. To improve the readability of the time tables the project group suggest to look at figure 9.7 and 9.8 these methods of writing departure times is much more clear and is user friendly to the passengers. The times in these tables do not correspond with the current bus times in Alcoy, the task is to Vectalia to calculate the times for the new lines and add the new times in the schedule and hang them up in each bus stop. Of course it would be much easier to put the same schedule in every stop, but to make using public transport more attractive it would be a great improvement to hang a specified schedule in each bus stop.
NAME STOP; MONDAY TILL FRIDAY

| 06 25 | 06:47 |
| 07:01 | 07:16 | 07:31 | 07:47 |
| 08:02 | 08:17 | 08:32 | 08:47 |
| 09:02 | 09:17 | 09:32 | 09:47 |
| 10:02 | 10:17 | 10:32 | 10:47 |
| 11:02 | 11:17 | 11:32 | 11:47 |
| 12:02 | 12:17 | 12:32 | 12:47 |
| 14:02 | 14:17 | 14:32 | 14:47 |
| 15:02 | 15:17 | 15:32 | 15:47 |
| 16:02 | 16:17 | 16:32 | 16:47 |
| 17:02 | 17:17 | 17:32 | 17:47 |
| 18:02 | 18:17 | 18:32 | 18:47 |

Figure 9.7; Possibility 1 to write down order the different times the bus leaves.

Figure 9.8; Possibility 2 to write down order the different times the bus leaves.
9.6 Cost and investment

Costs of the regular bus stop includes all the construction work, bus stop element, tele and electrical work, working hours, excavator hours, vegetation and equipment of the bus stops. The bus stops should design to easy maintained which saves costs in long term. The bus stops should designed to withstand that the life cycle of the bus stop is long enough to have an investment back along the years. The costs are totally different with designed and unique bus stops. These bus stops must be calculated separately and maintenance must designed carefully to avoid unexpected costs.

The costs are from Finnish price level so they are more expensive than in Spain. Costs are not specific, but they give some direction. This direction give an estimated investment to have new bus stops in Alcoy.

<table>
<thead>
<tr>
<th>Costs</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>The following unit values have been used:</td>
<td></td>
</tr>
<tr>
<td>Demolish old bus stops</td>
<td>€2000</td>
</tr>
<tr>
<td>New high quality bus stops</td>
<td>€50000</td>
</tr>
<tr>
<td>Totally new bus stops</td>
<td>17</td>
</tr>
<tr>
<td>New bus stop, includes</td>
<td>€50000</td>
</tr>
<tr>
<td>Construction work</td>
<td></td>
</tr>
<tr>
<td>Tele and electrical work</td>
<td></td>
</tr>
<tr>
<td>Working hours</td>
<td></td>
</tr>
<tr>
<td>Excavator hour</td>
<td></td>
</tr>
<tr>
<td>Foundation structures</td>
<td></td>
</tr>
<tr>
<td>Vegetation</td>
<td></td>
</tr>
<tr>
<td>Constructions and furnishings</td>
<td></td>
</tr>
<tr>
<td>New bus stop</td>
<td></td>
</tr>
<tr>
<td>In total</td>
<td>€68000</td>
</tr>
</tbody>
</table>

Figure 9.9: table of costs

9.7 Advice

Taking account Alcoy’s circumstances, every solution cannot implement in the city. In the streets where is space enough, totally new bus stops should be implement (or improving existing bus stops). On narrow streets is recommendable replace every existing bus stop with new ones.

Timetables shown at the bus stops, should have exact time table which shown when the bus arrives at bus stop. If there is a real-time information board on the bus stop, it should present delays and other needed information. When there is an analogue timetable at the bus stop, delays and other information can be seen with the application. Time tables should be specified for every bus stop, clear to understand and easy to read.

For short term solution, every bus stop should improve with clear time tables and bus route maps. Also, the sign at the bus stop can be more clear. Long term solution is to build new bus stops with necessary equipment and renovate old ones for new correspondent. Building new or replacing old bus stops, sustainability and Internet Of Things (IOT) should taking account.
10. Free Wi-Fi, GPS-system and Ticketing System

10.1 Free-Wi-Fi
In almost every public space there are Wi-Fi hotspots available. People want to be able to connect their mobile devices to internet at all times. Because of this, a Wi-Fi hotspot is a service that increases the customer’s satisfaction and thus increase the usage of public transport.

The bus company Vectalia said that there are plans for next year to implement a Wi-Fi connection in the buses in Alcoy. The company already has some busses with Wi-Fi in other cities. The problem they experience with the Wi-Fi is that people stay in the busses for a longer time than necessary, because they do not pay for distance. A consequence of this is that the busses become unnecessary crowded. Another problem with the Wi-Fi in busses is that the costs can go up really high if the speed-, data- or time cannot be limited.

10.1.1 Solutions
There are already several products available to provide for a 4G Wi-Fi hotspot service. There are routers, which are designed to use in public transport systems like trains or busses. It offers a 4G connection with 100 available connections with mobile devices and the software offers the availability to limit data- and time usage (Wifibus, 2018).

The free Wi-Fi can be provided in return for the users data, which can be used for other services. The hotspot service can also sell packages to increase the customer’s available data usage.

10.1.2 Cost and investment
The costs will vary greatly based on whether it is chosen to limit the data usage to for example 500 MB or give unlimited data usage. It is recommended to set a data limit on 500 MB on city busses and 2000 MB on intercity busses.

10.1.3 Advice
It is advised to implement this service in the intercity busses sooner than in the city busses, since the internet on mobile devices is worse in between two cities than within a city and the trips of the intercity busses are normally longer.

Although the inhabitants wrote in the questionnaire that Wi-Fi would improve the busses in their opinion. It is not the most important thing, since most people have mobile internet enough to check their mails/whatsapp. Eventually Wi-Fi will be implemented in every bus, but there are other things that should be implemented first.
10.2 Ticketing system

At the moment the Vectalia buses only use a check-in pass and bus tickets, which can be bought at the bus driver. This is an inefficient system, because it provides less data than a check-in – check out system and it is impossible to pay per distance a user travels. A good ticketing system might increase the public transport users, because it increases the accessibility and would be more fair for the traveler. This solution will also provide travel users data by tracking behavior and mobility patterns and in the end could help with reducing the travel time by improving the bus lines (Civitas, Policy advice in ticketing, 2008).

Vectalia is running a pilot project on the app Yupi, which is an application that could be used as a check-in – check-out system by mobile phone. A current problem which will obtain to be a bigger problem in the future is that this application only can be used at buses that are operating by Vectalia, so the railway company and competitors are not included in this ticketing system. The source of this problem is that companies are protect their data from competitors and the public transport users have to use different ticketing systems for each public transport company.

10.2.1 Solution

A solution for this is a new company or department (governmental) which provides a general public transport ticketing system. The data will be available for all companies, which can be used for public transport service optimization.

10.2.2 Cost and investment

The costs vary a lot according to the type of system implemented, to the number of ticketing machines/validators as well as the number of vehicles equipped with the technologies.

The following cost estimation is based on a ticketing system with 16 vending machines and is provided by civitas.eu:

<table>
<thead>
<tr>
<th>Description of investment</th>
<th>Costs in euro</th>
</tr>
</thead>
<tbody>
<tr>
<td>hard- and software for integrated ticketing system</td>
<td>€13.000</td>
</tr>
<tr>
<td>Purchase of 16 ticket vending machines with back-office central management system</td>
<td>€712.500</td>
</tr>
<tr>
<td>Maintenance costs per year</td>
<td>€60.000</td>
</tr>
<tr>
<td>Marketing, promotion and training activities on a new ticketing system</td>
<td>€10.000</td>
</tr>
</tbody>
</table>

The implementation of the ticketing system, however also avoids certain costs. Each transport operator can reduce costs for distributing and selling tickets, because all operators use the same system, resulting in more favorable procurement terms. And the ticketing system leads to a more cost-saving way of ticketing. The implementation of the ticketing system requires about two years (Civitas, Policy advice in ticketing, 2008).

10.2.3 Advice

The advice is this system should be implemented as soon as possible as it has great benefits. The ticketing system should not be provided by just one mean of public transportation, but connect all different public transport operators. It is also not beneficial to have this system for just 1 city, but should implemented in a larger region.

A more detailed description of innovative ticketing systems, the benefits, the implementation steps, timeframe and investments costs can be found in the document civitas ticketing policy advice notes.
10.3 Application for public transportation

At the moment there is no application that gives a door to door travel time estimation for the public transport. It’s hard to find, when, where and how to use the buss in Alcoy when you are not used to it. This is probably a reason for people to not start using it. The Vectalia application route section is still in progress, but this will only apply to their busses. A public transport planner from address to address could increase the public transport users by a lot, because it increases the ease of use for public transport and decreases the time people have to wait for the busses.

The application should also be updated with a real traffic time system, that shows public transport users exactly when the buss will arrive at your stop (delay included).

10.3.1 Solution

Their already exists applications that show the fastest route from door to door based on real traffic time information. An example of this is the “REISinformatiegroep B.V.” This company owns the application 9292 in the Netherlands, which provide for multi-modal public transport or walking journey planner, trip duration estimation, real-time planning and situational info and price information (Wikipedia, Reisinformatie B.V., 2018).

10.3.2 Cost and investment

The company is funded by a yearly fixed contribution of all the participating public transport operators. So this company does not have to be invested in by the state, but can be ran by investments from several public transport operators (9292, 2016) (Wikipedia, Reisinformatie B.V., 2018).

10.3.3 Advice

The advice is convince all the public transport operators in Spain to invest together in such application and to not implement it for just their own company. The public transport users are looking for ways that brings them the fastest from A to B. The lower the travel time of public transport is, the more popular it will become.

Figure 2: Public transport application 9292.
11. Timeline

In the figure above you will find the time of implementing all the final solutions. This timeline is made to achieve the Paris agreement which has the deadline of 2020. To achieve this there is a lot of collaboration needed of the different stakeholders and companies involved in building the project. This will cost also al lot of money that the municipality and Vectalia should invest in a short amount of time. Because of these cons, the project group thinks this plan would not be realistic and stretched the different projects over a longer amount of time. You will find the realistic timeline in figure 11.2.

The order of the project stays almost the same, except for the implementing of Wi-Fi. This is because representative of Vectalia told the project group that they want to launch that in 2019.

In the plan the start of upgrading the public transportation in Alcoy will start with expanding the bus lines, which means that new bus stops need to be added so all the different areas of Alcoy will be reachable by bus. Because of these new routes the timetables will change, when this happens it will be a good moment to also change the format of the timetables. By this moment the users know exactly when the bus is leaving and are capable to reach all places in Alcoy. The municipality could also already change the street “l’Alameda” by this point.

When all the new bus stops are placed it is time to renovate the old once. When this is all done Vectalia could start with a pilot for their app “Yupi” and should find a way to improving the traveling app by combining it with different operators in public transport in the region or on national scale.

When the pilot of “Yupi” was successful the new ticketing system could be implemented.

The stars in the timeline represent the start of undefined incentives and marketing campaigns.
Figure 11.2 Timeline of implementing solution in a more realistic term.
12. Conclusion

What the group found out is that the system needs to change to make it more attractive and more users friendly. One of the biggest problems that arose is the people's habits and the status symbol of having a car. Inhabitants rather use their car to move from place A to place B, than use the bus. But we think if the municipality of Alcoy tries to change the infrastructure of the city and improve the buses and bus stops huge different can be made. By completing this changes, the inhabitants are forced to change their habits.

To reach these goals the municipality can use short and long terms solutions. The project group has made a timeline when and which solution to implement. In this time line, the project group has given time for six years to complete the changes. In that time the group believes that the city of Alcoy is able to achieve the figures in the research question.

The changes are not only depending on the municipality of Alcoy, there are other stakeholders included. Making change for the bus stops and their location also regards advertisement company, Impursa, who is responsible for the maintenance of the stops. If the city council decides to expand the current bus line routes, the bus company Vectalia need to adapt for this change. Vectalia already said that they are willing to change.

Vectalia has already starting to do some changes. They have an experiment going on with new application, Yupi. With that application, paying for your trip gets easier and faster. The company saves money with that improvement, because the driver does not have to turn back and forth in his chair each time and new passenger get in the bus.

The structure of the city is challenging with it mountains and its variable altitude differences. The city is old, it has architecturally beautiful houses, narrow streets and one-way roads in the central. This makes it hard to design new bus lines. Some of the streets are so narrow that there is not space for normal size bus stops. Therefore, the group came up with idea to have slim bus stops in those places. Those bus stops are made to fit on the narrow sidewalks and be easy to find.

The bus routes do not cover all areas in the city. The city has many industrial areas where workers do not have access by bus. Adding bus routes in those specific areas, would increase the number of daily users and save the amount of daily private car usage.

Cooperation with contact persons from Spain, Pedro Ramiro from the municipality of Alcoy and Manolo Llorca and David Gutiérrez Vañó from the Universitat Politecnica de Valencia, went flawlessly. Communication worked well and the group got good information and help when needed.
Recommendation

The recommendation of the group to the municipality of Alcoy is to follow the given solutions in the timeline. One of the most important things where the municipality of Alcoy should put effort in is those parts of the city where the busses aren’t driving. Adding bus stops in those areas increase the bus users a lot. What needs to be planned after this are the timetables that should be planned and scheduled(also in new areas) so that it is suitable for those who are working in the region.

Public transportation it should be marketed to the young people, children, teens and young adults, because if people learn to use public transportation in the early stages their life they might get used to it. It is recommended to give discount to those target groups and inform the organisations, where those people make use off, about the possibility to go by public transportation.

Furthermore, it is recommended to set up a business plan in which a general ticketing system for whole Spain is provided. Based on this ticketing system new optimization plans can be made for the whole public transportation system.
Literature list


## Appendix 1: Current daily bus users

<table>
<thead>
<tr>
<th></th>
<th>Line 1</th>
<th>Line 2</th>
<th>Line 3</th>
<th>Line 4</th>
<th>[ppl/month]</th>
</tr>
</thead>
<tbody>
<tr>
<td>January</td>
<td>36.151</td>
<td>36.238</td>
<td>43.162</td>
<td>8.549</td>
<td>124.100</td>
</tr>
<tr>
<td>February</td>
<td>37.647</td>
<td>37.831</td>
<td>44.788</td>
<td>8.717</td>
<td>128.983</td>
</tr>
<tr>
<td>March</td>
<td>38.366</td>
<td>36.796</td>
<td>44.028</td>
<td>8.855</td>
<td>128.045</td>
</tr>
<tr>
<td>April</td>
<td>37.051</td>
<td>34.429</td>
<td>43.176</td>
<td>8.814</td>
<td>124.611</td>
</tr>
<tr>
<td>May</td>
<td>40.830</td>
<td>41.472</td>
<td>49.082</td>
<td>9.612</td>
<td>140.996</td>
</tr>
<tr>
<td>June</td>
<td>40.670</td>
<td>38.485</td>
<td>46.691</td>
<td>9.476</td>
<td>135.322</td>
</tr>
<tr>
<td>July</td>
<td>34.260</td>
<td>29.408</td>
<td>37.331</td>
<td>8.330</td>
<td>109.829</td>
</tr>
<tr>
<td>August</td>
<td>25.692</td>
<td>20.723</td>
<td>22.713</td>
<td>7.435</td>
<td>76.563</td>
</tr>
<tr>
<td>September</td>
<td>38.610</td>
<td>37.969</td>
<td>45.583</td>
<td>8.813</td>
<td>130.975</td>
</tr>
<tr>
<td>October</td>
<td>40.242</td>
<td>42.988</td>
<td>46.174</td>
<td>9.655</td>
<td>139.059</td>
</tr>
<tr>
<td>November</td>
<td>39.790</td>
<td>45.442</td>
<td>47.618</td>
<td>9.952</td>
<td>142.802</td>
</tr>
<tr>
<td>December</td>
<td>36.721</td>
<td>40.903</td>
<td>42.843</td>
<td>9.223</td>
<td>129.690</td>
</tr>
</tbody>
</table>

[ppl/year/line]  
446.030  442.684  514.330  107.931  

in total [ppl/year] 1,510.975  
Average [ppl/day] 4.140  
Total users at the moment 6.90%