# Αλληλεπίδραση Ανθρώπου – Υπολογιστή

*Σχεδίαση διαδραστικής παρέμβασης/εμπειρίας για έξυπνες πόλεις*

## Smart Move


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# (1) User requirements / feasibility of intervention

Starting with the design of our interactive intervention, we had to consider all the requirements of our potential users and act accordingly. First of all, let's start with the interactive intervention which is the fastest movement of citizens within the city of Ioannina. This is achieved by giving priority to city bus traffic specifically on Dodonis Avenue, the busiest avenue in the city.

First of all, users of the intervention had to be found and grouped (primary users, secondary users, tertiary users). This was done and we discovered that our users are many more than we initially thought and they have specific requirements, depending on the group they are in.

Primary users are those who interact directly with the system frequently. These users are the citizens who use the web application to travel by public transport, the public transport workers who monitor the traffic regulation software through the smart communication of traffic lights and city buses, and the disabled .

For citizens who use public transport, we know that they demand speed, convenience and safety in every journey they make. These citizens, for the most part, are students and workers. According to questions we made to students who use the city buses, we were able to understand that their main problem is the low frequency of the routes resulting in the delay of their arrival at the university campus or the large crowding inside the bus.

So the students are demanding an increase in routes but also consistency in the arrival times of city buses at each stop. With the interactive intervention that we propose as a group, we intend, in collaboration with the "KTEL" company, to re-schedule the routes of specific buses that pass through Dodoni Avenue and also to help the users of public transport to better and more easily organize their weekdays their movements, through the web application we created, which offers real time data about the location of the buses and their arrival time at each stop, as well as online purchase of tickets for each category of travel.

People with special needs in Greece face daily problems in their movement. It is observed every day that the footpaths and infrastructure at crossings are incomplete in Ioannina. The specific users require security in their movements and facilities in the use of city buses.

People with mobility problems who use a wheelchair should know whether they will be able to enter a bus, given that the bus in question has disabled seats. Also, visually impaired people need to know that it is safe to cross a crosswalk or walk on the sidewalk.

The feature in the web application for monitoring seats for people with special needs in a city bus is a priority. Also, installing APS (Accessible Pedestrian Signals) on traffic lights will make it easier for visually impaired people to cross the crossings safely.

Secondary users are users who use the system less often or through an intermediary. Public transport workers in general are included in this category. We know that these users require professional rehabilitation and future-proofing. By investing funds in public transport and effectively implementing our interactive intervention in the city of Ioannina, more jobs will be created in this sector. A fact which will positively affect the lives of secondary users on a professional and, by extension, on a social and economic level.

Finally, third-party users, i.e. users who never use the system directly, but are affected by its introduction. These users are car drivers and commercial vehicle drivers. These users obviously demand faster and easier daily commutes.

The continuous increase in the needs for supplies and essential items from the stores, make the commuting time of commercial vehicle drivers the highest priority in their daily work. Also, safety in movement is an equally important requirement of the specific users.

Car drivers have similar requirements to commercial vehicle drivers. They too require faster daily commutes to fulfill their professional or non-professional obligations. The traffic congestion that prevails during peak hours on Dodonis avenue, intensifies the problem of commuting time and has a negative effect on certain psychological areas of the citizens.

For this group of users (third-party users), we believe that our intervention will result in a 20% reduction in travel time within Dodoni Avenue in total. Based on this effect, we can also carry out our transition to the positive effect of our intervention on the sociability of the daily life of citizens as well as on the smooth movement of the local market.

All of the above, however, could not have been formulated if there was not a clear goal and feasibility of the interactive intervention that we propose. As already mentioned in the first stage of the delivery, the proposal of our interactive intervention for smart cities is the fastest movement with city buses and by extension I.X and commercial vehicles within the city, with an interaction system between the bus and the traffic lights located at an intersection. In this way, the movement of city buses is facilitated to reach each of their destinations faster with the appropriate setting of the traffic lights (green when they are approaching or green is extended). Here to mention, that according to research on similar interactive interventions that have been implemented in New York City, giving priority to bus traffic has the effect of reducing travel time and the remaining vehicles within the specific street. [Source: www1.nyc.gov]

Also, apart from the IOT solution proposed, we will focus on an application intended for use by the citizens of Ioannina. Our software will offer helpful solutions for daily commuting by bus within the city. The main features will be finding the location of the buses and the estimated time of their arrival at each stop, the online purchase of tickets, information on the routes as well as news to inform the citizens.

With the interactive system we propose, several things are pursued at a social, environmental and economic level. First, based on the studies they have

carried out in similar actions that have taken place in New York, a reduction in the travel time of buses by 20% is observed. It is therefore also our goal to reduce the order of 20% in the city of Ioannina as well. [Source: www1.nyc.gov]

Moving to the environmental level, our goal is to reduce the production of carbon dioxide by 50%. We think that something like this would be possible after first reducing the travel time of the buses and also after replacing most of the buses with electric ones. The replacement of fossil fuel-powered buses with electric ones has been carried out in the city of Oslo and a 50% reduction in carbon dioxide emissions has been observed in 2020 compared to measurements made in 1990 [Source: www.theguardian.com ].

As we have already mentioned in the previous stage of the work, the citizens of Ioannina will begin to prefer traveling by bus, knowing that they will reach their destination faster and easier. In this way, they will not use their cars as often, resulting in a reduction in their emissions and the traffic in the city.

We will also focus on the most important level, the financial one. According to research that has been carried out, public transport is a big factor in national and local economies through the jobs they directly provide. The investment of capital in the specific sector creates a chain reaction in economic activity that is equivalent to three or four times more capital than the initial investment. Our main goal is that with the realization and effective implementation of our idea in the city of Ioannina, new jobs will be created in the field of public transport and there will be a positive impact on the local economy.

Finally, we should never forget people with special needs and the facility they should have in their daily movements. We are already researching solutions related to traffic lights and the visually impaired. Installing acoustic technologies (APS) that help these people understand when a traffic light is red and when it is green, so that they can safely cross pedestrian crossings is one of our main priorities in this project.

## (2) Final interactive intervention design

Starting from the description of the idea for an interactive intervention for Ioannina, and continuing with the initial design and a small presentation of it, we reach the point of the final design where everything (if anything) changed during these months above on topics such as users and their analysis, task analysis, indicative usage scenarios, similar systems, description of main screen features and finally hardware and cost estimation.

#### 1. Description

The system does not have some changes in its basic concept. It is divided into the IOT part, which is the installation of laser sensors on traffic lights at the intersection of Dodoni Avenue and Kenan Mesare, which will detect the movement and distance of

city buses from the traffic lights, which in turn will give priority to them, either by lighting a green signal, or by extending the already existing green signal.

The second part that will be the simulation that will be implemented by our team is the web application. It is an application that will make it easier for citizens to travel by city bus. The application will provide specific but essential features (Bus location, online ticket purchase, routes, news), in an easy-to-use User Interface for most citizens.

## 2. Successful systems with similar functionality

As a successful system with very similar functionality, remains the intervention that has been implemented in the city of New York, with the smart communication system with traffic lights and buses on the B46 SBS line. It is a line that includes 13 stops and extends from Utica Avenue to Malcom X Boulevard.

In this particular line, in addition to the IOT system, other infrastructures are included such as:

- ticket counter
- dedicated bus lanes extending as far south as Church Avenue
- Significant improvements in attitudes such as:

1. Real-time information about passengers
2. Sidewalk extensions at specific stops
3. Pedestrian safety improvements in large and complex intersections
4. New benches, tree plantings and shelter

With all these measures that took place on the specific avenues of New York between the summer of 2014 and 2017, a reduction of the travel time on the B46 line, which is used daily by 50,000 citizens, was achieved by 15% and a reduction of up to 25% in the travel time of all of other vehicles moving in the busiest lane of the road. [Source: www1.nyc.gov]

Finally, another system that has been crowned with success and has to do mainly with the problem of carbon dioxide emissions that we also want to deal with, is located in the city of Oslo.

In this intervention, buses powered by fossil fuels are replaced with modern electric buses. But apart from that, there is a plan to completely ban car traffic in the city center and invest in the electric bike market and studies that will help reduce the traffic problem.

Based on City Hall estimates, with these measures carbon dioxide emissions can be reduced by 50% in 2020 compared to 1990 and traffic congestion can be reduced by 20% by 2020 and by 30% by 2030.

# User Analysis

The groups of users who will use our completed project consist of a large number of citizens.

**Primary users**: The primary users of our intervention are those who interact directly with the system frequently. So these users are the citizens who will use the web application to travel with M.M.M., M.M.M. workers who monitor the traffic regulation software through the smart communication of traffic lights and city buses and People with Special Needs. For the citizens who use M.MM.M, we know that they require speed, convenience and safety in every movement they make. But in addition to the speed of travel, our plans to help people with special needs also have a positive effect in terms of sociability.

**Secondary users**: Secondary users are users who use the system less often or through an intermediary. This category includes M.M.M. workers in general. Based on studies, we know that with our intervention and the investment of funds in it, with the aim of its effective implementation in the city of Ioannina, several jobs will be created in the transport sector. This will positively affect the daily life of a large portion of citizens from an economic point of view.

**Frictional users**: These users never use the system directly, but are affected by its introduction. These users are car drivers and commercial vehicle drivers. For this group of users, we believe that our intervention will result in a reduction of their travel time within Dodoni Avenue by 20% in total.

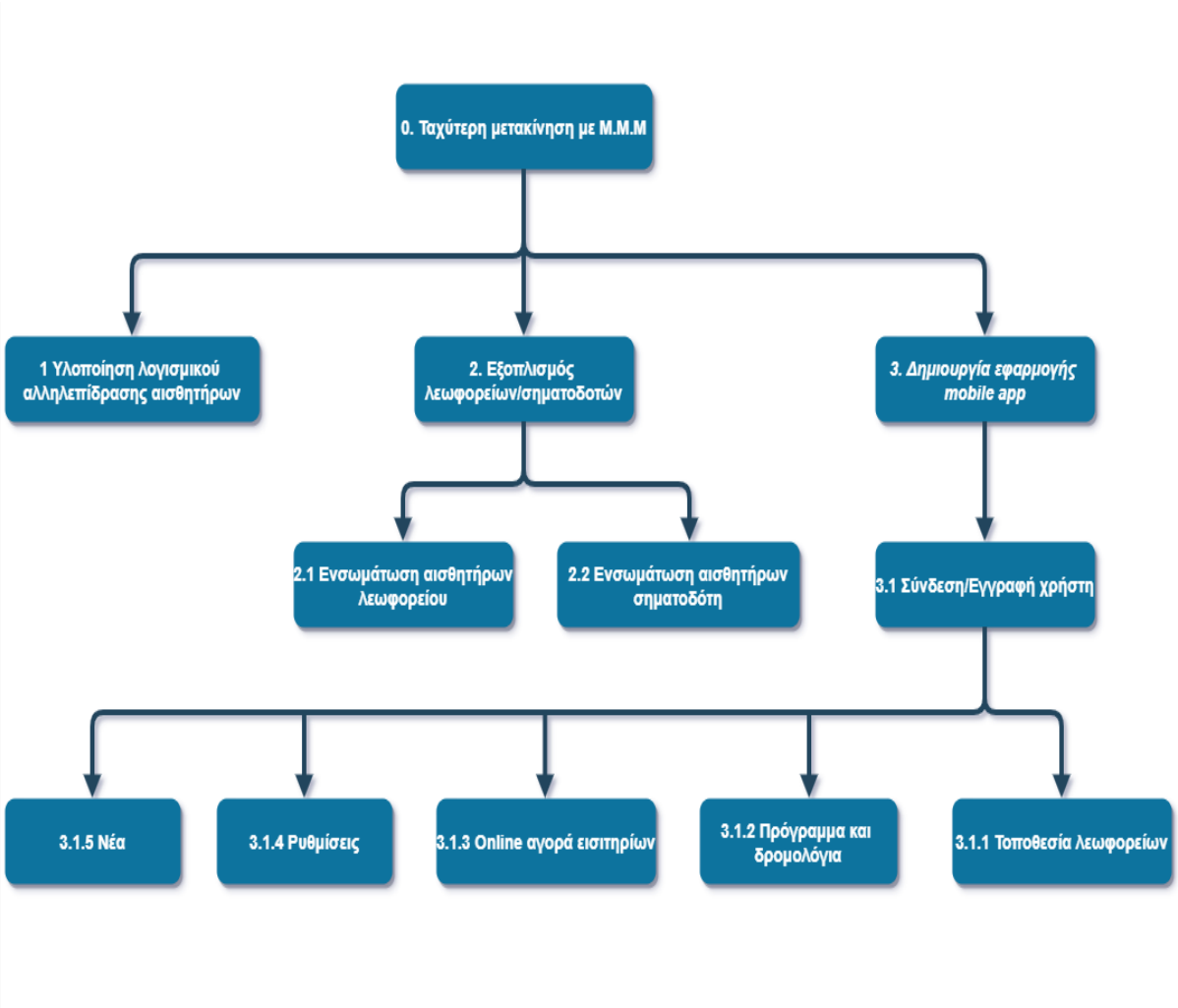
In summary, according to what we have mentioned we can observe that our intervention concerns a very large share of the citizens of Ioannina and has a positive effect on social, ecological and economic aspects of their lives.

# Analysis of Interactive System Tasks

The analysis of tasks mainly depends on the requirements of the users. There are many cases where users are unable to describe what they need to achieve their goals. For this reason, we created a hierarchical analysis model, with the aim of giving users answers to important questions such as:

- What is he trying to achieve with each task?
- What is the reason for trying to achieve it?

Hierarchical analysis makes it possible to break down the main functions into individual sub-tasks, so that it is understood what the main goal is and what actions are required by the user or the system to achieve it.




**Target**: Faster movement using Public Transport.

## Indicative System Usage Scenarios

The system that we propose with our team aims to make everyday life easier for our fellow citizens by making the use of public transport more accessible and optimal. This is achieved in 2 ways:

- Faster transport with their use, which also contributes to reducing the waiting time at each stop.
- Implementation of a web application where it will be quite user-friendly.

In this part we will analyze the usage scenarios of the application by the users (ie the 2nd way mentioned above).

### Step 1

First, the user must register in the system, in case he is already registered, then he does Login.

### Step 2

Then, after the user has logged in to the system, he is offered the following sequence of functions that he can use:

1. Location of buses
2. Schedule and itineraries
3. Online purchase of tickets
4. Settings
5. News

### Step 3

If the user has chosen one of the above functions then we have the following scenarios:

1. Login, Register→Bus Location→Select Stop→Print FromData(Bus_ID, Arrival time at the specific stop, disabled seats).
2. Login, Register→Schedule and routes→ Select route →Print from Data (Itineraries registered in the Data base)
3. Login, Register→Buy tickets online→Buy a ticket→Select a Ticket (student, normal, etc.)→Go to a secure environment to make the transaction→Choose yes the transaction receipt is sent via e-mail→Print fromData (Receipt of transaction, ticket_ID, time of purchase)
4. Login, Register→Buy tickets online→My tickets→Valid→Print fromData (Receipt of transaction, ticket_ID, time of purchase)
5. Login, Register→Settings→Changee-mail→Print fromData (New email)
6. Login, Register→Settings→Change Password→Print fromData()
7. Login, Register→New→Print fromData()

## Description of Characteristic Basic Screens

After peer-reviewing the interactive intervention design, we gathered their feedback to improve our app design. Specifically, questionnaires were made available as well as interviews, from which we drew very important conclusions for planning and implementation.

What we want to achieve is that any user can use the application, without needing some kind of learning. Every user is likely to use our application daily and even several times a day, for him

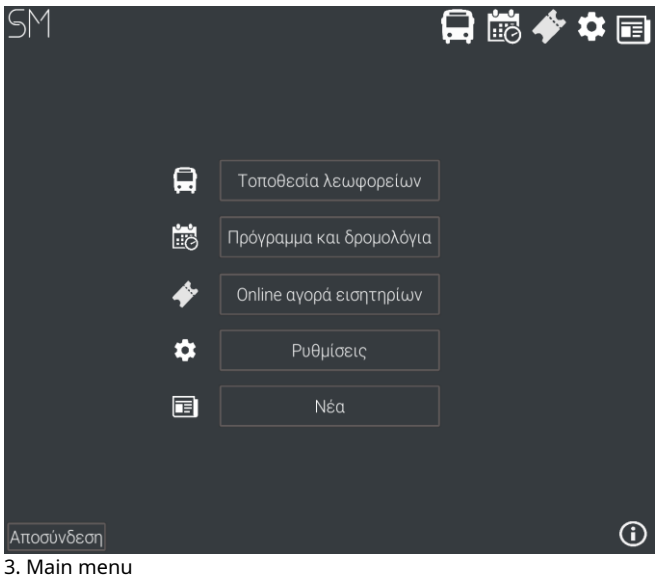
that's why we made sure the design was as simple and comprehensive as possible.

Opening the application, there is the logo and motto of the project at the top, below the fields where the user connects if he is already registered (see Figure 1), otherwise he chooses registration to become a member (see Figure 2).

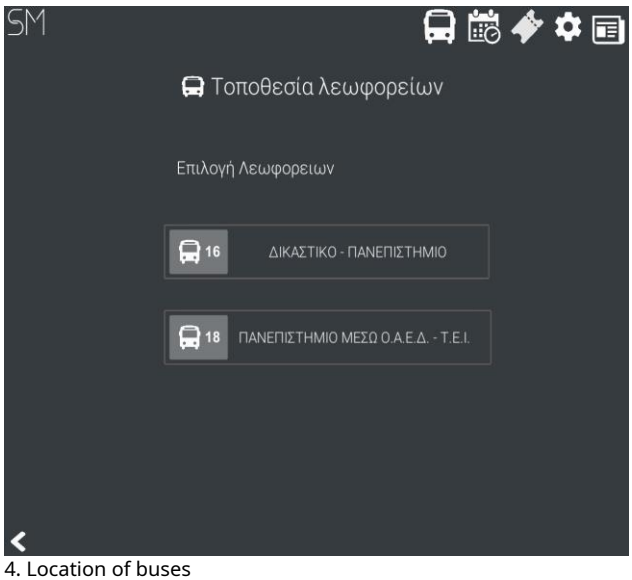
1. Login/Register

2. New member registration

**Main menu** : The user has to choose between the five most basic features of the application (see Figure 3). There is also the info button at the bottom right and the back button at the bottom left. The back button ( < bottom left of the screen) will be on every page that needs it. To the left of each option there are familiar icons, which correspond to the content of each option and make the experience of using the application more familiar and immediate. Also in the upper right are the functions with their badges for advanced users. More specifically, the main features are the five: Bus location, Schedule and routes, Buy tickets online, Settings, News. Each option also leads to its corresponding page.



3. Main menu

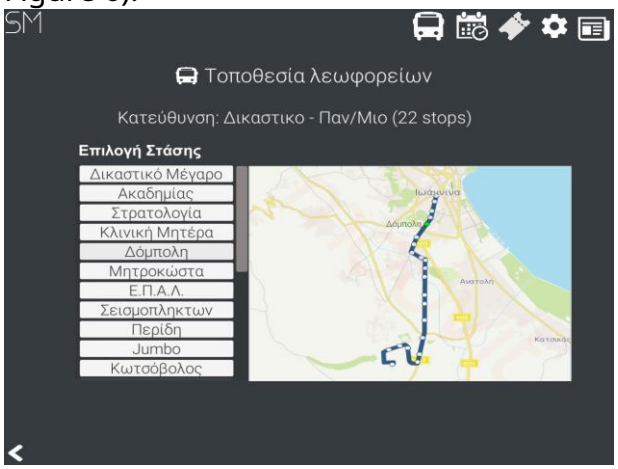


4. Location of buses

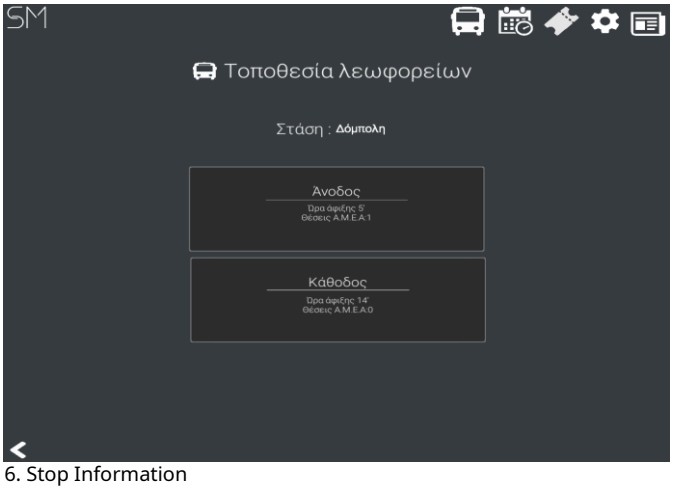
**Info** : It includes information such as, why someone would choose to travel with M.M.M and below we mention the creators as well as the version of the application.

**Location of buses** : On this page the user can choose the bus he wants to use (see Figure 4). After choosing, the route with all the stops is displayed

carried out by the bus (see Figure 5). He also has the possibility to choose any stop he wishes to see the arrival time and the free number of seats for A.M.E.A. (see Figure 6).



5. Route stops

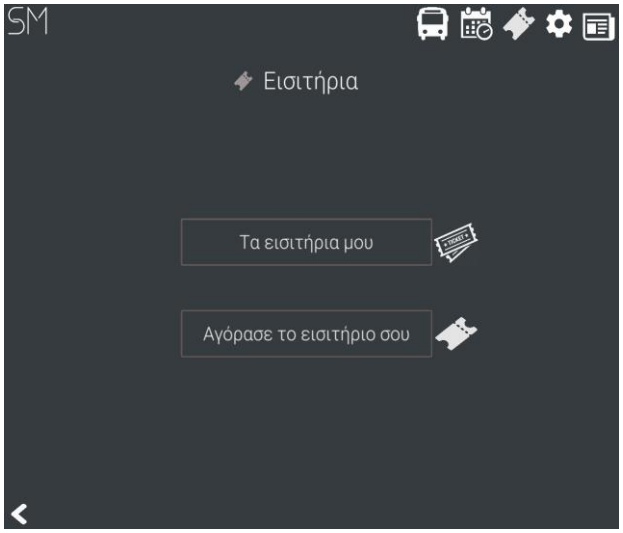


6. Stop Information

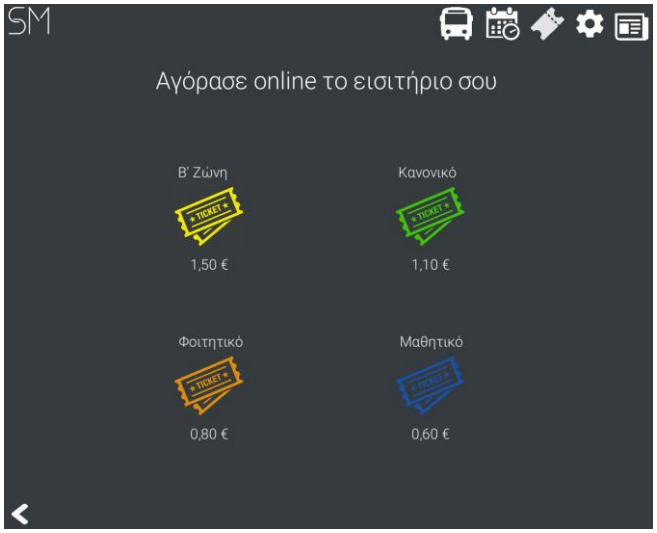
**Schedule and itineraries** : The user selects the program valid for the specific period (winter/spring) and below has the option to select a specific route. Then, by pressing the "Search" button, the days and times of arrival of the bus will be displayed.

**Buy tickets online** : Initially there are two options, *My tickets* and *Buy it your ticket* (see Image7).

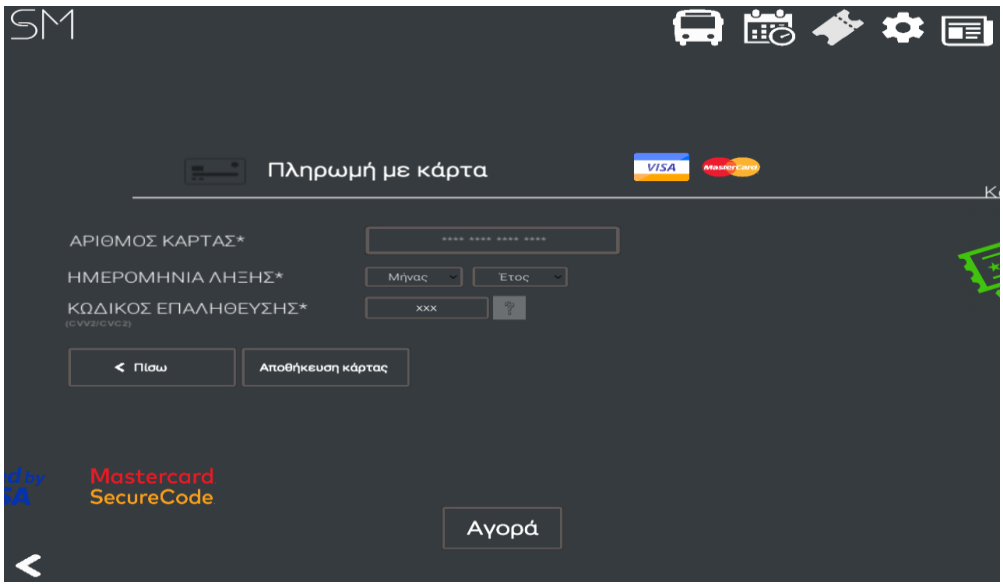
- *My tickets* : On this page there is information about valid tickets and validated tickets.
- *Buy your ticket* : in the center of the screen there are the tickets with the corresponding color (see Figure 8), above each one is written its type and below the price respectively. When the user selects their ticket, they are taken to a secure location of a partner bank so that there is no fear of their personal data being stolen (see Figure 9).



7. Ticket purchase



8. Ticket selection



9. Payment by card

**Settings** : The user has the possibility to change either the already existing password or the e-mail address stated during registration. For security reasons, the current password is required before making any changes.

**News** : On this page the user will be informed about any changes in itineraries, emergency itineraries, holiday schedule and more general information about traveling by public transport.

## Logistics Infrastructure/ Cost Estimation

Finally, we will move on to the required logistical infrastructure needed to carry out our intervention in the city of Ioannina as well as a cost estimate for this infrastructure.

### Required Hardware Infrastructure

1. Electric Bus.
2. Laser sensors in traffic lights.
3. APS(Accessible Pedestrian Signals) at each traffic light of the intersection.
4. QR Code Scanner/ contactless card transaction machine.
5. Software for traffic control through laser sensors on traffic lights and buses.

6. Software for citizens with possibilities to locate buses, buy tickets online, display routes, etc.

At this point we should mention that our intervention will begin

on a trial basis using 1 electric bus and will concern traffic mainly at the large central intersection of Dodoni Avenue, Kenan Messare and Dombolis. The traffic lights that will be equipped with the Laser sensors and APS systems will be located in the most central traffic lights of the city and are 6 in number. Also, apart from the electric bus, the machines with the QR Code Scanner will be placed on all the buses that pass through Dodonis Avenue.

After clarifying the aforementioned, below we will also mention the cost estimate for the logistical infrastructure:

**Cost estimate**

Electric Bus:**(Model Find and Supply) (1 employee of the Municipality) x (1 working month)**

6 Laser Sensors:**(Find Model, Supply, Install and Proper Operation) (3 employees of the Municipality) x (1 working month)**

8 APS Units:**(Find Model, Supply, Install and Proper Operation) (3 employees of the Municipality) x (1 working month)**

10 QR Code Scanners/POS:**(Find Model, Supply, Install and Correct operation) (3 employees of the Municipality) x (1 man-hour)**

Software for traffic control through laser sensors on traffic lights and buses: **(Implementation,Testing) (5 developers, 10 bus drivers, 4 MMM employees for testing) x (12 workers)**

Software for citizens with bus locator, online ticket purchase, route display capabilities: **(Implementation,Testing) (5 developers, MMM employees) x (10 workers)**

## (3) Valuation/evaluation

As part of improving our project, we conducted a mini-interview. The purpose of this was to be able to perceive any ambiguity that exists and to correct it before the application is completed. Of course, not only did we fix some not-so-understandable functions for the general public, but we enriched the system with more essential features, the need for which arose through the feedback we received from the public. We also increased the feedback the user receives when performing a function. Of course, this was done with a central idea, that the final product should not be annoying but pleasant and above all easy to use.

We have found that citizens are ready to accept new technologies in their daily lives, and after the evaluation we received, we are able to provide appropriate solutions related to the reduction of daily commuting time.

We know that the time that every citizen spends every day commuting plays a catalytic role in their psychology as well as in their social life. Below is the opinion of the polled public regarding our idea and its initial implementation. We present the way through which we were led to any changes that were necessary, but also to the radical re-design that was finally done in the graphic environment.

To the question *"You think that traffic congestion in Ioannina is a major problem issue;",* the respondents answered positively and indicated that there is a shortage of urban buses, the roads are in bad condition and that parking is a very difficult process in the city center.

When we asked them to tell us, what comes to mind when they hear the term smart mobility, we got different answers. They believe that when talking about smart travel, it is necessary that it be short and above all safe. They also imagine self-propelled vehicles, which communicate with each other, but also with traffic lights, which of course are now redundant. It was also pointed out to us that our own intervention can be considered a smart move.

Then, we asked if they think that the existing infrastructures for A.M.E.A. in the city of Ioannina are sufficient. Most of the respondents answered that the infrastructure for the disabled does not fully cover the needs of these people, especially in the buses.

To the question *"You think putting sensors in traffic lights intersections would be a good way to reduce traffic congestion",* the respondents answered that traffic congestion would definitely be reduced by placing sensors because the biggest problem is created at intersections. They also mentioned that in their opinion they need more buses that will operate in the evening hours.

To the question *"You think the environmental problem of its carbon dioxide emissions carbon can be solved by replacing existing buses with electric buses?"* the respondents answered that the main factor is the new technology vehicles vehicles, followed by the replacement of buses with electric ones.

In conclusion, we asked if they believe that an investment in the public transport sector will have a positive effect on the general economy of the city of Ioannina. Respondents agreed that it would indeed have a positive effect as it would encourage more people to use public transport resulting in overall market movement.

So taking these answers, we drew some conclusions. Citizens use public transport every day, but despite everything, they realize that in 2020 they look outdated. If the choice of these becomes more frequent and more attractive, the traffic problem in the city center will be reduced, and this will result in faster and more pleasant commuting.

The lack of many routes and evening hours of operation are a significant problem. As well as the incomplete infrastructure for A.M.E.A., these also contribute to the difficulty of movement. Some roads that are in not so good condition add to their burden. As the time a citizen spends daily commuting is valuable, we must provide a solution so that it does not negatively affect their psychology and social life.

Recapitulating, we are led to the conclusion that citizens have the need to modernize their daily life in terms of their movements. Our goal is for the city buses of Ioannina to become a priority in every citizen's daily commute.

Then followed a questionnaire about the experience of using the application that we presented to the group.

Regarding the initial design of our application, the majority found it very easy to use with one case finding it not so easy. So we made sure that the parts of the application that we thought needed improvement in terms of understanding, are now clear to every user, familiar with technology and not.

Regarding the desired frequency of use of our application, the answers we received were not as expected. With the average responses well above average, but not close to our desired limits, we reduced any unnecessary features and improved the feedback the user receives.

To the question *"How important do you consider the help of an expert to use it? application?",* the answer was clear that anyone, regardless of experience, can browse through it and make the most of it. So we, having this as the main criterion in the completion of the application.

Regarding the existing learning tools and indications of application use, our respondents indicated that they were not enough. For this reason, where we felt that some addition was necessary, we proceeded with it, without of course the redundancy of indications and pointless information, since our design is guided by a minimal and at the same time easy-to-use profile.

To the question *"How connected are the functions of the application to the purpose that does he want to succeed?"* the majority answered with nine out of ten, so we took that into account as well each function we tried to be even more accurate but also short in its implementation.

The next question was, if they think that our application is aimed at the whole range of ages, from children to the elderly. The average number of responses was close to eight. This bothered us and we made sure to reduce the number of steps of some functions so that they are not confusing when searching. We know that younger ages are much more familiar with the use of any new technology, so it was obvious that we should target.

In terms of how effective they think our app is, the average response was just over eight out of ten. Having made the above changes, we believe that its effectiveness has increased. This criterion has a direct connection with the next question concerning the flexibility of the system. The team responded that the system was already flexible enough, so with these changes, it remained consistent in that feature and maybe even improved.

In the next question, regarding the consistency of the application, the respondents answered nine out of ten. That means we could make changes to make it more consistent, and we think we did.

To the question *"How hard is the app to understand?",* only one case answered with three out of ten, i.e. a little difficult to understand, with the rest agreeing that there are no points that are not understandable. So by enhancing the application with explanations where this is necessary, we consider that there are no more concepts and functions that are not fully understood.

Finally, we asked how easy they found the app to use, with the average being five and a half out of ten. We thought this was due to the not so good communication of the app's functions. Nevertheless, we redesigned the application, studying the graphical environment and the user experience so that there are no ambiguities and difficult concepts.

## (4) Presentation of Final Interactive Intervention with Examples.

In order to fully understand the interactive intervention of our team, in this section, we will list some examples about how it will work effectively both in the IOT part and in the part of the web application.

Let's start by first analyzing the IOT part of our intervention. As mentioned above, the IOT part consists of an interaction system of urban buses and traffic lights. The bus, when approaching a traffic light placed at an intersection, will be given priority by changing the red signal to green or extending the time of the already existing green signal.

Below is an example specifically for the area where the above installation will be applied. The installation will be installed at all the traffic lights at the intersection of Dodoni avenue and Kenan Messare. The intersection in question was chosen because the biggest traffic problem during peak hours occurs there and these 2 roads serve the majority of citizens in their daily commutes.

### Example 1

The city bus "16" which serves the majority of students and its line is "Court-University" starts from the starting point. It passes through Dodonis avenue without any particular problem until the "Dodonis-Kenan Mesare" intersection. There, laser sensors will be installed on all traffic lights of the intersection. Laser sensors can record the size of an oncoming object and the distance between sensor and object. The laser sensor will recognize the oncoming bus and directly send a signal to the traffic light through an IOT software. This signal will either be a command to the traffic light software, to flash a green signal from a red one, or to extend the time of the already existing green signal.

Once the traffic light receives the command and executes it, then directly everyone else at that intersection must adjust accordingly to regulate traffic and avoid accidents. All vehicles behind the traffic light that gave priority to the bus will pass with it.

It is therefore observed that a smooth movement of the bus takes place in a shorter period of time.

### Example 2

A different example in our final intervention, is the case, at the particular intersection, where there are more than two buses at the intersection. Suppose we have two buses on the rise and fall of Dodoni Avenue. In this particular case, there will be no issue in the regulation of the traffic lights, since they cross different directions on Dodonis avenue.

However, in the event that there are four buses on the intersection, i.e. two that cross Dodonis avenue (up and down) and two others, one of them should pass through Kenan Mesare, in the direction of Dodonis or Domboli, and the other, respectively, should pass Domboli, in the direction of Dodonis or Kenan Mesare, the appropriate priority should be given and all traffic lights adjusted accordingly. In this case, priority will be given (according to K.O.K) to buses crossing Dodonis Avenue, which is also the priority road in

specific intersection.

Moving now to the second part of our intervention, quite different scenarios will be observed from the IOT part. The second part as mentioned above is the web application. The web application was designed exclusively for citizens who use a city bus for their daily commutes or even less frequently. It contains the features "Bus Location", "Online ticket purchase", "Itineraries", "News" and "Settings".

Then some examples will be given that will make the understanding of the web application part easier for the reader.

**Example 1**

In the first example, we will assume that the user of our application is a student of the University of Ioannina or TEI of Epirus, who use the buses numbered "16" and "17" respectively. This particular student is at home getting ready for his day. It should also be mentioned that this student does not have a ticket in his hands.

The first thing it does is open our app. If he is a registered user then the application automatically logs in and redirects him to the main menu. While in the main menu, he opens "Bus Location" and through it he can see exactly the estimated time of arrival of city bus "16" at the stop "Domboli" from where he will board. He can see that the bus will take 10 minutes to reach this stop, so he calculates his preparation time in order to catch up.

Soon after, he thinks he doesn't have a ticket and won't be able to get one on his way, either because there's no booth, or because he doesn't have cash. It goes back from the “Bus Location” page in the main menu and opens “Buy Ticket Online”. Through it he can buy his ticket online. When the online market opens, different types of tickets are presented (Student, Student, Full, B zone). He selects Student and the application directs him to the payment page. On this page, if they have not filled in their card fields before, they will be prompted to do so and will be presented with the option to save their card for faster future transactions. Our example student,

Finally, when he goes to the stop and boards the bus, he can validate his electronic ticket with the unique QR code.

**Example 2**

In the second example, we will assume that the user of our application is a person with special needs and uses the bus for his commute. It is well known that, for these people, commuting is quite difficult every day and especially with the city buses and the large number of passengers that move in them.

Therefore, they must be informed correctly and in time about how many seats for PWDs are available on each upcoming bus. So, this person automatically logs in if they are already registered in the application and the main menu is displayed. Then, he clicks on the option "Bus Location" and in addition to the arrival time of the bus at a certain stop, he is also shown the number of seats available for PWDs on it.

In the last part of our intervention, we focus on helping people with special needs in their daily movements. Below is an example for people with visual impairments.

**Example 1**

In this example, the Accessible Pedestrian Signals (APS) system used worldwide to make it easier for visually impaired people to cross pedestrian crossings safely will be explained. As a pilot, these APS units that we mentioned above will be installed at the most central traffic lights in the city, at the busiest crossings.

So, a visually impaired person walks along the Epirus district building in order to cross the 2 pedestrian crossings at the traffic lights at the rise of Dodoni avenue, and reach the central square. As it approaches the first crossing, it hears the sound produced by the APS units and is informed whether the traffic light at that crossing is green or red and crosses safely. The same thing happens at the next crossing as a result of which he crosses the road safely and reaches his destination.

## (5)Simulation Description

The simulation that has been implemented by our team concerns the citizens of Ioannina and more specifically those who use public transport as their means of transportation. The primary goal of our team is to make every citizen's experience with city buses more pleasant, so that it is in their preferences when they need to move. The approach we chose concerns the creation of a mobile app that will interact directly with the user and will inform him appropriately.

More specifically, the Smart Move application provides the following possibilities to the user:

1. Create Account
2. Account connection
3. Exact arrival time of the city bus from the stop attended and availability in A.M.E.A. positions.
4. Detailed schedule inventory of each bus
5. Online ticket purchase
6. Show tickets that have been purchased
7. Ability to change password andlogin email
8. Update with the latest developments concerning city buses
9. Log out

**1theMode**

The user must create an account by filling in the mandatory fields placed appropriately. If any of the fields are missed then an appropriate message appears and notifies the user. There is also a control where the code that the user wishes to set is classified into three categories (weak code, average code, bad code). After he has placed the code he wants and at the same time accepted by the system, then he must verify it in the field below, where a message appears informing the user if the codes match. When his registration is complete, then a welcome message appears and redirects him to the main menu.

Creating an account is a mandatory step, as there is a database with each user where the ticket purchases that have been made are stored.

**2theMode**

If the user already has an account, he can log in with his details and proceed to the main menu of the application. When he places his information in the appropriate fields, the database is checked and if there is a match, then the connection is made. If the connection is successful, an appropriate message appears on his screen and informs him, otherwise he is asked to enter his details again. When his connection is complete he goes to the main menu where he can continue his experience.

**3theMode**

The user can now through the application know at any stop the arrival time of a city bus in real time and how many available A.M.E.A. seats there are. When the specific function is selected, the city bus schedules are printed on the screen. After he has chosen the route he wants, he goes to the point where he has to choose the stop. At this point, the map with the route followed by each route with all its stops is displayed. At each stop that is on the map there is a message that is activated when he selects it and shows him its name. This way the margin of error is ensured by the user in case he does not know the name of the station he is on.

In order to print the specific data for each bus, there is an update process for each bus and the system server. Once this step is done then the data is printed on the user's screen uniformly.

**4theMode**

In this function the user can be informed about city bus schedules. After he has chosen the route he is interested in, you print on his screen a table with three columns (daily, Saturday, Sunday), where in it are all the timetables for the route he has chosen.

**5theMode**

It is possible through the application for the user to purchase tickets. When the specific function is selected from the menu, the available ticket categories are displayed (student, 2nd zone, regular, student) to choose one of them. He then goes to a secure environment where he is shown the ticket he wishes to buy and the fields to fill in his card details. He can also choose to save his card details for future purchases, so he can avoid having to fill them in every time. If he has chosen to save his details, then in his next purchases his card will be displayed and he can immediately carry out the transaction he wishes.

When the transaction is completed, the user goes to the ticket window, where you display an appropriate message about the purchase that has been made. Also in this window you give him the possibility to make a new ticket purchase again or to see the tickets he has already bought.

### 6theMode

The user can now see the tickets he has purchased. Tickets are divided into two categories based on their validity (valid, non-valid). The first category includes tickets that have not gone through the special machine where they will be scanned and remain valid. The second category includes tickets that have been scanned and are no longer available for use by the user.
Each ticket has a barcode, date of purchase and an ID indicating its type. In this way, the user can know at any time what he needs for the tickets he has purchased.

### 7theMode

In this particular mode the user can change his password and email. When selected it refers the user to a new window where the user name used is printed and 2 options (Change password, change email). For the first option (password change), three fields are displayed that must be completed if you wish to change the password. The first field refers to the current password used by the user, in this way we validate his identity. Then the second and third fields concern the new password he wishes to enter. The same logic that you use in the registration applies to these fields. For the second option (change email), 2 fields are displayed, one of which is for him to enter his code to be validated again and the other is for him to enter the new email he wants. For each option that has been completed correctly, an appropriate message is displayed to the user informing them.

### 8theMode

This feature is about the news and latest developments of city buses. In the event that a change is made to a route, the system informs you in time and prints the changes that are about to occur to the user.

### 9theMode

The last function is about disconnecting the user from our application. If he chooses to log out there is a button where he completes the log out and refers him to the initial login menu.

# Delivery of Software

Below is the link to the web application emulation repository:

https://github.com/mulonas/AllilepidrasiAnthropouYpologisti