My-TRAC

MY TRAVEL COMPANION

Deliverable D4.2
Affective and Persuasive HMI concepts and models

Project funded by the European Union's Horizon 2020 Research and Innovation Programme (2014 – 2020)

Shift2Rail

Contract No. H2020 –777640

D4.2 Affective and Persuasive HMI concepts and models

Due date of deliverable: 31/08/2019

Actual submission date: 15/09/2019

Start date of project: 01/09/2017 Duration: 36 months

Dissemination Level		
PU	Public	X
CO	Confidential, restricted under conditions set out in Model Grant Agreement	
CI	Classified, information as referred to in Commission Decision 2001/844/EC	

Document Control Sheet

Deliverable number:	D4.2
Deliverable responsible:	CERTH
Work package:	WP4
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Editor name	Organisation
Eleni Chalkia	CERTH

Modifications Introduced			
Version	**Date**	**Reason**	**Editor**
0.1	June 2019	First version	Eleni Chalkia
0.2	July 2019	General review and comments	Miguel Monteiro
0.3	July 2019	General review and comments	Javier Gavilanes Ruano
1.0	August 2019	Second version	Eleni Chalkia
1.1	September 2019	Quality review	Ismini Stroumpou
1.2	September 2019	Quality review	Miguel Monteiro
2	September 2019	Final release	Eleni Chalkia

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Executive Summary

One of the main scopes of My-TRAC, and especially WP4's, is to create a traveller Companion that will offer an intuitive User Interface (UI) to the travellers providing them with a smooth, seamless and personalized door to door experience. My-TRAC traveller Companion will focus on a creating an ecosystem of functionalities presented to the user through a personalized interface (which is to be created in WP4) based on different passenger profiles (including persons with disabilities) to create an enjoyable and seamless travel experience that will change satisfaction from engaging with PT.

The aim is to create an interface that will adapt and personalize the information to user's needs and this is the scope of the current report. Thus D4.2 "Affective and Persuasive HMI concepts and models" aims to reach personalization throughout the companion services, supporting the requirements of the traveller profile groups, which will be achieved by clustering different behavioural patterns and socioeconomic factors. Therefore, My-TRAC traveller Companion, through its UI will offer personalised adaptation based on the user type (e.g. elderly, disabled, children, parents, etc.) profile and user behaviour.

In the aforementioned context, the current Deliverable focuses on providing the core information about My-TRAC personalization strategy through its three pillars of design, namely; **Persuasive**, **Inclusive** and **Affective**. Through a structured methodology that starts from My-TRAC vision, taking also into account the tasks completed during the rest of the project (i.e. D5.1 and the elicitation of requirements) and having the user in the centre of the process, following a User Centred Methodology (UCD) we started from empathising the user. Creating user empathy is a major task when designing an application, since it will be used by the user and it needs to fulfil the user's (and not the designer's) needs. Focus groups with developers and users lead us to develop 5 personas that capture, group-wise, the target groups of our application. These personas have been accompanied by user stories and later on have been coupled with the actual user characteristics that were extracted from a large user survey. Around220 users answered the survey and results regarding their demographic status, personality traits and car usage have emerged.

After studying and empathizing the user, we go a step further to the analysis of the principles that we will follow in order to achieve personalized interfaces taking in to account Persuasive, Inclusive and Affective concepts. Having our mind focused on in the User Experience, rather than the typical User Interface, five persuasive principles have been presented and detailed along with the way of implementing them in the design. The same stands for the Inclusive principles, were specific section for understanding the user needs has been drafted and followed by a description of the formal accessibility standards. A lot of effort has been given to define our strategy towards achieving Affective design, since this is also considered to be one of the main novelties of our framework. Being able to achieve emotional design assumes a thorough understanding of the users' affective needs. So, we developed a questionnaire in order to elicit the affective requirements towards My-TRAC traveller Companion from the actual users. Around 220 users answered the survey and their results allowed us to create the first design of My-TRAC application.

Finally we present the wireframes of the My-TRAC application that will be used by WP5 for implementation and further on the WP6 for testing, accompanied by the My-TRAC UI style guide that makes our designs more accessible and readily available to the rest of My-TRAC team.

Abbreviations and Acronyms

BFI	Big Five Inventory
D	Deliverable
DoA	Description of Action
HMI	Human Machine Interaction
ISO	International Standards Organisation
PT	Public Transport
UI	User Interface
UX	User Experience
UCD	User Centred Methodology
WP	Work Package

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1 INTRODUCTION

In My-TRAC we develop a traveller Companion with a smart **User Interface** (UI) to provide users with viable access to the information, depending on their individual needs, specifically addressing specific impairment types of stable or transitory nature (e.g. visual impairments). Designing this UI is the overall objective of WP4. The basic HMI concepts that will be structured in such a way to cover the functional requirements of the user, based on D5.1 (Antoniou, Guisado-Gámez, Stroumpou, & Papacharalampous, 2018), have been developed in Task 4.1 and reported in D4.1 (in process). These basic HMI concepts have been handed to Task 4.2, which created the personalised version of them respecting the look and feel of the general project and having in mind the needs of the user in respect of persuasive, inclusive and affective needs, reported in D4.2 (current report). Finally, the final My-TRAC traveller Companion application UI has been handed to Task 4.3 to develop a wizard which is a transparent overlay of UI hints given to the user to get a nudge in the right direction when realising a task, reported in D4.3 (in process). These three tasks and their outcomes provide a complete framework regarding My-TRAC traveller Companion User Interface and their components are depicted in the following figure.

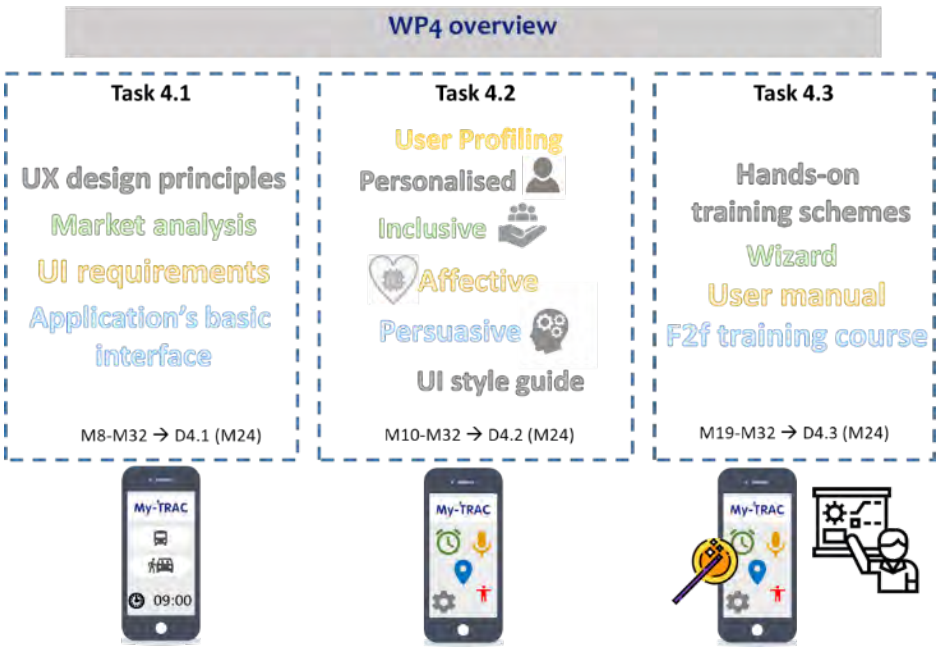


Figure 1: My-TRAC traveller Companion User Interface strategy through WP4 tasks.

In the current Deliverable we focus on the personalisation features of My-TRAC traveller Companion User Interface. The personalization settings included will be adaptable to specific user profiles providing an accessible interface taking inputs from the users, following a User Centric Design methodology and analysis that aims to enhance overall user experience when using the application.

Thus in Chapter2 of the current document we present My-TRAC Human Machine Interface (HMI) or as mentioned in this documents User Interface (UI) strategy to be followed for achieving personalisation. The need for personalisation in our work is also captured there together with the followed methodology. A hybrid UCD methodology, where User-Centric design is mixed with design thinking process has been developed and implemented in order to focus as much as possible to the user, retrieving the most useful results for our research.

Having the user in the centre of our methodology is a core concept of our work and this is being depicted in the current report in Chapter 3. This is chapter is all about users, realising a step-by-step process to empathise them. We have created user personas that cover all the user groups that My-TRAC addresses, as well as respective user stories for each persona. Finally, we conducted a thorough user survey with around 300 participants in order to retrieve real user feedback in terms of user characteristics and user affective needs, as presented later on in the report.

In Chapter 4, we move from the user to the design, presenting in detail all the personalized principles that will be taken into account in My-TRAC UI design. These are namely, the **Persuasive**, **Inclusive** and **Affective** principles. There is one section for each one of these concepts that is describing which are the specific principles to be followed and how will they be implemented in our design. Special focus has been given to the affective design concept where principles are more user specific, thus we realized a process for eliciting these affective requirements through a user survey, which results are the foundation of our first draft UI design.

This first draft UI design is presented in Chapter 5. Starting with the representation of the specific UI elements through a UI style guide, which details all UI components used in the first version of My-TRAC traveler companion. Following the respective wireframes that cover the Use Cases to be implemented from WP5 for this phase of the project are depicted. The design of these wireframes is covering the persuasive principles and the affective user needs of Chapter 4. Finally, the accessible version of My-TRAC traveler companion is presented. In this first version, we covered the groups of impairments that outstanded from our users' survey, which is the group of visual impairments. Later on in the project, we will cover additional impairments' groups.

2 My-TRAC HMI DESIN STRATEY

Design is so simple.
That is why it is so complicated.

-Paul Rand

2.1 INTRODUCTION

Today, more than ever, people are **engaging with their smartphones** that enable and encourage constant connection to information, entertainment and also connect each other in crucial moments and in everyday life. Peoples' phones put the world at their fingertips and rarely leave their sides, putting them in a sea of millions of apps that declare to improve their welfare.

Users have always been picky about the applications they use, but now more than ever they expect to be truly immersed. Thus, and given the amount and the quality of the existing applications, engagement this is a really difficult task to achieve. Based on a study from localytics (Rodde, 2018) in 2015 25% of users used an app only once and Google verifies it (Tiongson, 2015). Today though, this percentage has been reduced and **21% of users abandon an app after one use**, which is still too many. And this gets even more interesting if we consider that the most important reason for not engaging in an application is the bad User Interface (UI).

Thus, since you never get a second chance to make a first impression, it is really important to provide a well-designed app with the most reliable and comprehensive user interface by using many techniques, new technologies, and frameworks, providing users with an efficient and delightful experience. So, the focus at the end of the day is to achieve a better user experience in whole, ensuring a clear and meaningful interface for the end user of the application. But the **User eXperience (UX)** should not be considered the same as the **User Interface (UI)**. UX is a combination of tasks allowing the user to achieve effective and enjoyable use of the application, while the UI design is its complement, the look and feel, the presentation and overall interactivity of a product (Kapoor, 2016).

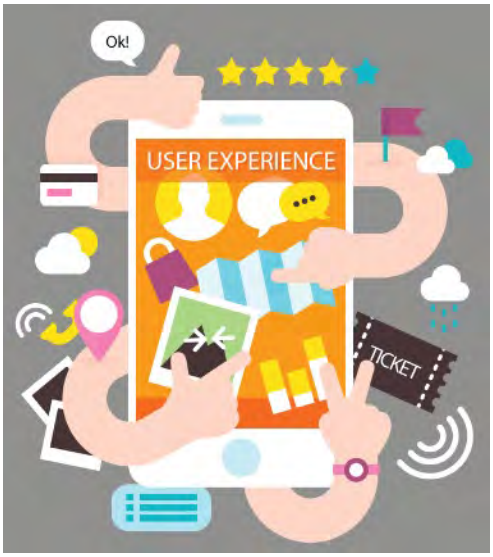


Figure 2: Complexity of Use Experience in mobile applications.

"How you climb a mountain is more important than reaching the top", Yvon Chouinard said. And to interpret this in the world of mobile applications, the experience of the user in order to achieve a task is of the greatest importance. Personalized messaging, effective design, inclusive interfaces, unobtrusive experiences, rich content and a bunch of other features are crucial elements that are used for a great UX and a well-designed UI allows this to happen.

To give to the user a great UX, **usability is no longer enough**. Usability stands for "can do", but "can do" is no longer the request, it is a prerequisite. What is important is if the user "will do" or "enjoy doing", these are some of the questions that should be answered. There are many tasks that everybody can do,

but really few are doing. The important thing is finding ways to engage and persuade users to act and use the application. Thus, we have to go a step forward into the next loop of UX, which is about designing for persuasion, emotion, and trust by implementing personalized, affective, inclusive & persuasive UI design.

2.2 SCOPE OF OUR RESEARCH

One of the main objectives of My-TRAC and the scope of our research is to provide a user interface to the travellers including improved trip planning information customized to their needs and state-of-mind (from WP2 and WP3) through the Travel Companion application. Hence, designing a good and usable UI is one of our main targets.

The design of a good UI is based, not only but mainly, on its **visual appeal**. People have different ways of responding to visual stimuli. The pre-attentive, unconscious, and highly emotional is the one and the conscious and analytical is the other (Barry, 1997). That makes us postulate that even if we design applications so far based fully on cognition, people are not as rational beings as we think they are and a more complex and inseparable blend of emotional and cognitive reasoning should be followed (Norman D. , 2004). This is also verified by Jordan who states that nearly all human factors studies are "concerned with the level of effectiveness, efficiency and satisfaction with which people perform tasks – not with their emotional responses to the products that they are using and experiencing" (Jordan, 2000). Thus, the affective and experiential aspects of an application design determine its success as much as, if not more than, the functional tasks enabled by it (Williams, 2007). As very well stated by Williams "this expanded notion of "quality" means designs that stimulate and satisfy our intellects; that please our emotions; and that engage our senses all while helping us to achieve an instrumental goal".

The scope of My-TRAC is to design a UI that embeds much more than the typical functional requirements, but it also includes principles that allow the creation of a UX design framework to be used by the UI design teams in order to achieve successful design innovation and user experience management using design thinking and technology-driven approaches, by creating **transformative experiences which are user-focused**. Thus, My-TRAC will develop a smart **Human Machine Interface** (HMI) to provide users with viable access to the information, depending on their individual needs, specifically addressing impairments of stable or transitory nature (e.g. visual impairment, technological illiteracy) through My-TRAC travel Companion.

The goal is to **attract**, **delight** and **engage-retain** users. This requires the development of a uniquely tailored approach of building the UX, with the users in its kernel, providing them with an end to end users' experience lifecycle with respect to their personality, affection, and evolving needs. Focusing on the users, the scope is providing them with simple and memorable experiences tailored to their needs. So, a concrete methodology is what matters the most.

Referring to UI as being part of the **information design**, we could say that a complete UI is comprised by an interdisciplinary approach that includes of document design, typography, human factors, technical communication, ethnography, linguistics, graphic design, architecture, instructional design, library science, and most recently emotional design (Albers M. , 2003). However, as Albers notes at his "Content and Complexity: Information Design in Technical Communication" the "proportions which each underlying discipline contributes widely and tends to be apparent in any individual definition." So, to which extend each UI component is significant is different for each individual, so it is personalized.

Despite the variety of its components, a good UI, as historically understood, is fundamentally about **making information more manageable** for users to understand, where user speed, efficiency and accuracy expedience define "**easy**". So, considering users' needs and emotions when interacting with an application is a key factor in software product success (Väänänen, Väätäjä, & Vainio, 2009). This success requires to understand what the users really want and prioritize their needs since when the designers understand the user, they can understand how small changes in design can have a significant impact on users' experience (UX).

According to the ISO 9241 (2010), users' experience (UX) is defined as: "a person's perceptions and responses that result from the use and/ or anticipated use of a product, system or service". The user experience explores how a person feels about using a product, i.e., the experiential, effective, meaningful and valuable aspects of application use (Vermeeren, et al., 2010). The focus on the user's **personal needs and emotions** while interacting with an application is a key factor for application's success (Sproll, Peissner, & Sturm, 2010). Therefore, **user experience modelling** is especially important for understanding, predicting and reasoning about UX processes, with implications for the software design (Law & Schaik, 2012).

So, what UX design is attempting to do is go further the traditional user-centred design (UCD) where people were mainly considered in terms of their thinking and performance. Additionally, newer models such as **affective design** recognize the need to contemplate people's thoughts and feelings, pains and gains that is, the interaction between cognition and affect ((Schriver, 2001), (Albers & Mazour, 2003)).

Our design-thinking lead process targets to mix **advanced technology** with **unique and personalized experiences** for the user. There are three different but also complementary principles that drive our design process in My-TRAC and are focusing on providing the user with a tailored and personalized experience and these are the following.

- Design Pillar one →**Persuasive design.** That makes the user want to use My-TRAC.
- Design Pillar two →**Inclusive design.** That enables all users to use My-TRAC.
- Design Pillar three →**Affective design.** That gives pleasure when using My-TRAC.

The aforementioned pillars, do not only focus on usability, which is considered as a prerequisite, but also to the **pleasure** of the users, as well as their **convenience** and **joy** while using My-TRAC application. Traditional usability-based approaches, encourage a limited view of the person using the product, falling short of offering optimal experiences for all users (Jordan, 2000). Applying these principles and following this tailored design process will provide lots of benefits to the UX including improving the mood of the user, increasing trustability and facilitating the utility of the application.

The personalization of the UI has been something that designers are trying to implement for years. In My-TRAC, we go a step forward form the personalization as implemented so far, by adding a combination of affective, persuasive and inclusive attributes into the design. This aims to improve the mood of the user essentially, since for example there are a lot of studies about colours and the way they affect people's mood, making them aggressive, calm or passive. But this is not the same for every person. Each one may have a different mentality about the UI presented, thus the scope is to have it as personalized as possible depending on people identities in the first place, but also in the context of use. The target is to make users smile or feel peace and harmony when they open the application and this can be established by designing a visually appealing interface that develops a pleasant and engaging atmosphere which gets users' attention for a long time and not only once.

2.3 METHODOLOGY

When designing the UI for a research project, the experience of the user is what matters the most. Building a good UX is based on the strategy and methodology that will be followed and it actually entails researching and recognizing the constraints and concerns from all sides involved in the process. The current Deliverable aims to provide all the principles followed for My-TRAC UI personalized design following a methodology that keeps the user in the centre of the processes.

My-TRAC UI vision has been clearly defined from the beginning of the project's conception and it has been defined to the projects' proposal.

The vision is to develop a smart UI to provide users with viable access to the information, depending on their individual needs, specifically addressing impairments of stable or transitory nature (e.g. visual impairment, technological illiteracy) through My-TRAC Travel Companion.

My-TRAC UI concept will enable this vision through personalisation techniques, creating a common backbone of interaction methods that will support different local variations that cover specific needs and habits of different users. The methodology to achieve this is depicted in the following figure.

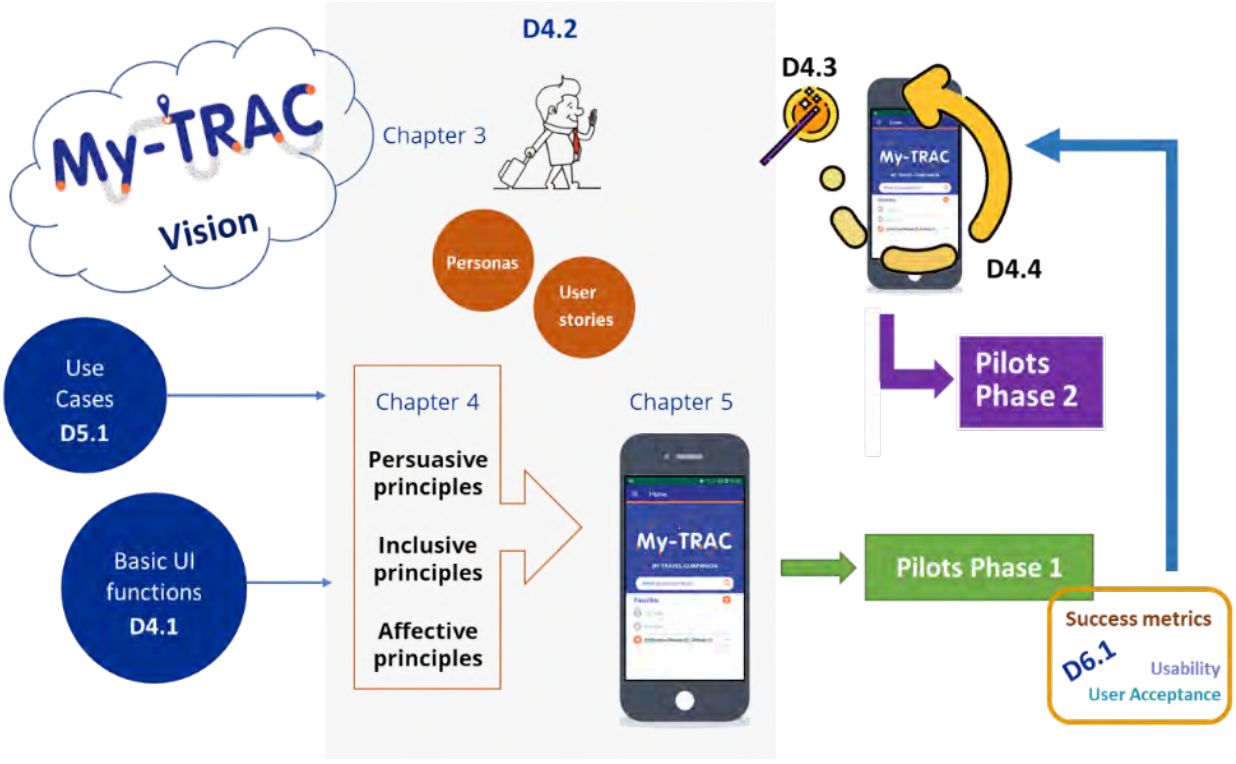


Figure 3: Methodological framework.

To achieve My-TRAC UI vision, explicit **design criteria** for My-TRAC UI have been identified, as this has been one of the major topics of WP4 "Personalized Human Machine Interface". The basic design criteria have been defined in D4.1 "UI prototypes for integrated My-TRAC platform" (under development). In the current document we make a thorough review of the personalised design criteria for My-TRAC UI, as presented in *Chapter 4My-TRAC UX design principles*. These design principles have been taken into account when designing the actual look and feel of the application presented in Chapter 5My-TRAC UI design.

The applications of use for My-TRAC UI have been defined in D5.1 "Elicitation of requirements document for My-TRAC" (Antoniou, Guisado-Gámez, Stroumpou, & Papacharalampous, 2018) where specific Use Cases have been drafted. In the current document we define the "who, what, when, where, and why" of the application. We do this through user personas defined in *Chapter 3My-TRAC* . User personas enable us to make tangible design decisions based on users' actual needs.

Building a good UI is one thing and validating its success is another. To assess the usability and the User Experience of our UI design we have drafted a thought usability study that has been reported in detail in D6.1 Pilot execution plans (under development). A short reference on our validation plans is given in *Chapter 6Conclusions and Next steps*.

On the top of all the aforementioned statements, our methodology for designing My-TRAC UI is based on the users' perspectives. Following a User Centred Approach has been the one major goal of our strategy, since the users are the ones who will evaluate and use our product at the end of the day. Thus, our entire design process has been revolved around assisting users in satisfying their goals, as opposed to getting caught up in new features or improvements.

To achieve better user involvement a hybrid methodology combining the typical **UCD approach** that is iterative and includes also basic principles of the "design thinking" has been used. The 5 stage Design Thinking model proposed by the Hasso-Plattner Institute of Design at "Stanford d. school" has been merged with the typical User Centred methodology and the process is depicted in the figure below.

Figure 4: Hybrid UCD and design thinking process.

Empathy is crucial to a UCD process and Design Thinking, as it allows designers to set aside their own assumptions about the application they are developing and gain insight about users and their needs. So, the first stage of the process is to gain an empathic understanding of the user and the problem are encountering. A good understanding of the users results to a good problem definition. The next step is to define the core problems that the designers' team has identified from empathizing the users. The step now is to identify new solutions to the problem statement that answer to the users' needs. It is important to develop as many ideas (problem solutions) as possible at the beginning of the Ideation phase and start prototyping a number of inexpensive, scaled down versions of the product. Prototypes should be tested within the development team, before getting to the ones that will pass to the next step; testing with

actual users. Testing is the final stage of the 5 stage process, but in an iterative process as in My-TRAC, the results generated during the testing phase are used to redefine problems and inform the understanding of the users, how people think, behave, and feel and to empathise them again.

Apart from this linear relationship between the design process elements, in practice, the process is carried out in a more non-linear fashion. For example, when designers start prototyping they get insights that provide feedback to the ideas step. Also, results from the testing phase can reveal important insights about users, which in turn may lead to another definition of the problem (Define) or brainstorming session (Ideate) or the development of new prototypes (Prototype).

3 My-TRAC Users

"People ignore design that ignores people".
– Frank Chimero

3.1 Introduction

From our UCD methodology presented in the previous Chapter, we see that the first step towards a creation of a successful product is to develop empathy for the users. IDEO, in its Human-Centred Design Toolkit (2011) defines empathy as "deep understanding of the problems and realities of the people you are designing for". User empathy is about trying to identify, prioritise and take into account any user's perspective on the product under research. It's about being able to identify user needs, requirements and expectations represent in the correct way when making decisions on the design of the product.

Empathy helps designers gain a deeper appreciation and understanding of people's physical and emotional needs, as well as the way they understand, see, and interact with the world around them. It also helps to understand how all of this has an impact on their lives generally, specifically under the contexts being researched. Empathetic research, unlike traditional marketing research, is not concerned with facts about people, but more about their motivations and thoughts.

According to Smashing Magazine creating empathy for the users and developing products towards this goal helps getting more profitable products to the market at a quicker pace. Some of the most important benefits of having the user in the centre of the design process and empathise them, are the following:

- **Have better products in the end.** Processes that involve end users will always result in products that work better for their intended purpose.
- **Cheaper to fix problems**. Involving the user in the process from an early point of the design, allows you to fix problems without having end up to the final product yet and make changes while it's still mostly just on paper, using wireframes or prototypes.
- **Ease of use is a common requirement.** Involving users allows you to find things regarding "usability" and "user experience" of the product and implement them in an early stage of the design, having the user satisfied.

By starting with users and understanding their hopes, fears, and needs, we quickly uncover what's most **desirable** for them. But this is not the only variable we should be concerned about. Once we've determined a range of solutions to the problem we have defined (Ideate), we then start to determine what is exists in terms of technology (**feasibility**) and how to create profits or business benefits (**viability**). It's a balancing act, but it is totally critical in order to designing solutions that are successful and sustainable.

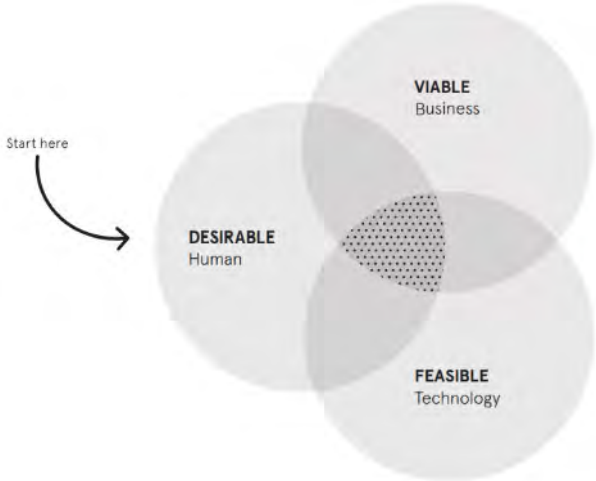


Figure 5: Successful and sustainable design aspects.

3.2 My-TRAC Empathy Map

The initial step towards a more profound understanding of users is to visualize their attitudes and behaviours in an empathy map. Empathy is a critical part of the human-centred design. Empathy has been employed as a defining characteristic of designer-user relationships when the design is concerned with user experience entails (Wright & Mccarthy, 2008). Traditional empathy map from Mathews (Gray, Brown, & Macanufo, 2010), drawn in XPLAIN is split into four quadrants (Says, Thinks, Does, and Feels), with the user or persona in the middle. After, Bland (2016) improved the empathy map by including Pain and Gain areas. As a result, the empathy map consists of six areas: (a) **See** – what the user sees in his/her environment; (b) **Say and Do** – what the user says and how s/he behaves in public; (c) **Think and Feel**– what happens in the user's mind; (d) **Hear** –how the environment influences the user; (e) **Pain**– the frustrations, pitfalls, and risks that the user experiences, and (f) **Gain** –what the user really wants and what can be done to achieve one's goals. Empathy maps provide a glance into who a user is as a whole, by helping designers understand the user's mind-set and allows capturing and using specific personas in the UX design.

So, there is a major difference between the design that focuses on users in general and the design that focuses on people's individual persons. In the first case of the more traditional models, the scope is on "thinking and performance", also known as **self-interest**, while newer models recognize the complex interactions of **emotion and cognition** too. Thus, personalized design is, by all means, trying to penetrate the ways humans interact with technology, figuring out how to make UX more useful, usable and most of all **compelling**, creating a personalized experience.

It's important to highlight that empathy maps can be developed for a general understanding of a concept, or for specific tasks and situations. A useful and efficient tool is the "broad empathy maps" which are not based on a single user scenario but they are representations of represent a group of users, such as a stakeholders' segment.

In My-TRAC we developed broad empathy maps by brainstorming within the designers' team. We realised focus groups with 5 designers and it took about 20-30 minutes for each empathy map to be developed, following the steps below.

1) **Determine the person you want to understand and also the context.**

Name the person and provide three noteworthy characteristics like name, age, etc. Write down a few details about the person: what is their family status, do they have a job, is there something else distinctive about their daily life?

2) **Put yourself in that person's shoes and feel their experience**.

Thinking about them as users of the application, you need think about their life holistically and focus on their experience with the application. What are they Saying? Seeing? What questions or insights arise? How can you use insights to design instruction or instruction services that respond to your persona's perspective?

3) **Provide the right materials.**

Set aside sheets of paper with the template of the broad empathy maps (Figure 6: Broad empathy Map template) and share them to all the participants or draw the template on a whiteboard. Then hand out

sticky notes and encourage everyone to write down their thoughts regarding each of the empathy map's four quadrants. Finally, review the completed empathy map and discuss any patterns and outliers.

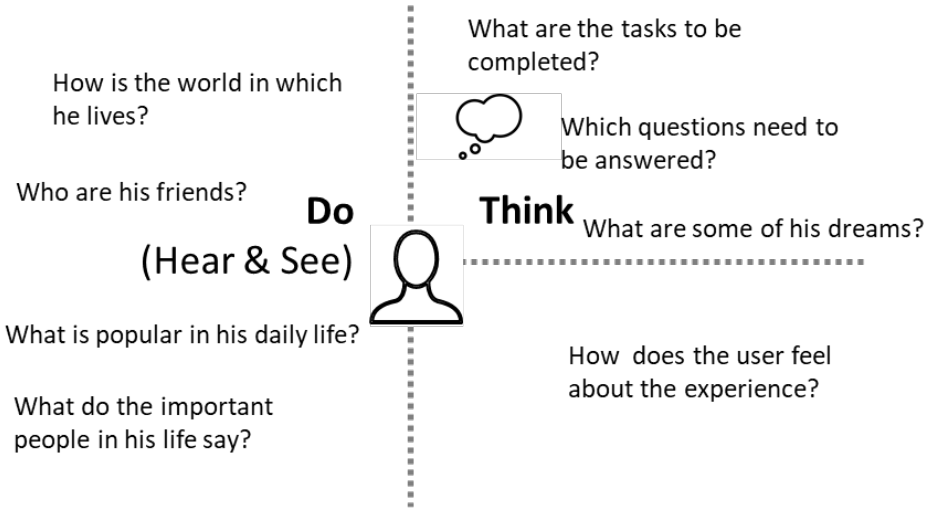


Figure 6: Broad empathy Map template

For starting the creation of My-TRAC empathy maps we used the personas derived from Anable (2005). Anable realised a study to cluster the users in segments related to their demographic characteristics, their personality traits, as well as their transportation mode preferences. So she ended up with malcontent motorists, the die-hard drivers, the aspiring environmentalists and the car-less crusaders. The focus group session among the designers' team was inspired by these personas, which were enriched based in My-TRAC users' need and after following the steps above, they ended up creating five broad empathy maps.

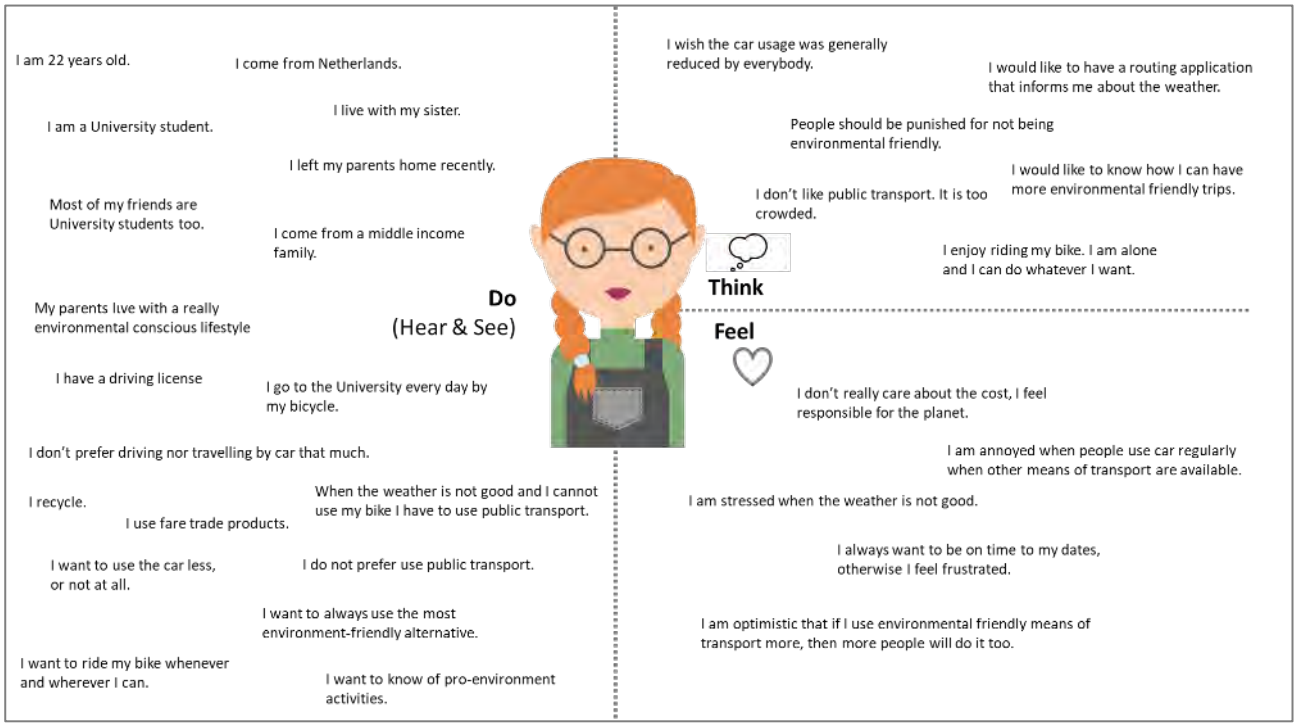


Figure 7: Martha's broad empathy map

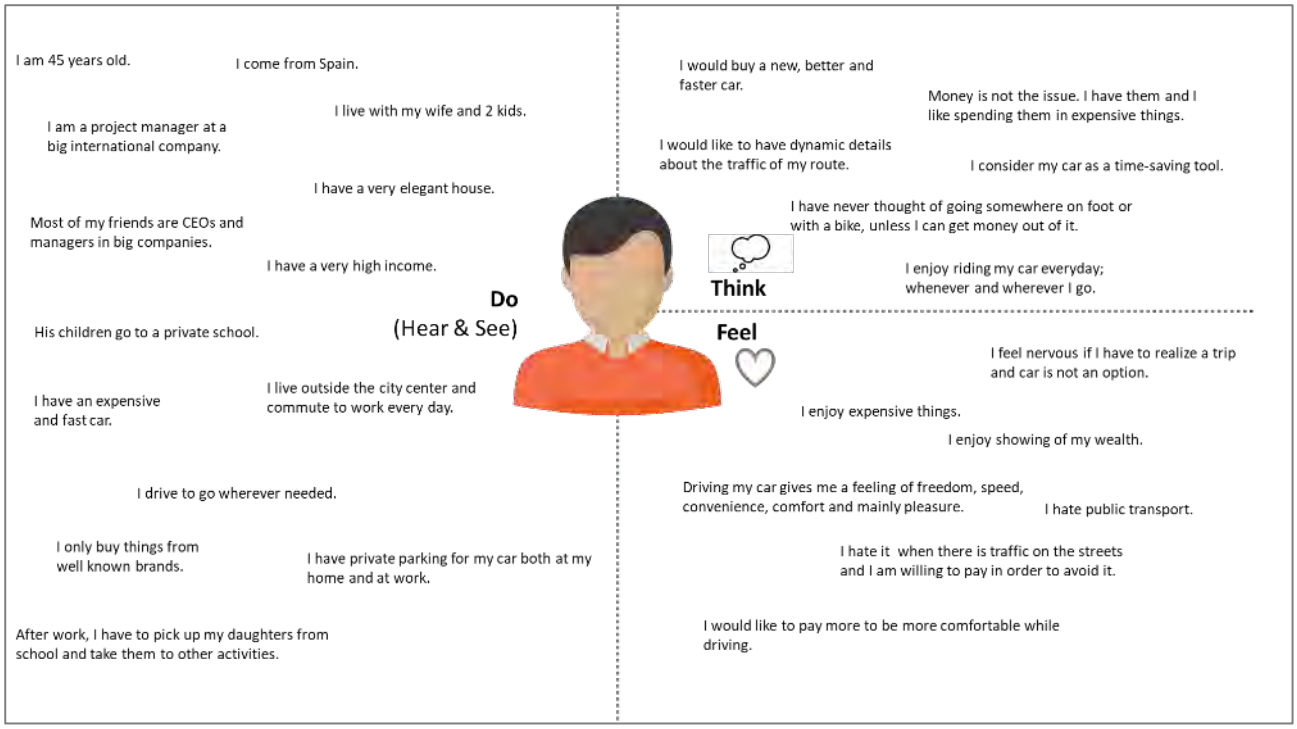


Figure 8: Jose's broad empathy map

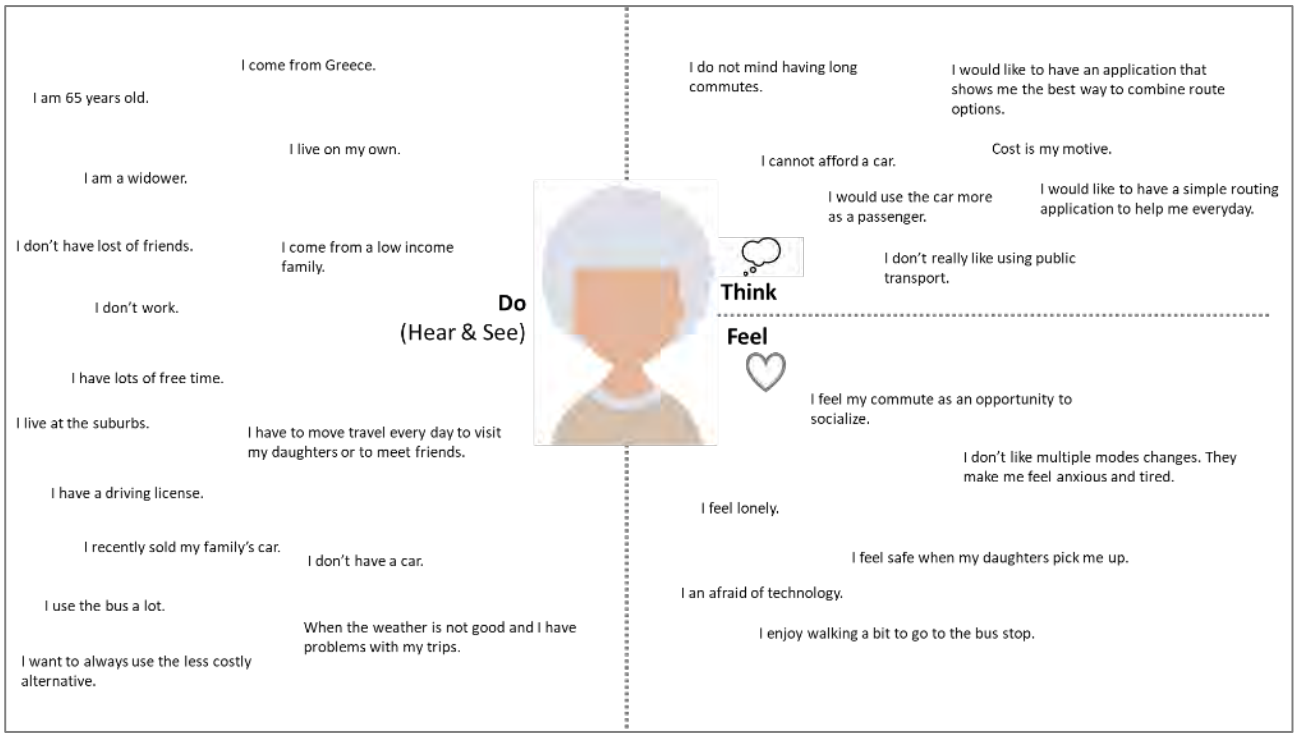


Figure 9: Sofia's broad empathy map

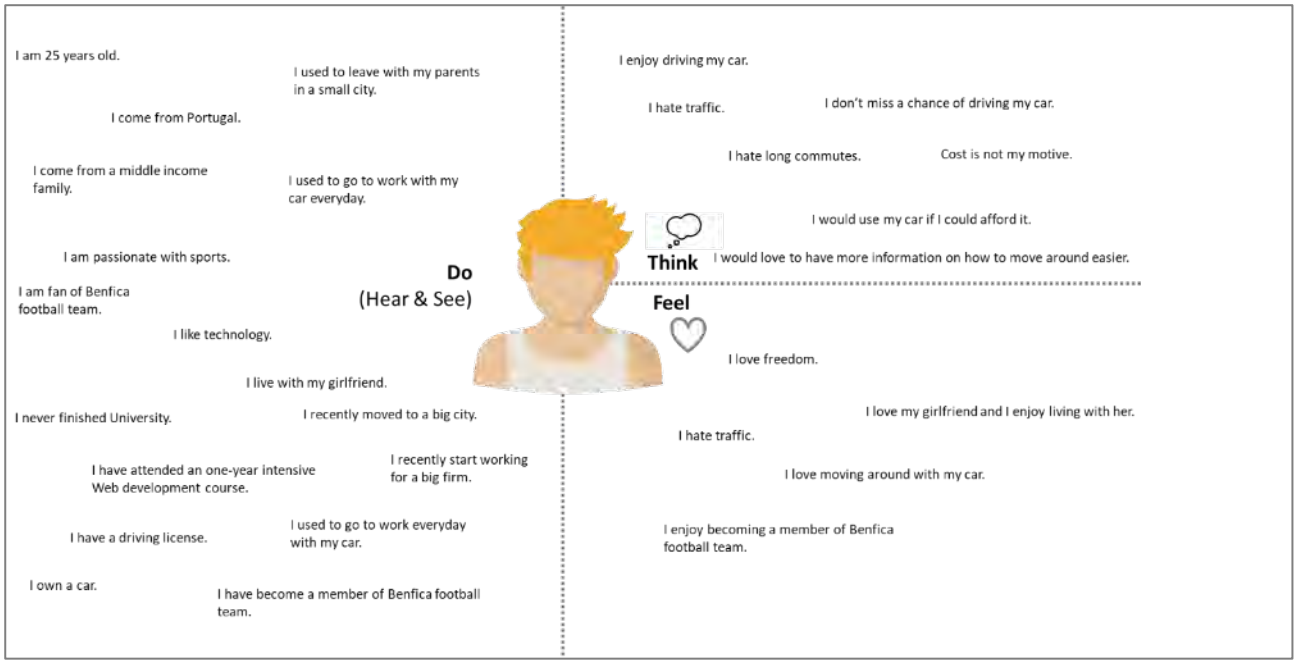


Figure 10: João's broad empathy map

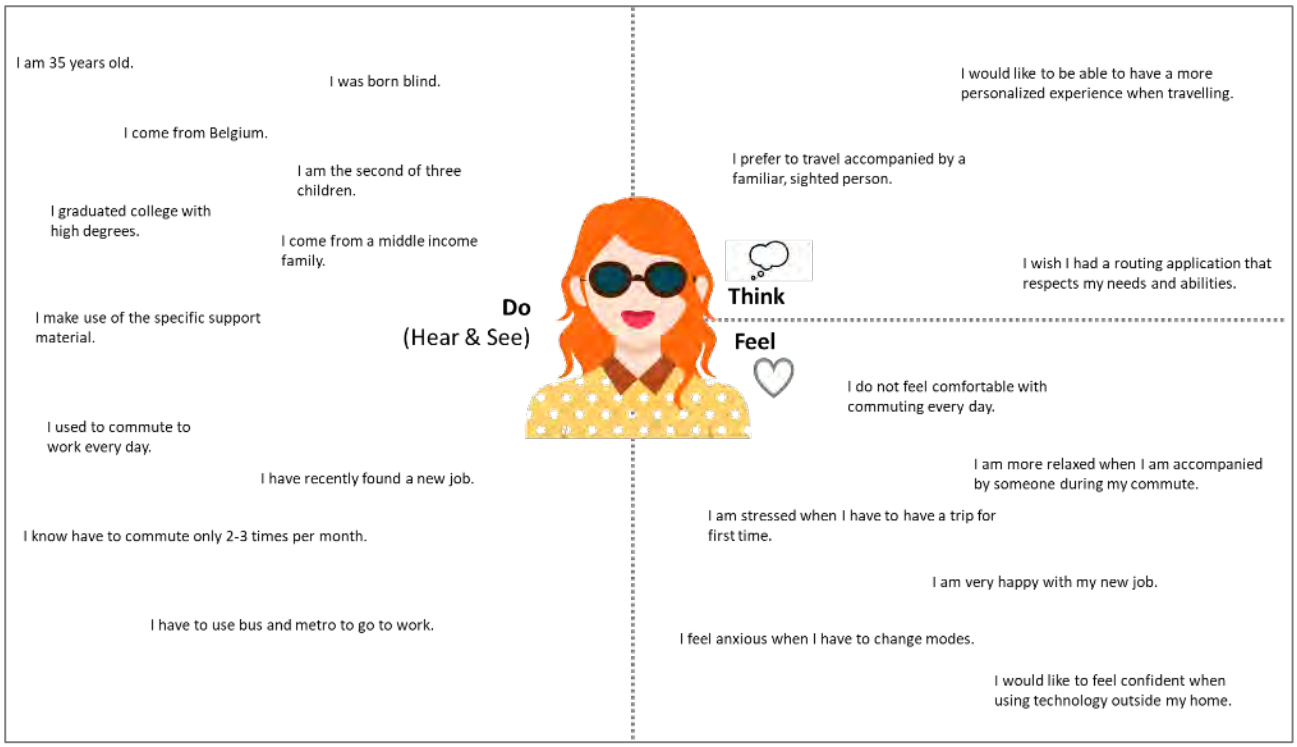


Figure 11: Maria's broad empathy map

3.3 MY-TRAC PERSONAS

Having done the Empathy Map exercise allowed us to notice specific themes that emerged in our research, which can be flowed into a User Persona and be used to guide all different parts of the user's journey when using the My-TRAC application.

Personas are hypothetical archetypes of larger segments of users (Osterwalder & Pigneur, 2013) , who share the same goals and characteristics that represent their needs. A persona is usually presented in a one or two-page document that describes behavioural patterns, skills, goals, attitudes, and background information. Some information about the environment in which the persona operates are also mentioned there. Designers usually present some fictional personal details also in the description, so as to make the persona come closer to a realistic character.

The few benefits of using personas in an application development process are summarized below:

- Personas help team members to have a consistent understanding of various user segments. Data about the user segments can be put in the proper context and in this way they can be understood in coherent stories.
- Proposed solutions of the problem under research can be ranked by how well they meet the needs of the project's Personas. Application features can be prioritized based on how well they address the needs of one or more personas.
- Personas provide a human "face" and allow to create empathy for the users of the application.

Personas also help preventing common design pitfalls like the following:

- **Self-referential design**. This happens when designers are designing for oneself rather than for the audience, when in fact the target audience is quite different from them. So, their savviness and familiarity with the application under development actually prevents them from being able to solve the users' problems.
- **Elastic user**. An elastic user is a generic user created by designers' teams, who has little to do with the goals, abilities, and contexts of real users.

In My-TRAC we have used the Empathy Maps from the previous Section to guide the personas creation. Our user personas consist of the following characteristics.

- Persona's name
- Photo
- Demographics (age, nationality)
- Lifestyle & Identity characteristics (key socio-demographic variables such as income, gender and car ownership, Environmental attitudes, worldview and knowledge, including Moral norms, attitudes, behavioural or personality characteristics.)
- Transportation patterns (Habit)
- Experience with Technology: the experiences that the persona had with other technologies, as well as application characteristics that please and displease the persona. The goal of this field is to get a better understanding of the user's Interface preferences.
- Needs and wants

Name: Martha

Age: 22

Nationality: Dutch

Meet Martha, an **aspiring environmentalist and car-free chooser**

Lifestyle & Identity characteristics

Martha is a 22 years old student at Delft University. She and her sister left the family nest in Amsterdam and they are living together in a small apartment in Delft for the last couple of years. Martha is coming from a middle-income family, both her parents were teachers in the elementary school.

Steaming from her parental environmental conscious lifestyle, Martha is feeling the most responsible for environmental problems. She is recycling, using fare trade products and tries the most to keep her lifestyle environmental-friendly. She considers pro-environmental behaviour as being very important and worthwhile and supports that the negative effects of car use should enter into the decision-making process when choosing the transportation mode for travelling and commuting.

Transportation patterns

Martha does have a driving licence, but she does not prefer driving nor travelling by car that much. This helps her making environmentally friendly choices in her everyday commute. On the other hand, Martha does not really enjoy using public transport either. She feels restricted by time and space constraints public transport endorse and she prefers to walk or use her bicycle to move around. Nevertheless, she prefers to use public transport than car driving, so she is willing to try using it under specific circumstances, e.g. when bicycling or walking is difficult (i.e. rain, snowy weather).

Experience with Technology

Martha is comfortable around technology, although she is not a huge fan of it, mainly because she thinks that such an abundance of technological devices is harmful for the planet. She owns a smartphone, which she uses to chat with her friends and check social networks and a laptop for her university studies.

Needs and wants

Martha at the moment is happy with her choices and the way she commutes to the university every day. She has really strong beliefs and it is really hard for her to change at the moment. She is walking to the University for 2 years now. So, why change?

In order to use another mode of transport, Martha needs to know in detail the alternatives that she has and the effect each alternative has to the environment. Additionally, she enjoys the fact that along with commuting, she also exercises a bit! But there are days that she has to carry too many stuff with her and the weather is terrible and it would be nice to have an alternative.

Name: Jose

Age: 45

Nationality: Spanish

Meet Jose, a **Die Hard Driver and car addict**

Lifestyle & Identity characteristics

Jose is a 45-year-old project manager at a big international company in Barcelona. He has a very high income, but his wife also works since she does not like to sit at home all day long. He lives outside the city center and commutes to work, which is located in the city center, every day. Jose has 2 daughters, one 12 and the other one 9 years old and he is married to Maria, a 42-year-old working mother.

Jose likes luxury. His house is very elegant and his wife also. His children go to a private school and he has lots of friends in high positions in international corporations. He really enjoys having the financial ability to buy expensive gifts to his wife and kids. Additionally, he enjoys driving so much. He has to go to work, in the city center, every day, but he is really happy every time he has to drive his luxurious car. For Jose, driving his car gives him a feeling of freedom, speed, convenience, comfort but mainly pleasure. He hates when there is congestion on the streets and he is willing to pay in order to avoid it, but he would never get rid of his car for another mode of transportation.

Transportation patterns

Every day Jose goes to work driving his car. There, he has a parking slot available for him every day and he is really thankful for that, since parking at that specific area is a real problem. Jose considers his car as a time-saving tool. After work, most days of the week, he has to pick up his daughters from school and take them either to the ballet classes or other activities. He has no idea how to do this complex trip without his car.

Experience with Technology

Although not an expert, Jose really does enjoy technology. He has no problem spending his money in a new TV or other home appliances, and he always has the latest smartphone model and several gadgets. He mainly uses his phone for email, chatting and reading the news.

Needs and wants

Jose needs really strong motives to change his attitude towards car, as well as the rest of the transport modes. At the moment there is no need for him to use other mode than car, since his income allows it and his identity imposes it.

Name: Sofia

Age: 65

Nationality: Greek

Meet Sofia, a **Reluctant Rider**

Lifestyle & Identity characteristics

Sofia is a 65-year-old mother of two. Both her daughters are married and have left the family home years ago. So, now Sofia leaves on her own, since she has recently lost her husband too. Her place is at the suburbs and Sofia has to move to other parts of the city every day either to visit her daughters or to meet friends.

Sofia has lots of free time, so she does not mind having long commutes. This time is also her time to be with people and not stay alone in the house doing nothing. Moreover, Sofia does not have a car. She considered it more like a burden than a convenience, so she decided to sell it after her husband's death. Her income is not that high also, to allow her to have a car and move around with it in the traffic of Athens every day. It is not that she enjoys moving around with public transport, especially when there are delays or multiple mode changes, but at least she can afford it. Sometimes, her daughters have to pick her up and take her to the doctors and she really enjoys this when it happens, since she does not have to take public transport.

Transportation patterns

Sofia commutes every day. She mainly visits her daughters, who leave nearby. She takes the bus in order to go there. The bus stop is a few minutes' walk from Sofia's house, so she also has the opportunity to take a small walk every day. A couple of days during the week she also has to visit the city center, either to go to doctors' appointments or visit friends. In order to go to the city center Sofia has to take first the bus and then the metro. So, she really enjoys the days when their daughters take her to the doctors with the car.

Experience with Technology

Sofia has never been too involved with technology. She has always found it confusing and complicated to understand. However, lately she has been using a smartphone to speak and chat with relatives and friends, and is starting to appreciate its benefits, even using some simple apps.

Needs and wants

Sofia needs to create a positive behavior towards public transport, having enhanced attributes like scenery, sociability and relaxation while travelling. She also needs to be aware of the various alternatives that she has for her commute and be able to choose the most appropriate for her trip.

Name: João

Age: 25

Nationality: Portuguese

Meet João, a **Routine Freak**

Lifestyle & Identity characteristics

João is a gaming, computer science and sports passionate. He also is fan of Benfica football team and watch all the games. Figueira da Foz is his hometown, where he has lived his entire life with his parents. He is from a middle-class family, his mother is a teacher in the elementary school and his father is a police officer.

João frequented the University but was not able to finish it. Thus, he decided to attend a one-year intensive Web development course at a certified professional agency.

When João completed his course, he started working for a start-up in Coimbra with a 35 minutes commute by car. Some years later João's girlfriend, who is a nurse, finished her course and got a job in Almada. So, after a year working in Coimbra, João decided to move to Almada with his girlfriend and started to work in a big company in Lisbon.

Transportation patterns

João is the kind of guy who really loves the freedom of getting a car to drive wherever he wants: to play football, to go out at night or even just for fun.

After the move to Almada, with a long commute by car due to traffic, João had definitely to adapt his lifestyle. For João to get to work, he now catches one train and one metro, a journey that takes one hour and fifteen minutes.

Experience with Technology

João has always been really passionate about technology. He follows the latest developments and reads every blog about it. He would like to have every device and gadget, but he cannot afford it, so he is very wise about his purchases. In his phone, he uses an application for as many tasks as possible, being those that offer more customization options the ones that he enjoys the most.

Needs and wants

Nowadays João never misses a change to drive. Off course that he would prefer the freedom he had in Figueira, but he is happy to be next to his girlfriend. In addition to that, the fact that he has registered for a membership of Benfica makes him even happier.

In the two lifestyles that he experienced, he had to adapt his needs to the existing solutions and he would love to have more information on how to move around easier by using the public transportation system to regain part of the freedom he had in the past.

Name: Maria

Age: 35

Nationality: Belgian

Meet Maria, **a commuter with accessibility needs**

Lifestyle & Identity characteristics

Maria, born blind, lives in a very happy family in Brussels. She is from a middle-class family and the middle of three children; in school and at college she did very well; she made use of the specific support material (audio tapes and books) and she graduated. For a long time, the job opportunities she had, required her to commute daily, which Maria wasn't very comfortable with. Fortunately, during the last month, she has found a job as an audio books translator and she needs to visit the premises of the publisher two to three times a month. Her sister Linda has accompanied her once to the premises of the publisher in order to help her learn the route and familiarise herself with the transport means. However, Maria does not feel confident yet to commute by herself and needs to be accompanied one more time, but as Linda is currently at a later stage of pregnancy, she cannot assist Maria anymore. Maria has much experience in listening to audio books, so she is familiar to following audio output at high speed and she has also developed great skills at recognising foreign words or abbreviations (which sometimes cause problems to the screen readers operation).

Transportation patterns

Maria is very happy with her new job and although she really enjoys the time she spends at the office and the cooperation with her colleagues, the truth is that she still feels quite anxious in using public transport for meeting with her employer in the city centre, especially since she has to use two different PT means (bus and metro) to get there.

Experience with Technology

Technology has been part of Maria's life since she started using it to make common tasks easier for her, for example using a Perkins Brailler for writing texts. Nowadays, she uses her phone without problems, thanks to the accessibility options that it provides, for tasks like speaking and chatting, or emailing.

Needs and wants

Maria has used several assistive technologies in the past (i.e. text-to-speech)but mainly in her home environment where everything has been setup/adapted especially for her and she would now like to be able to use similar assistance in public places as well, so that she can gain confidence while being outside the house and thus increase her independence in travelling and mobility.

3.4 MY-TRAC USER STORIES

The next step in understanding My-TRAC users is the elicitation of user stories from the personas described in the previous section. While personas tell us who the user is, user stories tells us what they do. They are descriptions of how the users may interact with the system.

A user story is a short statement or abstract that identifies the user and their need/goal. The adoption of user stories as a method to elicit user requirements is growing, especially in the context of agile software development (Garm Lucassen, 2016). These statements determine who the user is, what they need and why they need it. They usually follow the template:

***As** a <type of user>, **I want**<certain goal>**so that**<some reason>*

Below, the user stories derived from the identified personas are detailed.

- **Martha**

As an environmentalist, I…

(1) …**want** to ride my bike to the university whenever I can, **so that** I do not have to deal with public transport's annoyances.
(2) …**want** to always use the most environment-friendly alternative, **so that** I can be coherent with my beliefs.
(3) …**want** to have alternatives to biking if there is bad weather, **so that** I can reach my destination without trouble.
(4) …**want** to know of pro-environment activities, **so that** I can participate in them.

- **Jose**

As a die-hard driver, I…

(1) …**want** to always drive my luxurious car, **so that** I can enjoy the trip.
(2) …**want** to be able pay to avoid traffic, **so that** I do not have to waste time.
(3) …**want** to have a parking spot available every day, **so that** I do not have to look for one.
(4) …**want** to know how to pick up my daughters from school and take them to other activities, **so that** I can do it in the fastest way.

- **Sofia**

As a reluctant driver, I…

(1) …**want** to have enhanced attributes like scenery, sociability and relaxation while travelling, **so that** I can create a more positive attitude towards public transport.
(2) …**want** to enjoy myself and meet people when I travel, **so that** I seize the times when I do not have to stay alone at home.
(3) …**want** to be aware of the alternatives I have for my commute, **so that** I can choose the most appropriate one.

- **João**

As a routine freak, I…

(1) …**want** to drive a car whenever I can, **so that** I can enjoy the freedom it brings.
(2) …**want** to have more information on how to move around easier in public transportation, **so that** I can regain part of the freedom I had.

- **Maria**

As a commuter with accessibility needs, I…

(1) …**want** to stop feeling anxious about using public transportation alone, **so that** I can travel on my own.
(2) …**want** to have assistance during my trip, **so that** I can learn the route and familiarize myself with the means of transport.

…**want** to be able to use assistive technologies, like text-to-speech, out of home, **so that** I can increase my independence.

3.5 My-TRAC User Profiles

3.5.1 Introduction

My-TRAC user profiles have been extracted from the analysis of the demographic part of the survey that was realised to get the affective needs of the users. The survey, as well as the tolls that were used (questionnaire) are described in detail in Section 4.3.4.1Affective requirements Web Survey. In the Section below, we present the descriptive analysis of the demographic characteristics, personality traits and car ownership status of the users who participated in the survey and try to create different user profiles, based on their characteristics, as well as the personas described above. The final profiles though will be defined in Section 4.3.4.2My-TRAC User Survey Results, were we will see the correlations between the design elements and the user characteristics. The aim of this work is to help us understand for whom we are really building our application for and allow us to recruite the right users in our pilot studies.

3.5.2 Demographic Characteristics

Participation in the study was voluntary and not financially rewarded. The response rate was on average 41%, which is in line with former studies based on register samples. The resulting sample was slightly biased with regard to the same sociodemographic groups, as most register samples are ((Groves, 1989), (Koch, 1998)), underrepresenting elder respondents and respondents with low levels of education, and people from rural areas. The survey took place in Greece with 216 respondents and in the Iberian Peninsula with 172 respondents. Table 1, shows the sociodemographic composition of both samples (N_{GR}=216, N_{IP}=77) and separately for males and females ($N_{GR,m}$=111 *and* $N_{GR,f}$=105, $N_{IP,m}$=36 *and* $N_{IP,f}$=41 respectively). Within each of the socio-demographic characteristics, due to missing data the reported values do not always add up to 100%. Finally, categories with no answers have been removed.

Table 1: Sociodemographic composition of the total sample in Greece and Iberica Peninsula

	GREECE		IBERICA PENINSULA		GREECE		IBERICA PENINSULA		GREECE		IBERICA PENINSULA	
	Total sample		**Total sample**		**Male subsample**		**Male subsample**		**Female subsample**		**Female subsample**	
	N=216		N=77		N=111		N=36		N=105		N=41	
Age	Absolute frequency	Relative frequency	Absolute frequency	Relative frequency	Absolute frequency	Relative frequency	Absolute frequency	Relative frequency	Absolute frequency	Relative frequency	Absolute frequency	Relative frequency
18-24	19	8,8	45	58,44	8	7,2	3	8,33	11	10,5	16	39,02
25-54	168	77,8	22	28,57	82	73,9	24	66,67	86	81,9	15	36,59
55-65	26	12	10	12,99	18	16,2	8	22,22	8	7,6	10	24,39
65+	3	1,4	0	0,00	3	2,7	1	2,78	0	0	0	0,00
Chronic Condition												
Yes	10	4,6	12	15,58	6	5,4	35	97,22	4	3,8	0	0,00
No	206	95,4	65	84,42	105	94,6	1	2,78	101	96,2	41	100,00
Education												
High school degree or equivalent	15	6,9	34	44,16	6	5,4	22	61,11	9	8,6	12	29,27
University degree or equivalent	169	78,2	40	51,95	85	76,6	14	38,89	84	80	26	63,41
Doctorate	31	14,4	3	3,90	20	18	0	0,00	11	10,5	3	7,32
Employment												
Employed full time	174	80,6	30	38,96	95	85,6	30	83,33	79	75,2	20	48,78
Employed part time	14	6,5	5	6,49	4	3,6	2	5,56	10	9,5	3	7,32
Student	15	6,9	40	51,95	6	5,4	1	2,78	9	8,6	16	39,02
Unemployed/ Retired	12	5,6	2	2,60	6	5,4	3	8,33	6	5,7	2	4,88

	GREECE		IBERICA PENINSULA		GREECE		IBERICA PENINSULA		GREECE		IBERICA PENINSULA	
	Total sample		Total sample		Male subsample		Male subsample		Female subsample		Female subsample	
Income												
Less than 20,000	70	32,4	37	48,05	35	31,5	9	25,00	35	33,3	15	36,59
20,000 to 49,999	112	51,9	28	36,36	56	50,5	21	58,33	56	53,3	15	36,59
50,000 to 99,999	28	13	7	9,09	16	14,4	6	16,67	12	11,4	7	17,07
Over 100,000	3	1,4	4	5,19	2	1,8	0	0,00	1	1	4	9,76
Living arrangements												
Alone-Single	55	25,5	22	28,57	34	30,6	25,0	69,44	21	20	11,0	26,83
Couple	65	30,6	10	12,99	28	25,2	7	19,44	28	36,2	7	17,07
Family	94	43,5	45	58,44	48	43,2	20	55,56	46	43,8	23	56,10
Urbanisation												
Rural	6	2,8	6	7,79	3	2,7	1	2,78	3	2,9	5	12,20
Sub-urban	52	24,1	25	32,47	26	23,4	10	27,78	26	24,8	15	36,59
Urban	158	73,1	46	59,74	82	73,9	25	69,44	76	72,4	21	51,22
Lifestyle												
Active	35	16,2	15	19,48	17	15,3	6	16,67	18	17,1	9	21,95
Classy	21	9,7	4	5,19	8	7,2	2	5,56	13	12,4	2	4,88
Domesticated	83	38,79	30	38,96	47	57,32	15	41,67	33	42,86	19	46,34
Fun	57	26,4	26	33,77	25	23,4	9	25,00	31	29,5	11	26,83
Other	18	8,3	2	2,60	9	8,1	4	11,11	9	8,6	0	0,00

Below there are chart that depict the results of the table above. There are charts for the whole sample and then from males and females separately, so differences in the groups can been seen more clearly.

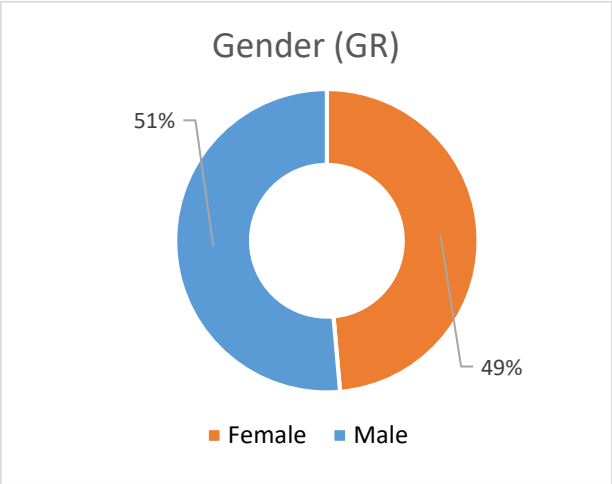


Chart 1: Gender distribution, Greece.

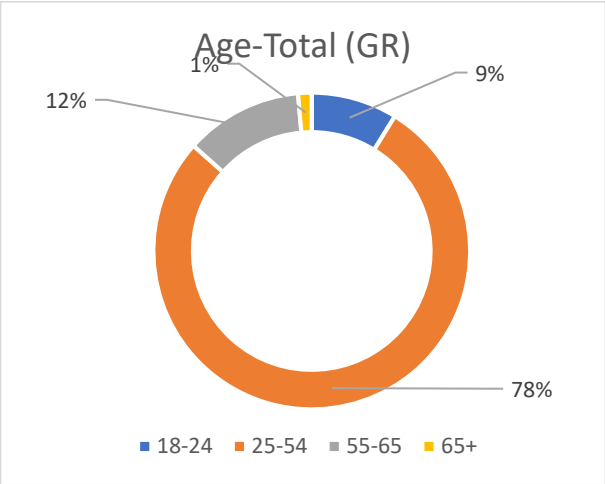


Chart 2: Age distribution, Greece.

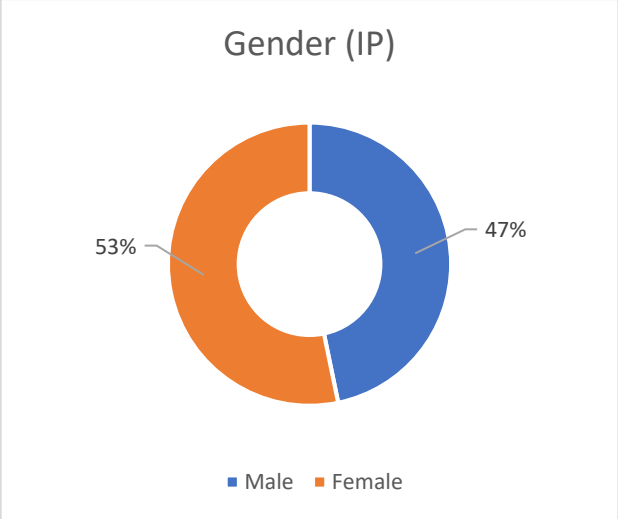


Chart 3: Gender distribution, Iberica Peninsula.

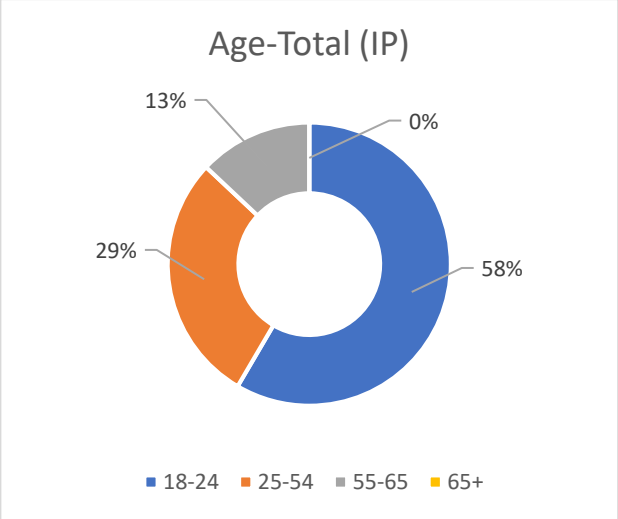


Chart 4: Age distribution, Iberica Peninsula.

Gender-wise, the distribution was really even in both cases, having 51% males and 49% female participants in Greece and 47% male and 53% females in the Iberica Peninsula. Regarding the age, we see very different distribution among the responders in Greece and in the Iberica Peninsula. In Greece the majority of the respondents (78%) was 25-54 years old; this age group in the Iberica Peninsula responders covers 29%. On the other hand, the majority of the respondents (58%) in the Iberica Peninsula was 18-24 years old, while the Greek responders of that age (18-24) was 9%.

The charts that follow depict the age distribution amond male and female respondents in Greece and the Iberica Peninsula.

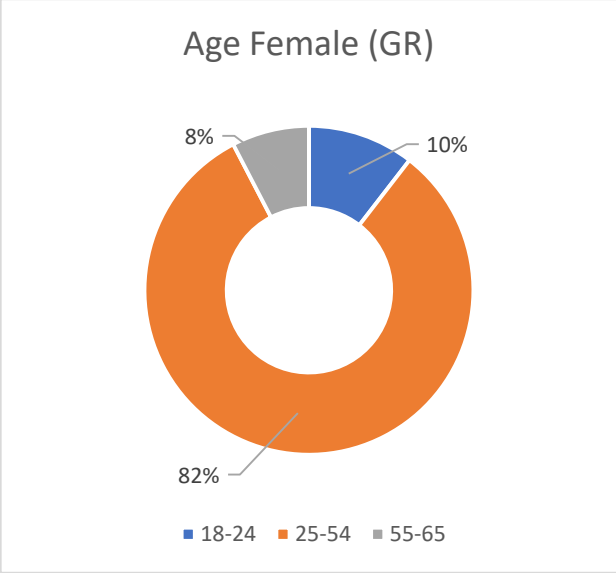


Chart 5: Age distribution females, Greece.

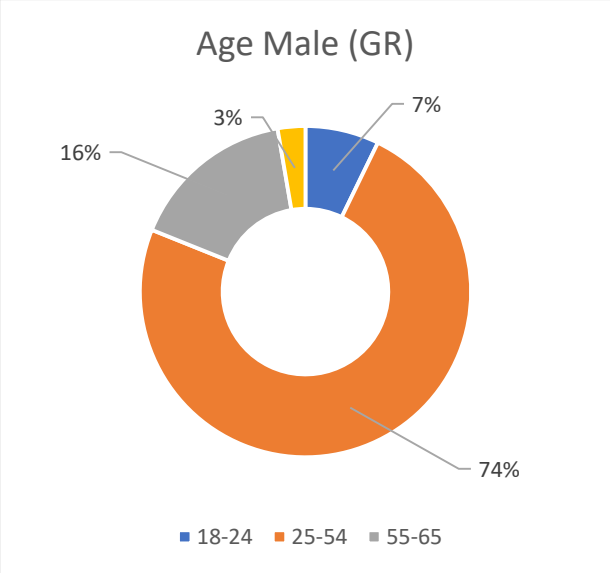


Chart 6: Age distribution males, Greece.

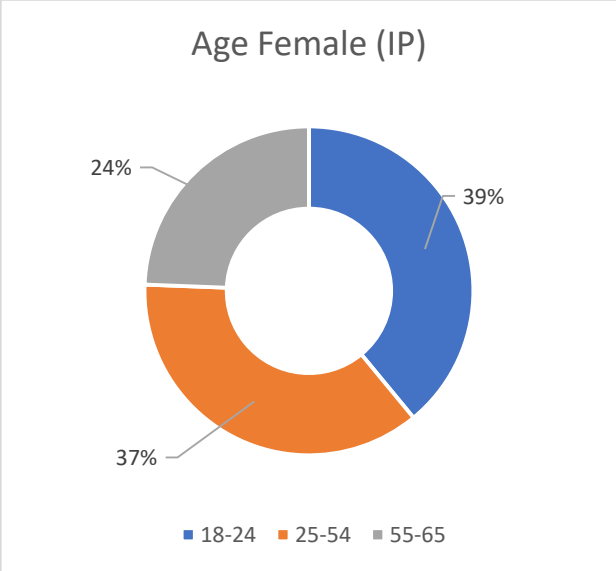


Chart 7: Age distribution females, Iberica Peninsula.

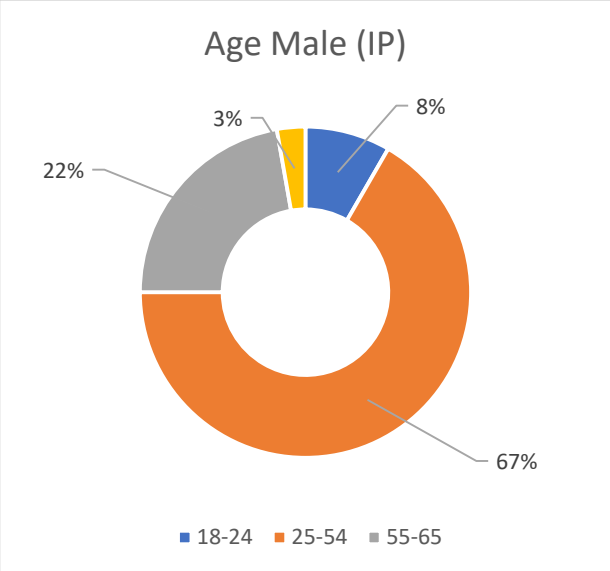


Chart 8: Age distribution males, Iberica Peninsula.

Regarding the age distribution we do not see much difference among female and male Greek participants. The female participants of the age group 18-24 were slightly more that the male ones. Respectively, the male participants of the age group 55-65 were slightly more that the female ones. On the other hand in the respondents sample from the Iberica Peninsula, we see a very even distribution in the female ones and not an even one among the males were 67% belongs to the age group 25-54. In both cases, Greece and Iberica Peninsula, we see that participatns over 65 years old are all males.

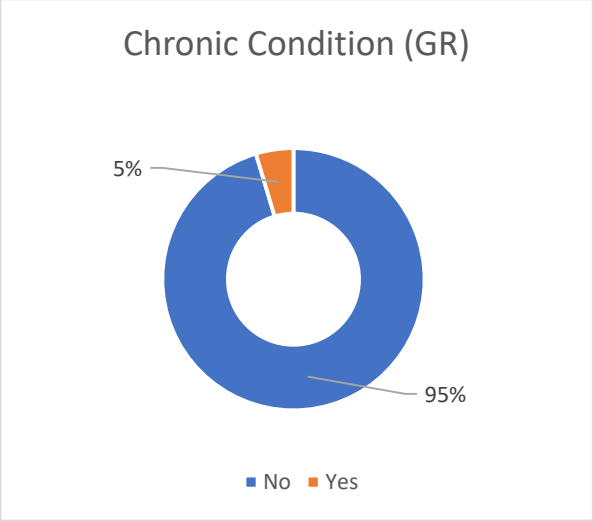


Chart 9: Chronic condition in the whole sample, Greece.

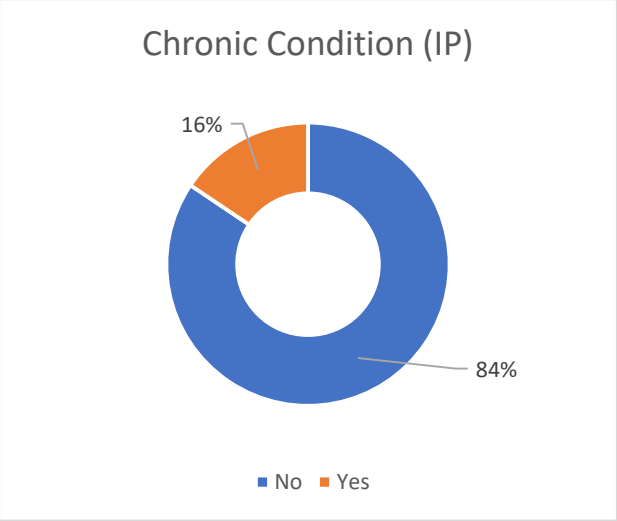


Chart 10: Chronic condition in the whole sample, Iberica Peninsula.

Regarding chronic conditions, only 5% of the respondents from Greece and 16% reposnders from the Iberica Peninsula answered that they had one. The majority of them had a chronic non severe condition related to their vision. Thus the prevailing percentage has non severe visual impairments.

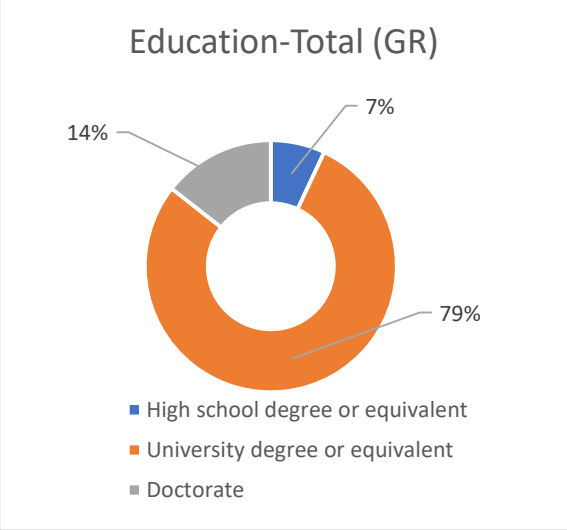


Chart 11: Education level in the whole sample, Greece.

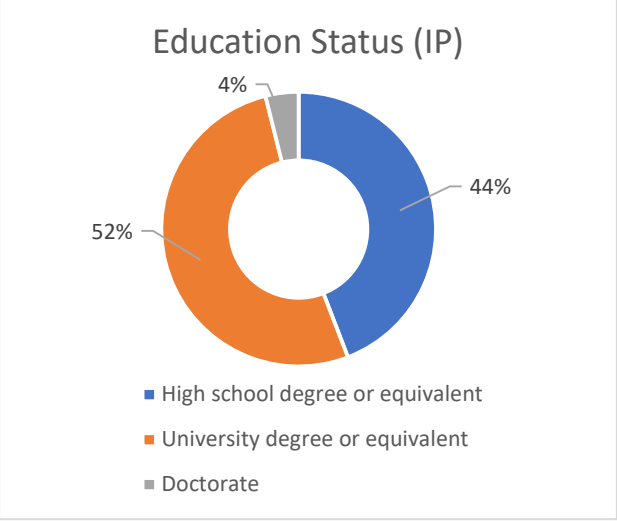


Chart 12: Education level in the whole sample, Iberica Peninsula.

Regarding the education level, as we mentioned in the beginning of the section also, there were no participants with only basic education. This highlights the social phenomenon that the population is highly literate in our times and also that the users or My-TRAC application are also literate people. Nevertheless, in both countries we see that the prevailing majority, 79% in case of Greece and 52% in case of Iberica Peninsula, have a university degree or equivalent. In the case of Iberica Peninsula this is followed by the respondents who had high scool degree, 44%, which were only 7 perscent in the case of Greece. Finaly, the responders who hold a PhD are 14% in the Greek sample and 4% in the sample of Iberica Peninsula.

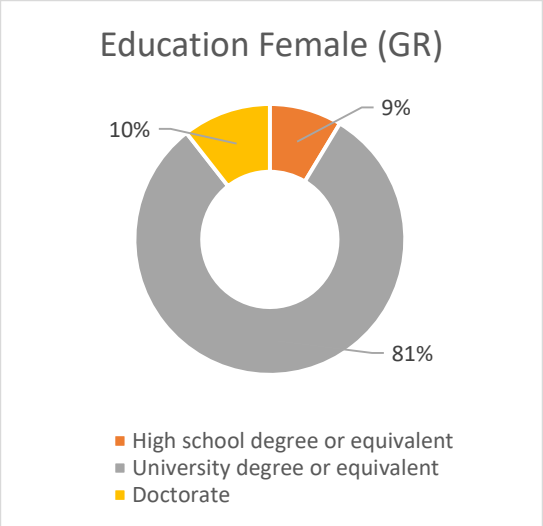


Chart 13: Education level females, Greece.

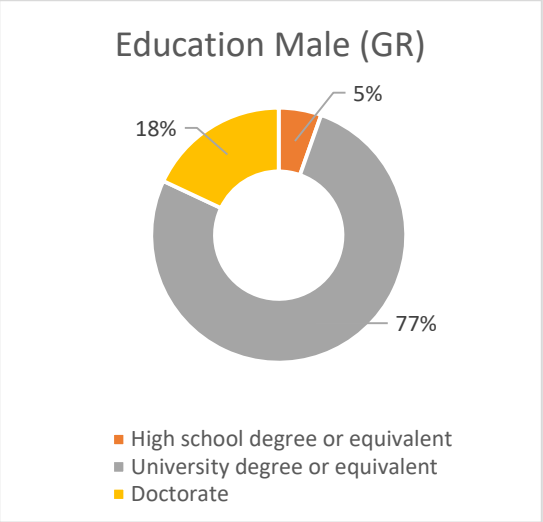


Chart 14: Education level males, Greece.

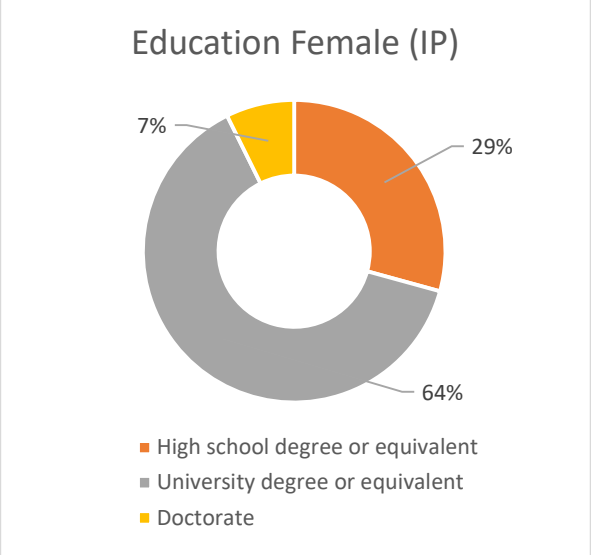


Chart 15: Education level females, Iberica Peninsula.

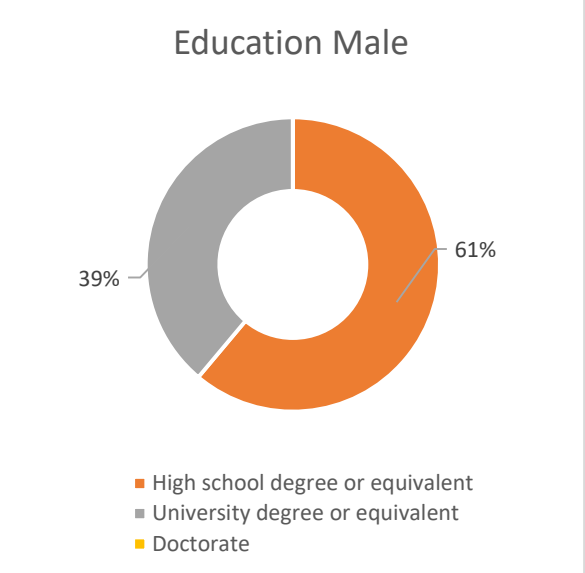


Chart 16: Education level males, Iberica Peninsula.

In the Greek sample, we don't see huge differences between male and female respondents. The only remark that can be done is that male PhD holders or candidates are slightly higher than the female ones. On the other hand, this is not the case in the Iberica Peninsula sample. There, the majority of the female respondents (64%) have a university degree while the male with university degree are 39%. The marotiy of the male respondents (61%) have a highshcool degree, while this group in the female responders reached 29%. Finally, there are no male PhD holders in the Iberica Peninsula sample.

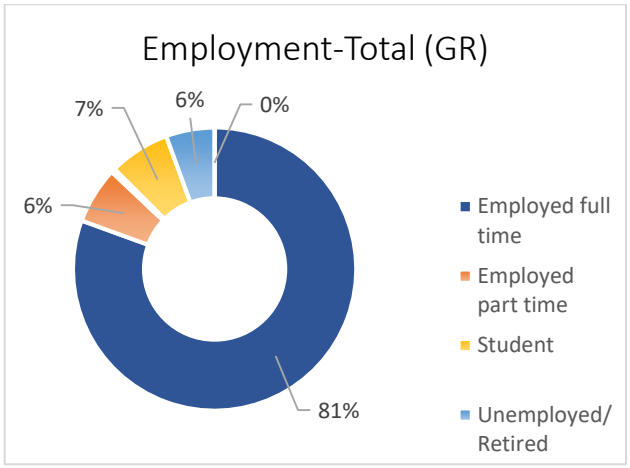


Chart 17: Employment status in the whole sample, Greece.

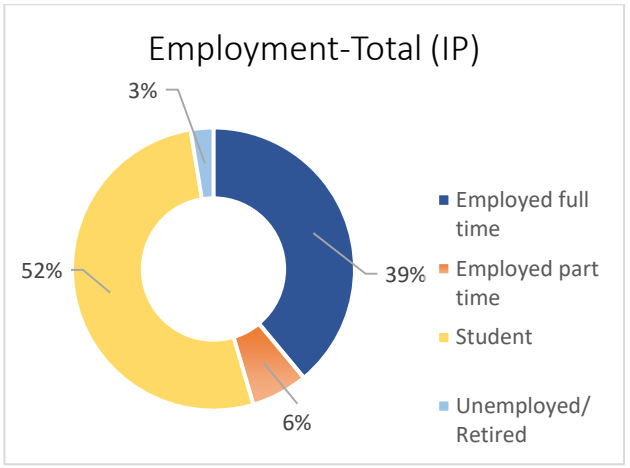


Chart 18: Employment status in the whole sample, Iberica Peninsula.

Regarding the employment status, as we mentioned in the beginning of the section also, there were no participants who are unable to work neither in Greece nor in the Iberica Peninsula. Among the Greek respondents, the majority (81%) are full time employees. The full time employees in the Iberica Peninsula cover the 39%. In the case of the Iberica Peninsula sample, the majority comes from students, which in the Greek sample cover only the 7% of the respondents. So we see a great diference between the two sample populations reagarding the employment type of the respondents. The ontly consencus is at the part time employees who are covering the 6% of the sample population in both countries and the unemployed who cover the 6% in the case of Greece and the 3% in the case of the Iberica Peninsula.

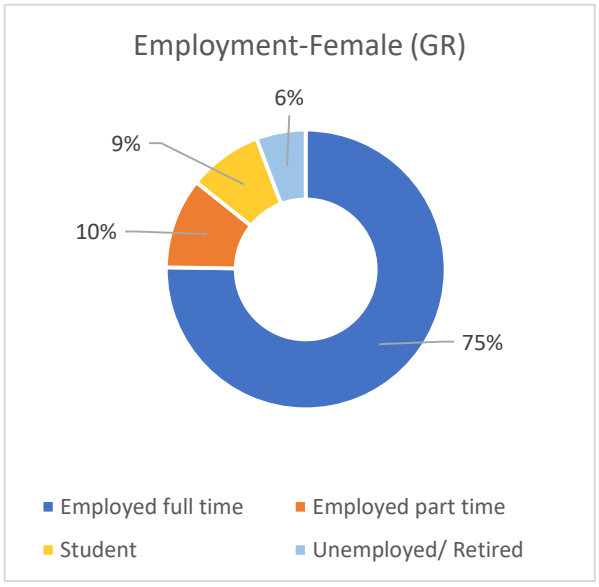


Chart 19: Employment status females, Greece.

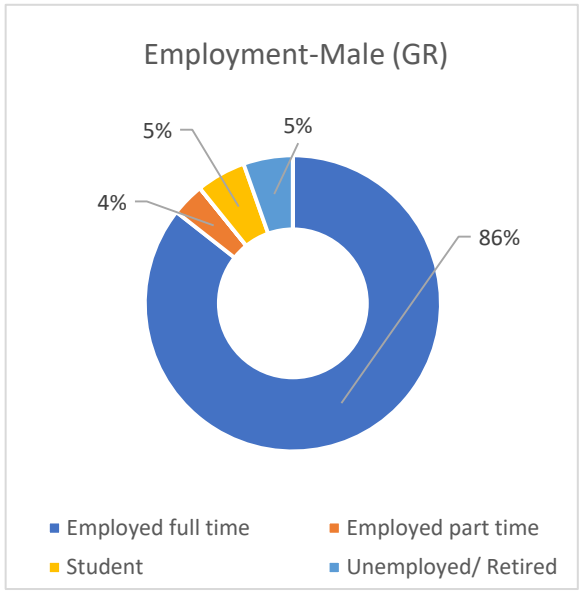


Chart 20: Employment status males, Greece.

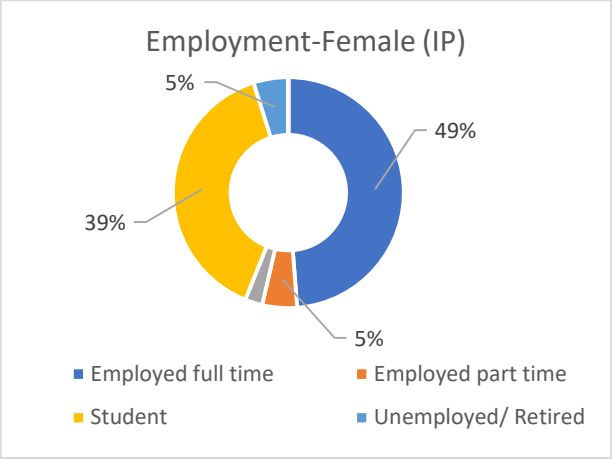


Chart 21: Employment status females, Iberica Peninsula.

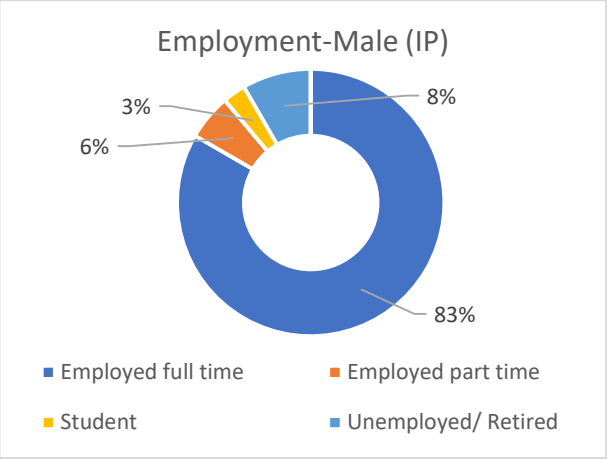


Chart 22: Employment status males, Iberica Peninsula.

Regarding the employment status among the Greek respondents we see that there are slightly more female respondents in total who are not full time employees, but they belong to other -looser- employment groups like part time employees. In the Iberica Peninsula sample population we see greater differencies. The majority of the male (85%) and female (49%) respoders sample is also covered by full time employees, but the female students percentage are far more greater than the male students percentage, 39% to 3%.

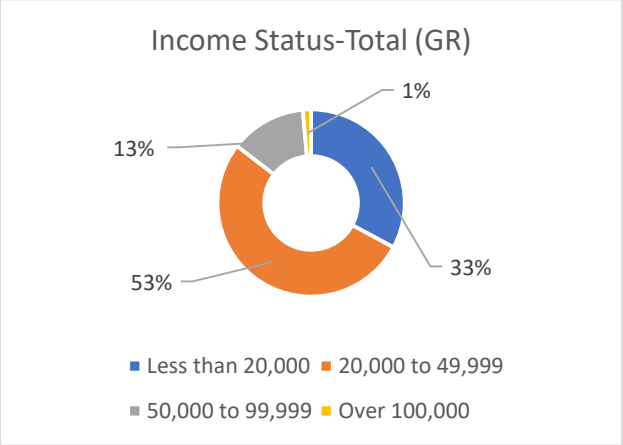


Chart 23: Income status in the whole sample, Greece.

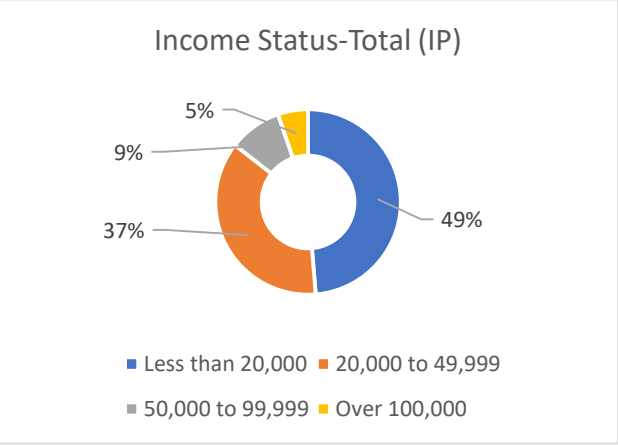


Chart 24: Income status in the whole sample, Iberica Peninsula.

As we can see from Chart 23 and Chart 24, the majority of our sample in both cases is of a medium to low income, 86% in case of the Greek and the Iberica Peninsula sample population. In more details, the majority of the Greek sample (53%) is of a medium income and the majority of the Iberica Peninsula (49%) is of low household income. Taking into consideration especially the fact that emerges from the following data related to the living arrangements of the sample, where we can see that the majority lives in a household with more than 2 people. Additionally, the following category is people with low income. Here we can make the assumption that this low income fact can emerge from the crisis, especially in the countries were the survey was realised (Greece, Portugal and Spain).

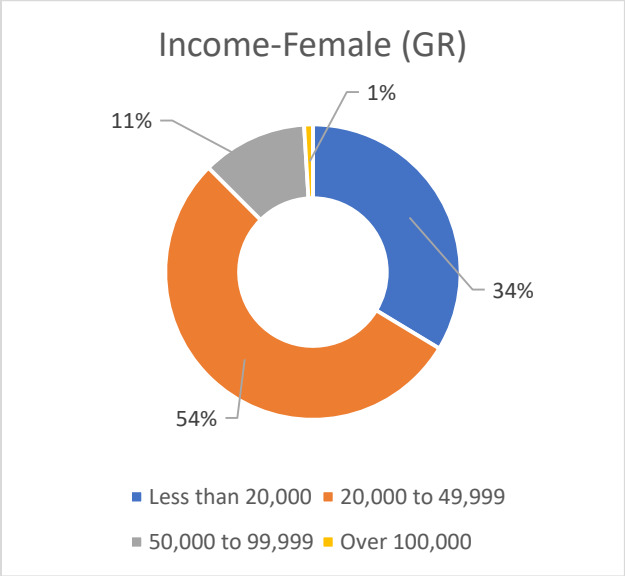


Chart 25: Income status females, Greece.

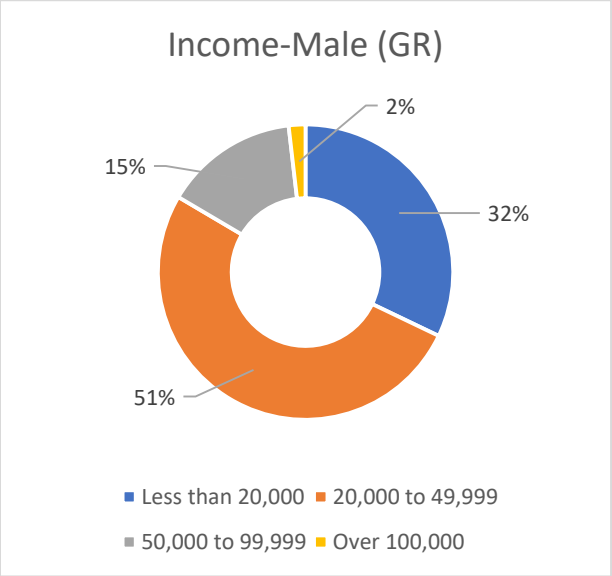


Chart 26: Income status males, Greece.

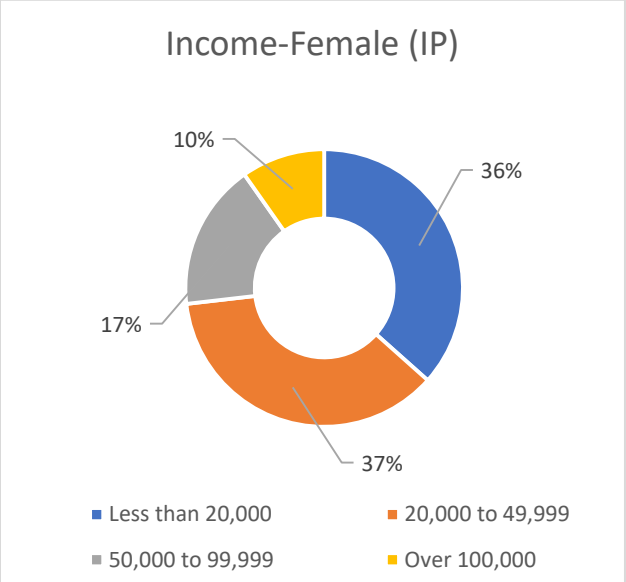


Chart 27: Income status females, Iberica Peninsula.

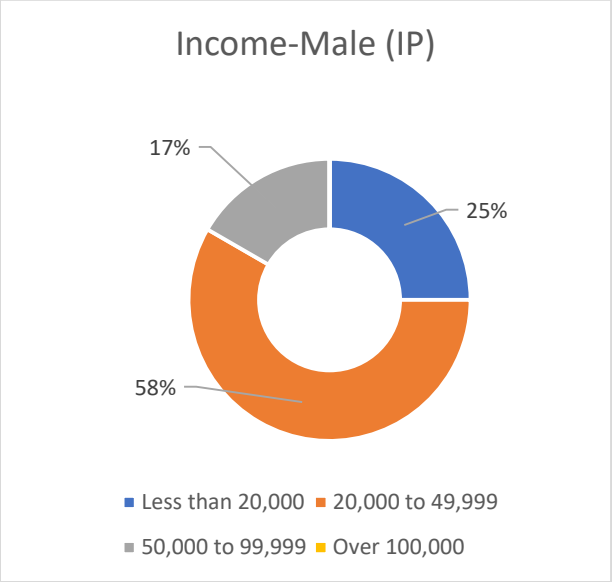


Chart 28: Income status males, Iberica Peninsula.

There is no significant difference regarding the income status between females and males respondents among the Greek responders. The same stands more or less for the Iberica Peninsula sample too. There, we see slightly more male than female responders with medium income (20,000€ to 49,000€), but in the female responders there is a percentage (10%) with income over 100,000€, while there is no male responder with so high income.

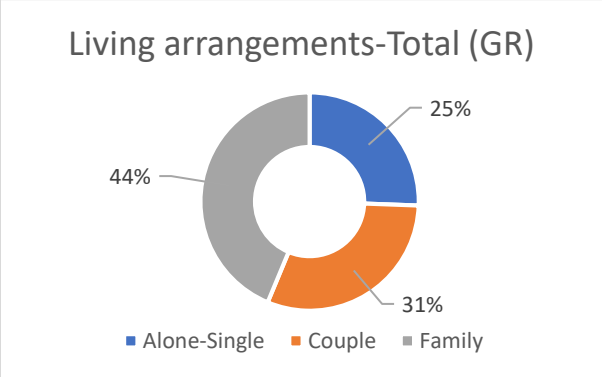


Chart 29: Living arrangements status in the whole sample, Greece.

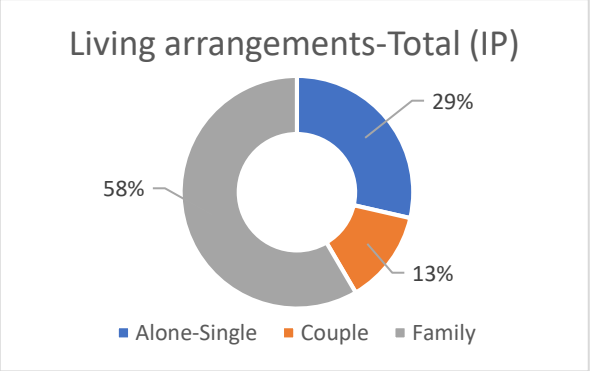


Chart 30: Living arrangements status in the whole sample, Iberica Peninsula.

Regarding their living arrangements status, the distribution of our sample is quite similar in both countires. The majority of both countries' sample, 44% for Greece and 58% for the Iberica Peninsula, live alone, followed by people who leave in couples 31% in Greece and 13% in the Iberica Peninsula. Finally, the 25% of the Greek respondents sample and the 29% of the Iberica Peninsula sample, live with their their families.

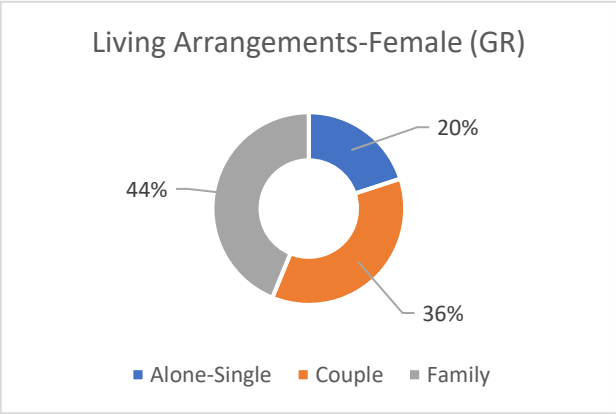


Chart 31: Living arrangements status females, Greece.

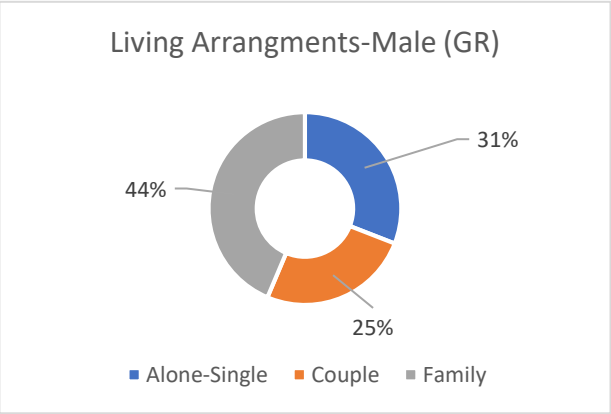


Chart 32: Living arrangements status males, Greece.

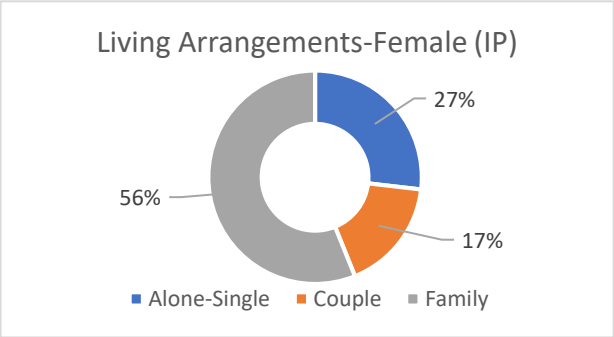


Chart 33: Living arrangements status females, Iberica Peninsula.

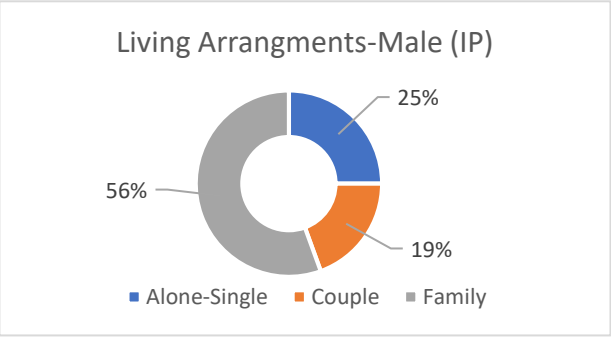


Chart 34: Living arrangements status males, Iberica Peninsula.

Regarding the living arrangements per gender, we don't see significant differences among male and female respondents in either countires.

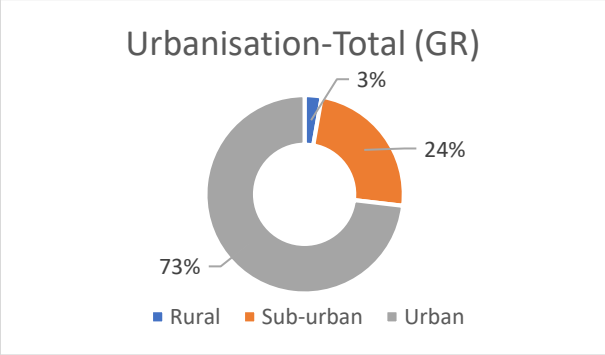


Chart 35: Urbanisation status in the whole sample, Greece.

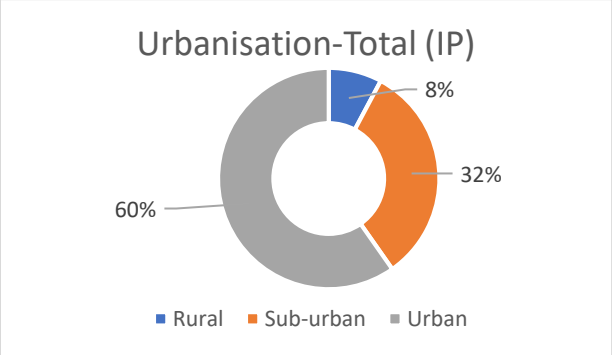


Chart 36: Urbanisation status in the whole sample, Iberica Peninsula.

The urbanisation status question was mainly asked in order to separate people who live in the city with people who live in the suburbs. So, the sample was also picked in such a way as to fulfil this scope, since we needed our sample to use a variation of transportation means during their trip (possibly metro included). This explains our bias towards the rural areas respondents, since we see that the majority of the respondents in both countires, 73% in the case of Greece and 60% in the case of Iberica Peninsula, live in urban areas.

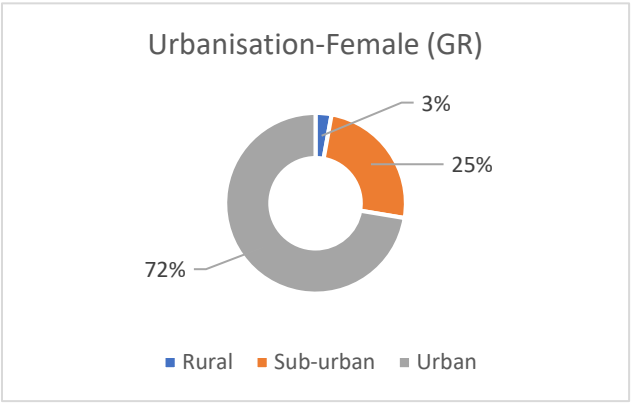


Chart 37: Urbanisation status females, Greece.

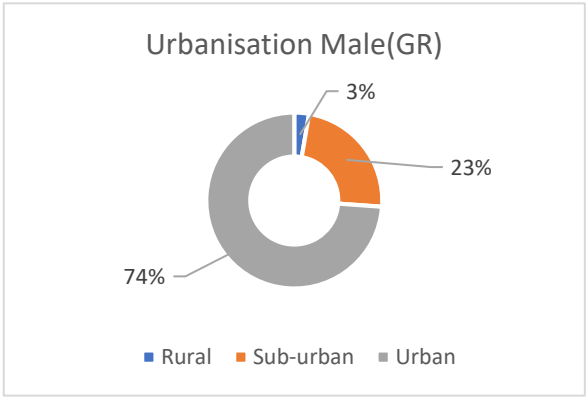


Chart 38: Urbanisation status males, Greece.

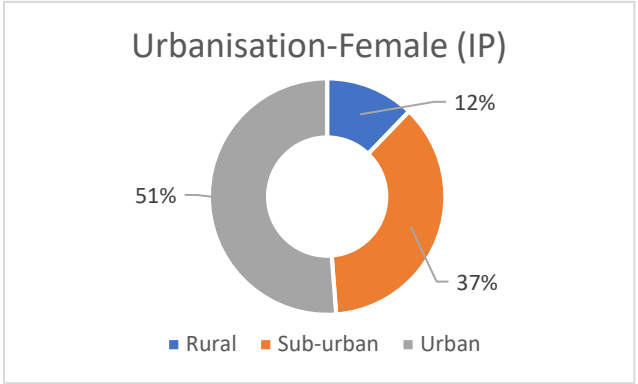


Chart 39: Urbanisation status females, Iberica Peninsula.

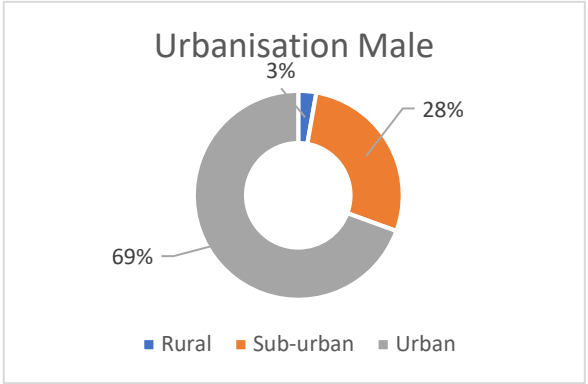


Chart 40: Urbanisation status males, Iberica Peninsula.

We see that there is no significant variation between female and male respondents regarding urbanisation status.

Regarding their lifestyle, users had to pick among the following options.

- Active - outdoor, sports-oriented, adventurous
- Classy - elegant, luxurious, trendy
- Domesticated - family-based, homely
- Fun - pleasure seeking, sociable

The following charts depict the results of the lifestyle question for the Greek and the Iberica Peninsula samples of responders.

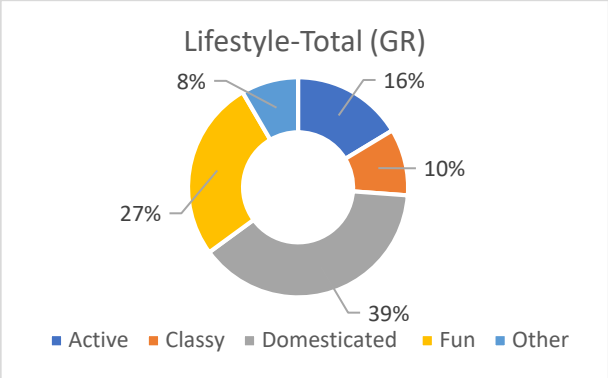


Chart 41: Lifestyle status in the whole sample, Greece.

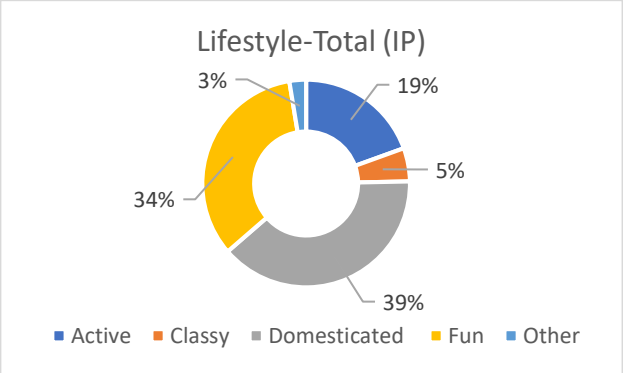


Chart 42: Lifestyle status in the whole sample, Iberica Peninsula.

The lifestyle status questions is one of the introductory ones to step from the strictly demographic data, to more personality and self-assessment ones. It is a question that is related to how the respondents live their lives. Regardless the fact of what they are doing in their everyday life, this question is related to the way they do it. We can see from the chart above that most respondents, in both countires (39% in both cases), feel they have a domesticated lifestyle, which is family-based, homely. This is followed by a lifestyle that is characterised as fun and playfull (27% in Greece and 34% in the Iberica Peninsula).

Comparing the answers of male and female regarding their lifestyle status we did not see any interesting findings in both countires. On the contrary we did see some interesting finding comparing the different age groups' lifestyle status self-assessment as they are presented in the following charts.

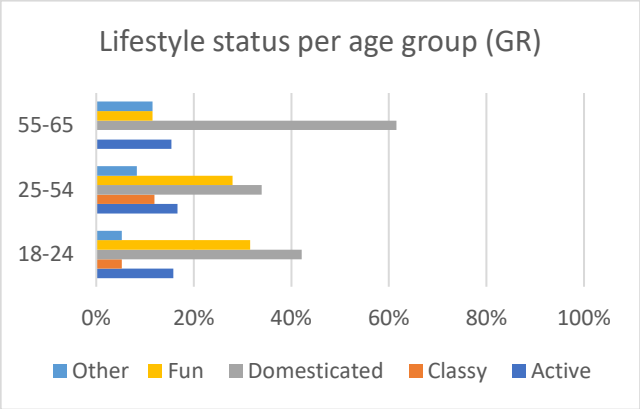


Chart 43: Lifestyle status per age group, Greece.

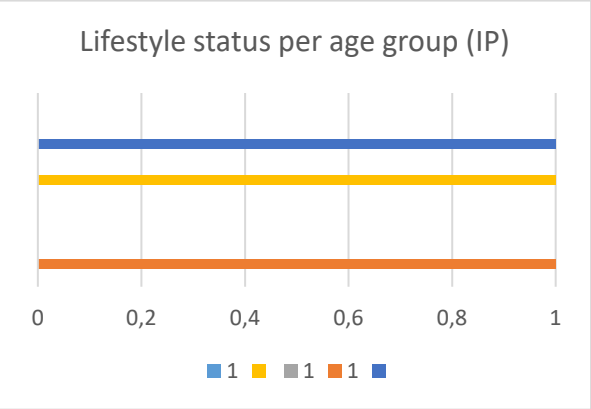


Chart 44: Lifestyle status per age group, Iberica Peninsula.

In the Greek sample, all age groups find their life domesticated and mostly the older group (55-65), among which the domesticated lifestyle is far the most preferable option. The same stands for the older group

of respondents from the Iberica Peninsula. The domesticated lifestyle is followed by the fun one in the Greek sample of respondents. The same stands for all the groups of Iberica Peninsyla but the olders ones who find their life active.

There is a significant amount of respondents who did not find any of the answers capable of covering their self-assessment of lifestyle and choose other as an option. Most of them answered that their life is characterised from a combination of the aforementioned values and they could not choose one as the more representative one. Others, 10 respondents in total, find their lifestyle business oriented.

3.5.3 PERSONALITY CHARACTERISTICS

The personality characteristics of the sample population where extracted using the Big Five Inventory (BFI) -2 (XS) scale developed by Soto and John (Soto & John, 2017a), (Soto & John, 2017b). The Greek version was provided by the author and it was developed for use in the International Situations Project (credits to Papastenfanakis E., Kritsotakis G. and Spyridaki I.). The Spanish version was also provided by the author and developed by David Gallardo-Pujol and colleagues. The Portuguese version was translated within the project.

The Big Five Inventory is a self-report inventory designed to measure the Big Five personality traits; agreeableness, conscientiousness, extraversion, neuroticism and openness. The definitions of the Big Five personality traits follow.

Agreeableness refers to a desire to keep things running smoothly. This score means that respondents are caring and honest, they are interested in people around them and also believe the best about the others, being ready to help others if needed. Conscientiousness on the other hand describes a careful, detail-oriented nature. Having a relatively high score in conscientiousness describes a person who likes to keep thing in order, is goal-driven and is persistent. Extraversion refers to the energy drawn from social interactions. People with high extraversion score seem to make friend easily, speak without thinking and enjoy being with others. Openness refers to a sense of curiosity about others and the world. High openness scores show people that enjoy new things and are creative, having a vivid imagination and be willing to consider new ideas. Neuroticism describes a tendency to have unsettling thoughts and feelings.

Table 2 shows means, standard deviations, skewness, and kurtosis of the five BFI-2 (XS) scales for the total sample.

Table 2: Means, standard deviations, skewness, and kurtosis of the five BFI-2 (XS) scales.

	Greece				Iberica Peninsula			
	Mean	**SD**	**Sk**	**K**	**Mean**	**SD**	**Sk**	**K**
Extraversion	3,16	0,70	-0,42	0,15	2,91	0,65	-0,20	-0,29
Agreeableness	3,66	0,74	-0,6	0,84	3,04	0,75	-0,48	-0,11
Conscientiousness	3,63	0,79	-0,33	-0,44	2,52	0,70	-0,46	0,19
Neuroticism	2,50	0,89	0,54	0,22	3,19	0,70	0,46	0,19
Openness	3,05	0,72	-0,23	-0,28	3,14	0,56	0,05	0,15

Skewness varied among the five dimensions between –0.6 and 0.54 with an absolute mean of -0.21, and kurtosis between –0.44 and 0.82 with an absolute mean of 0.1. As absolute values greater than 1 indicate a substantial deviance from a normal distribution (Muthén & Kaplan, 1985), the five BFI-2 (XS) dimensions can be regarded as normally distributed.

Table 3 shows means and standard deviations of the five BFI-2 (XS) scales, reported separately for age, gender, education, employment, income, living arrangements, urbanization and lifestyle.

Table 3: Means and standard deviations of the five BFI-2 (XS) scales

	Extraversion				Agreeableness				Conscientiousness				Neuroticism				Openness			
	Greece		Iberica Penins.		Greece		Iberica Penins.		Greece		Iberica Penins		Greece		Iberica Penins.		Greece		Iberica Penins.	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Entire sample	3,15	0,66	2,91	0,66	3,62	0,73	3,04	0,76	3,62	0,77	2,52	0,71	2,50	0,88	3,19	0,71	3,05	0,70	3,14	0,56
Age																				
18-24	2,71	0,56	2,68	0,66	3,52	0,62	3,04	0,86	3,48	0,66	2,65	0,71	3,13	0,86	3,07	0,71	3,22	0,56	3,20	0,57
25-54	3,22	0,63	3,19	0,54	3,66	0,74	3,00	0,59	3,62	0,78	2,29	0,68	2,46	0,85	3,42	0,68	3,02	0,71	3,05	0,60
55-65	3,08	0,76	3,36	0,43	3,71	0,69	3,17	0,62	3,80	0,75	2,48	0,69	2,32	0,88	3,24	0,69	3,08	0,66	3,07	0,49
Gender																				
Female	3,21	0,65	2,57	0,66	3,56	0,76	2,99	0,78	3,67	0,82	2,63	0,71	2,39	0,84	3,08	0,71	3,00	0,71	3,01	0,57
Male	3,12	0,67	3,21	0,50	3,76	0,70	3,14	0,75	3,58	0,73	2,51	0,64	2,59	0,89	3,20	0,64	3,10	0,64	3,27	0,56
Education																				
High school degree	2,91	0,70	2,62	0,63	3,54	0,59	2,96	0,93	3,32	0,66	2,68	0,64	2,77	0,75	3,03	0,64	2,86	0,46	3,19	0,57
University degree	3,15	0,65	3,12	0,59	3,65	0,75	3,16	0,56	3,61	0,78	2,45	0,73	2,48	0,90	3,27	0,73	3,04	0,69	3,13	0,55
Doctorate	3,36	0,66	3,49	0,50	3,76	0,72	2,46	0,84	3,89	0,78	1,75	0,60	2,51	0,86	3,97	0,60	3,14	0,74	2,62	0,63
Employment																				
Employed full time	3,21	0,62	3,13	0,58	3,63	0,74	3,17	0,60	3,68	0,77	2,42	0,81	2,39	0,84	3,29	0,81	3,00	0,69	3,13	0,54
Employed part time	3,08	0,88	3,24	0,13	3,88	0,71	2,81	0,78	3,54	0,78	2,57	0,20	2,84	0,94	3,14	0,20	3,36	0,55	2,57	0,46
Student	2,73	0,60	2,68	0,67	3,54	0,65	2,98	0,88	3,27	0,77	2,60	0,68	2,93	0,63	3,12	0,68	3,19	0,68	3,23	0,57

	Extraversion				Agreeableness				Conscientiousness				Neuroticism				Openness			
	Greece		Iberica Penins.		Greece		Iberica Penins.		Greece		Iberica Penins		Greece		Iberica Penins.		Greece		Iberica Penins.	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Unemployed/ Retired	3,03	0,83	3,45	0,84	3,93	0,68	2,98	0,17	3,63	0,83	2,50	0,51	3,24	1,17	3,21	0,51	3,08	0,73	2,86	0,34
Income																				
Less than 20,000	3,01	0,71	2,68	0,75	3,63	0,81	3,11	0,80	3,42	0,82	2,68	0,59	2,65	0,92	3,04	0,59	3,16	0,63	3,23	0,44
20,000 to 49,999	3,20	0,65	3,10	0,44	3,68	0,66	2,89	0,72	3,68	0,70	2,47	0,70	2,47	0,90	3,25	0,70	2,99	0,67	2,91	0,66
50,000 to 99,999	3,32	0,50	3,20	0,45	3,82	0,68	3,57	0,51	4,01	0,76	2,41	0,85	2,26	0,70	3,30	0,85	3,10	0,83	3,50	0,61
Over 100,000	3,89	0,49	3,39	0,74	2,86	0,63	2,62	0,75	3,65	0,69	1,49	0,71	2,54	0,73	4,23	0,71	2,30	0,36	3,21	0,31
Living arrangements																				
Alone-Single	3,13	0,61	3,03	0,77	3,43	0,76	3,19	0,62	3,32	0,72	2,40	0,68	2,71	0,89	3,31	0,68	3,06	0,68	3,23	0,63
Couple	3,17	0,65	3,12	0,52	3,71	0,75	3,14	0,72	3,72	0,82	2,40	0,65	2,40	0,94	3,31	0,65	2,99	0,65	3,19	0,68
Family	3,17	0,70	2,79	0,61	3,75	0,69	2,94	0,84	3,75	0,74	2,65	0,68	2,46	0,82	3,06	0,68	3,08	0,72	3,07	0,51
Urbanisation																				
Rural	2,86	0,84	2,60	0,57	3,61	0,92	2,26	0,97	3,41	0,92	2,88	0,64	2,38	1,01	2,83	0,64	3,02	0,61	3,05	0,65
Sub-urban	3,20	0,67	2,68	0,62	3,70	0,62	3,20	0,75	3,64	0,80	2,65	0,57	2,56	0,89	3,06	0,57	2,95	0,63	3,15	0,50
Urban	3,16	0,65	3,29	0,56	3,65	0,76	3,11	0,54	3,64	0,77	2,26	0,79	2,49	0,88	3,46	0,79	3,08	0,71	3,15	0,62
Lifestyle																				
Active	3,31	0,62	2,89	0,72	3,57	0,78	3,21	0,72	3,69	0,74	2,46	0,71	2,31	0,74	3,25	0,71	3,07	0,60	3,14	0,64
Classy	3,32	0,65	3,33	0,34	3,54	1,07	3,75	0,60	3,71	0,67	2,68	1,02	2,27	0,79	3,04	1,02	2,82	0,67	3,10	0,85
Domesticated	2,96	0,69	2,77	0,66	3,72	0,66	2,91	0,77	3,67	0,82	2,59	0,70	2,57	0,98	3,13	0,70	2,97	0,74	3,18	0,43
Fun	3,25	0,63	3,01	0,65	3,66	0,72	2,95	0,77	3,49	0,79	2,55	0,62	2,60	0,82	3,17	0,62	3,16	0,68	3,06	0,65
Other	3,33	0,53	3,10	0,67	3,69	0,56	3,57	0,00	3,76	0,76	1,43	1,01	2,47	0,90	4,29	1,01	3,21	0,61	3,57	0,00

The chart below presents the mean and standard deviation of the entire sample of respondents.

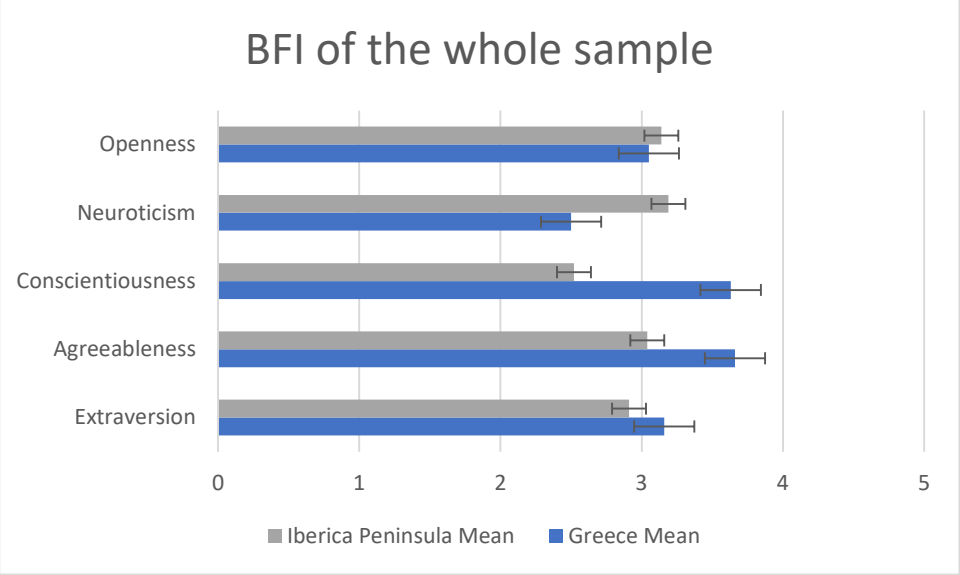


Chart 45: BFI results for the whole sample

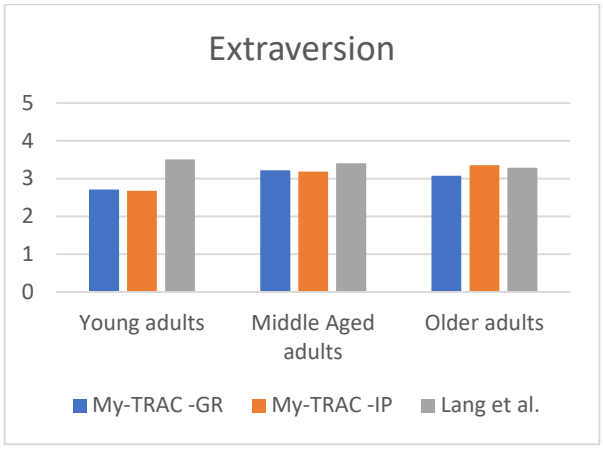
From the chart above we can see that the Greek sample scored high in agreeableness and conscientiousness, followed by extraversion and openness. On the contrary, the sample from Iberica Peninsula, scored high in Neroticism and Openness, followed by agreeableness and extraversion.

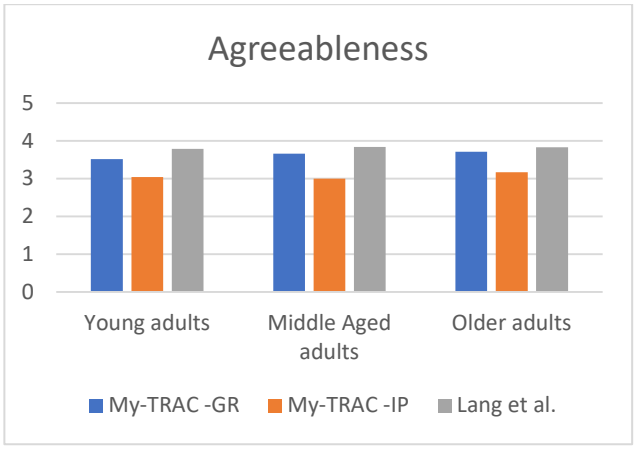
Not many norms regarding the BFI-2 (XS) scale exist in the literature. Lang et al. (2011) realised a survey in 2011 regarding different methods for successfully capturing BFI scores in Germany and they used BFI-2 (XS). From their research we have specific norms per age group which we compare with our sample scores in the following table.

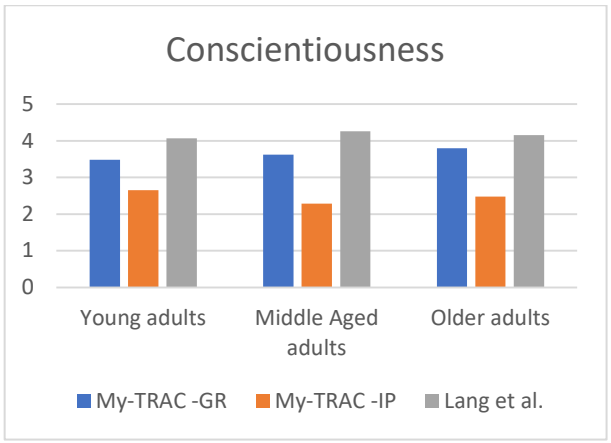
Table 4: Comparing My-TRAC sample scores with Lang et al. norms

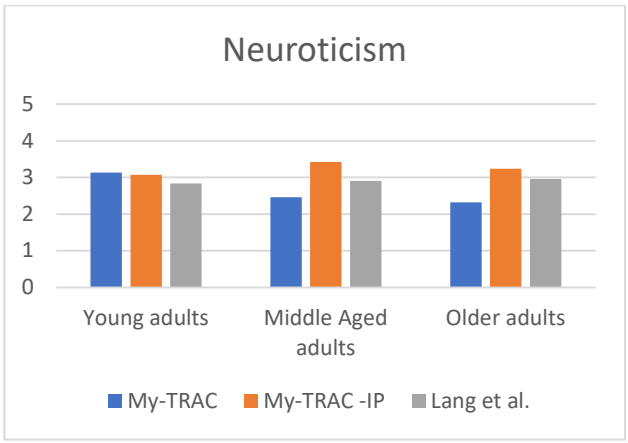
	Extraversion			**Agreeableness**			**Conscientiousness**			**Neuroticism**			**Openness**		
	My-TRAC -GR	My-TRAC -IP	Lang et al.	My-TRAC -GR	My-TRAC -IP	Lang et al.	My-TRAC -GR	My-TRAC -IP	Lang et al.	My-TRAC -GR	My-TRAC -IP	Lang et al.	My-TRAC -GR	My-TRAC -IP	Lang et al.
Age															
18-24 (Young adults)	2,71	2,68	3,51	3,52	3,04	3,79	3,48	2,65	4,07	3,13	3,07	2,84	3,22	3,20	3,24
25-54 (Middle Aged adults)	3,22	3,19	3,41	3,66	3,00	3,84	3,62	2,29	4,26	2,46	3,42	2,91	3,02	3,05	3,21
55-65 (Older adults)	3,08	3,36	3,29	3,71	3,17	3,83	3,80	2,48	4,16	2,32	3,24	2,96	3,08	3,07	3,14

The charts that follow depict the above results.









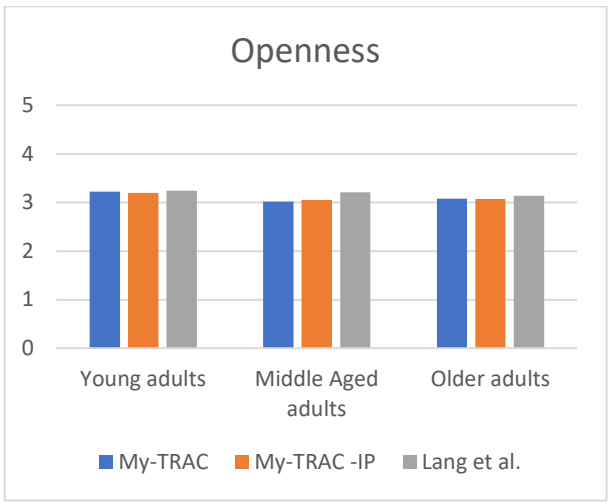
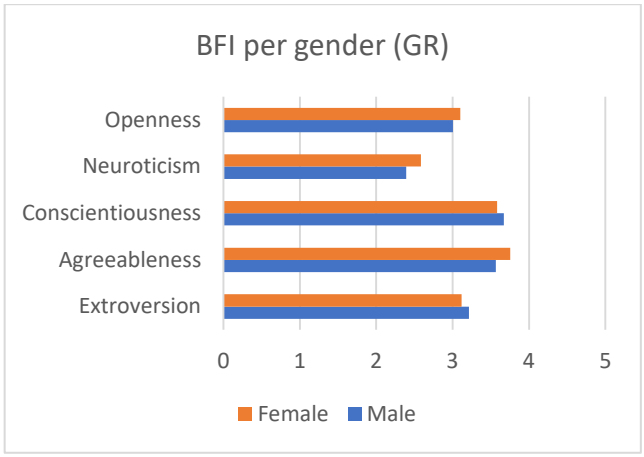


Chart 46: Comparison of My-TRAC BFI scores with Lang et al. norms

In more detail we can see that the Greek sample is closer to Lang et al.'s norms noticing though some specific deviations. In general, on both the Greek and the Lang et al.'s samples conscientiousness and agreeableness are the ones that have the highest scores. On the contrary at the Iberica Peninsula sample, the neurotisism is the one with the highest score. In Lang et al.'s sample conscientiousness and agreeableness are followed by extroversion in all age groups which is not the case in our sample of respondents. Especially in the young adult's group (18-24), where according to Lang et al. should have the highest extroversion score among all groups, in our sample's case it has the lowest score of all. In general, we expect extroversion to be reduced as we age, but this is not the case in our sample.



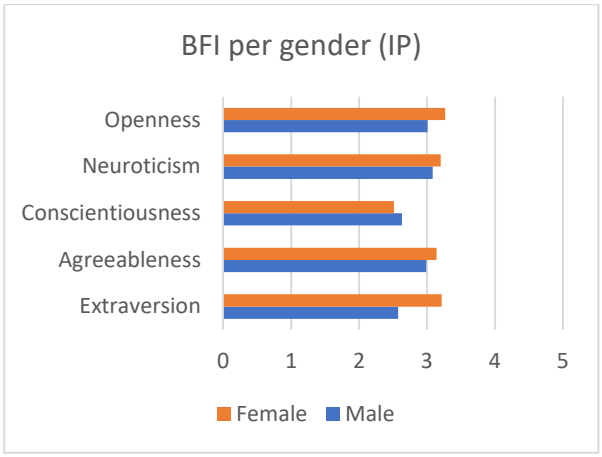
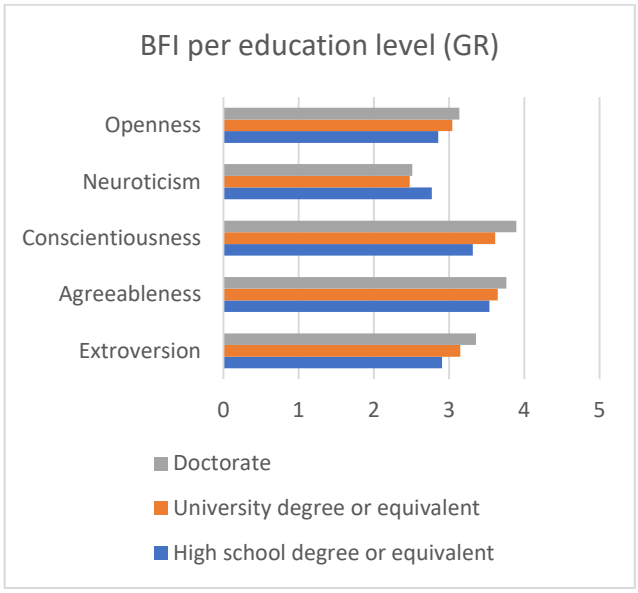


Chart 47: My-TRAC BFI scores per gender

The BFI scores per gender follow the same distribution in both countries. So, in both cases, the female respondents scored slightly higher in agreeableness, openness and neuroticism than the male ones who scored higher in conscientiousness. The rest are more or less the same for both genders in both countires apart from the extroversion were in Iberica Peninsula femalre respondents scored higher than the male ones, were in Greece the opposite happened.



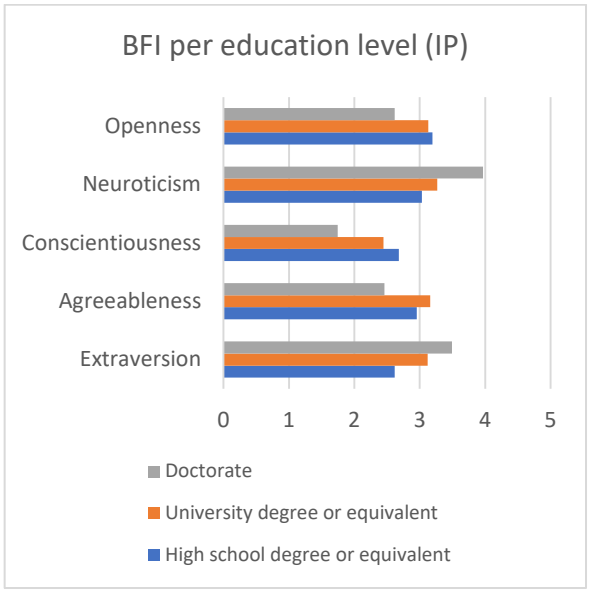


Chart 48: My-TRAC BFI scores per education level

The BFI scores per education level have great variation among different groups and in between the tow countires. Among the Greek participants, we can see from the charts above that the ones with PhD have higher scores in almost all personality traits and especially conscientiousness. On the other hand, people with high school degree scored higher in neuroticism. This is not the case in Iberica Peninsula, were PhD holders scored higher in neuroticism and extraversion.

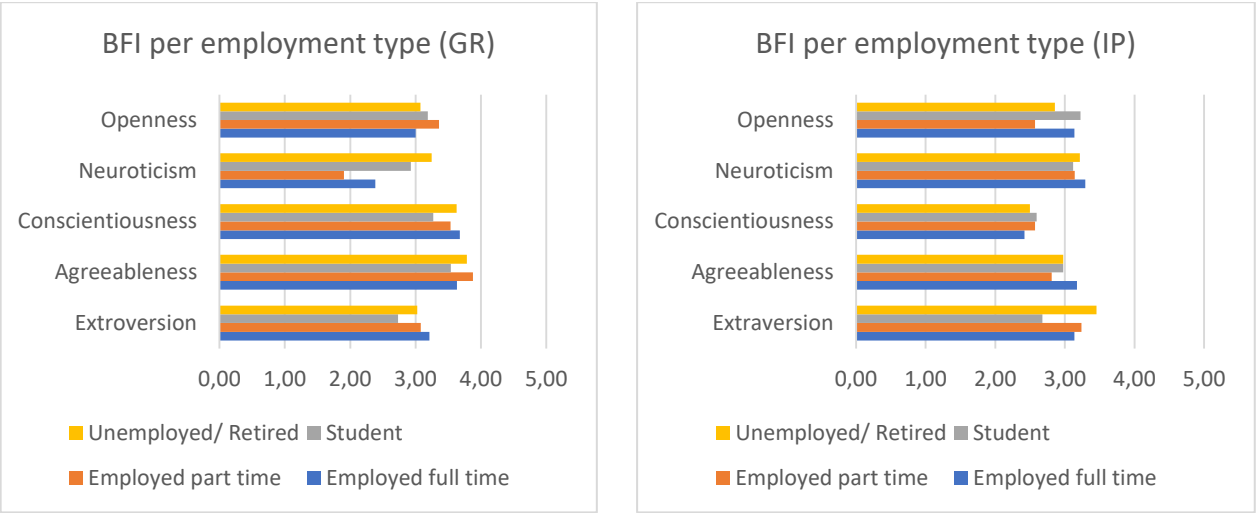


Chart 49: My-TRAC BFI scores per employment type

Regarding the employment type, again, we do not find any consistency among the two samples so we cannot jump to any conclusion.

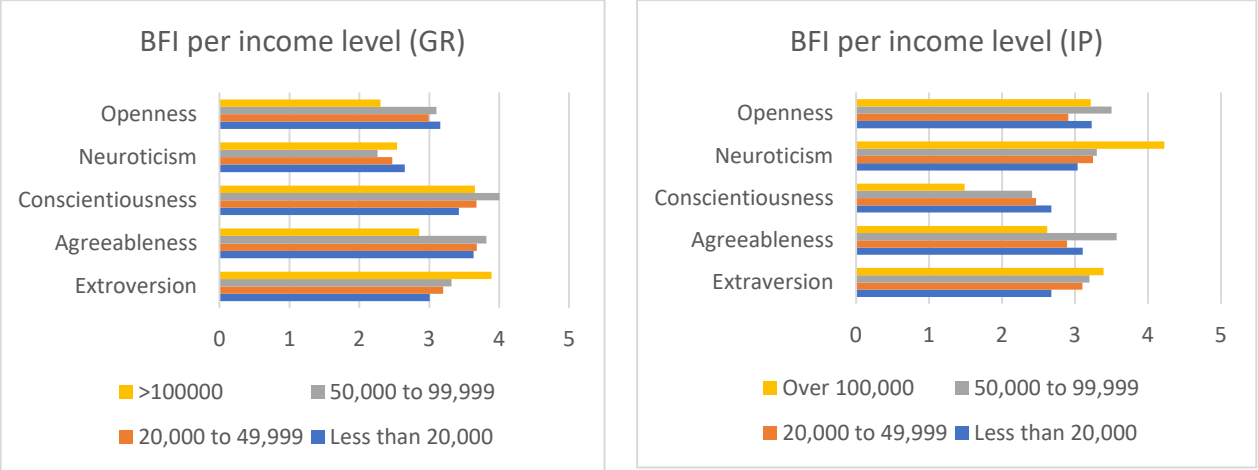
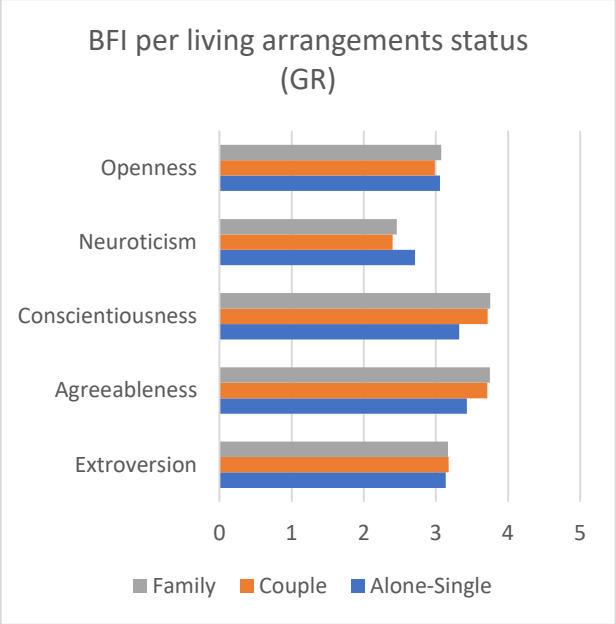


Chart 50: My-TRAC BFI scores per income level

Regarding the BFI scores per income level, we see that the Iberica Peninsula sample of users with income over 100.000€ ranked really high in the neuroticism and really low in conscientiousness. Additionally, we see that the less the income the lower the extraversion of the users in both countries.



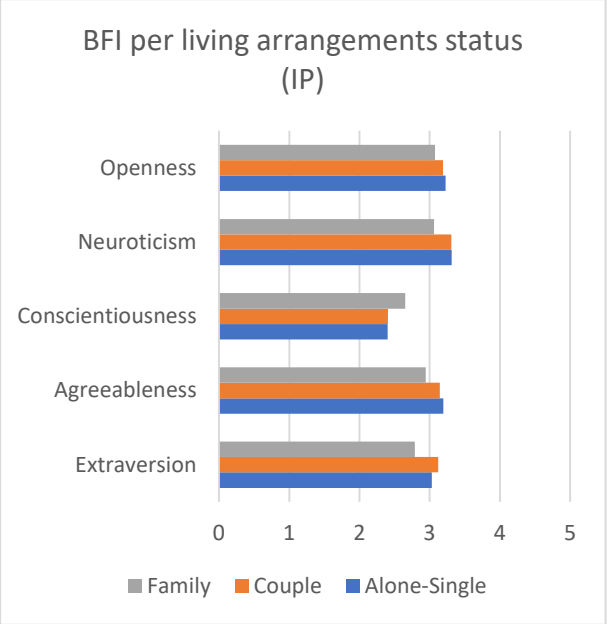
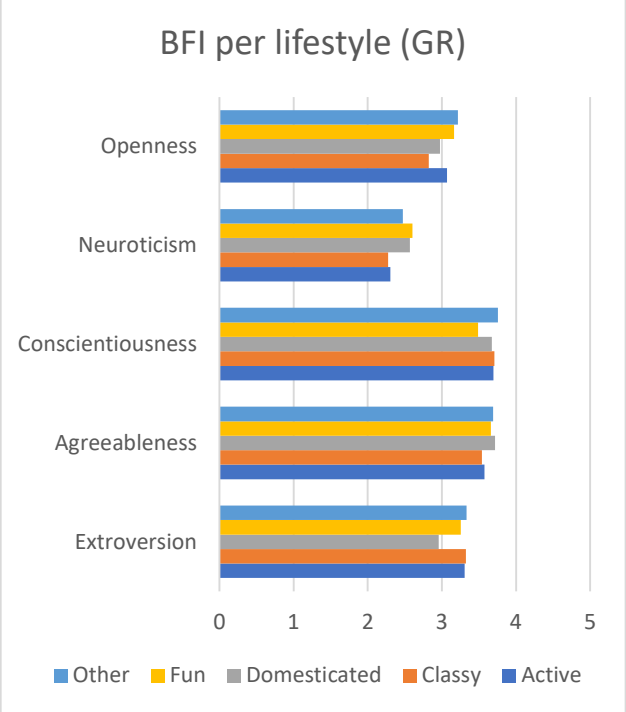


Chart 51: My-TRAC BFI scores per living arrangement status

Regarding the living arrangement status, almost all respondents groups scored the same.



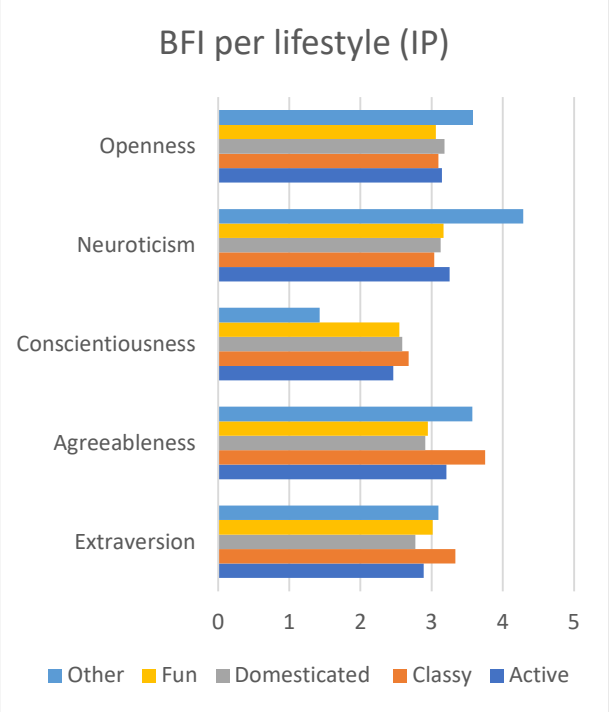


Chart 52: My-TRAC BFI scores per lifestyle

Regarding the lifestyle status of the respondents we see that each group follows the mean sample scores without any notable exceptions among the Greek sample respondents. The Iberica Peninsula respondents who have an active lifestyls have scored higher in neuroticism than the rest of the users.

Apart from the Big Five Inventory, in order to extract further personality characteristics of the respondents we also asked questions regarding their regret, using the regret and disappointment scale questionnaire (see Section 4.3.4.1.1). This questions were asked to have a concensus with the

questionnaires of WP2 and WP3, so as to be able to correlate the results in further research if needed. Additionally, in future research we might investigate the correlations between the regret scores of the users and their interface preferences.

Table 3 shows means, standard deviations, skewness, and kurtosis of the regret scale for the total sample for both Greek and Iberica Peninsula sample. Skewness is 0.21 and kurtosis is –0.74 for the Greek sample and Skewness is -0.72 and kurtosis is –0.46 for the Iberica Peninsula sample. As absolute values greater than 1 indicate a substantial deviance from a normal distribution (cf. Muthén & Kaplan, 1985), the regret and disappointment scale can be regarded as normally distributed.

Table 5: Regret and disappointment scale means, standard deviations, skewness, and kurtosis

	Mean	SD	Sk	K	Mean	SD	Sk	K
Regret scale	3,05	0,78	0,21	-0,74	2,23	0,90	-0,72	-0,46

Table 6 shows means and standard deviations of the regret and disappointment scale, reported separately for age, gender, education, employment, income, living arrangements, urbanization and lifestyle.

Table 6: Means and standard deviations for the regret and disappointment scale

Regret and disappointment scale				
	Greece		Iberica Peninsula	
	Mean	SD	Mean	SD
Age				
18-24	3,05	0,78	3,59	0,77
25-54	3,01	0,64	2,91	0,90
55-65	2,87	1,14	2,84	1,03
Gender				
Female	3,15	0,77	3,45	0,87
Male	2,95	0,78	3,23	0,92
Education				
High school degree	3,11	0,93	3,67	0,66
University degree	3,08	0,75	3,07	0,95
Doctorate	2,83	0,87	2,20	0,87
Employment				
Employed full time	3,02	0,74	3,05	0,97
Employed part time	3,24	1,06	2,69	0,82
Student	3,21	0,97	3,56	0,79
Unemployed/ Retired	3,04	0,80	3,50	0,99
Income				
Less than 20,000	3,01	0,91	3,61	0,72

Regret and disappointment scale				
	Greece		Iberica Peninsula	
	Mean	SD	Mean	SD
20,000 to 49,999	3,06	0,75	3,07	0,87
50,000 to 99,999	2,98	0,59	3,17	1,34
Over 100,000	3,73	0,61	2,20	0,71
Living arrangements				
Alone-Single	3,11	0,70	3,20	0,84
Couple	3,06	0,87	2,46	1,08
Family	2,99	0,76	3,56	0,76
Urbanisation				
Rural	3,63	0,77	3,57	0,85
Sub-urban	3,02	0,81	3,59	0,75
Urban	3,03	0,77	2,88	0,94
Lifestyle				
Active	3,09	0,73	3,29	0,96
Classy	2,92	0,71	3,00	0,91
Domesticated	3,00	0,85	3,58	0,75
Fun	3,14	0,75	3,06	2,80
Other	3,10	0,59	0,93	1,98

The results of the table above are depicted at the chart that follows. In generally we see that the regret and disappointment scale score are among 2.8 and 3.2 more or less for the Greek sample. The respondents from Iberica Peninsula have greater distance among higher and lower values of regret, having the lowest at 0,93 for the ones that have choosen the "other" lifestyle and having the highest at 3,61 for those who have the lowest income. Regarding the Greek sample, the only ones who see to me more regretful are people with high income and people who live in the rural areas. But since our sample is quite low regarding these groups, this cannot be considered as a formal statement. The chart that followes depicts the aforementioned findings.

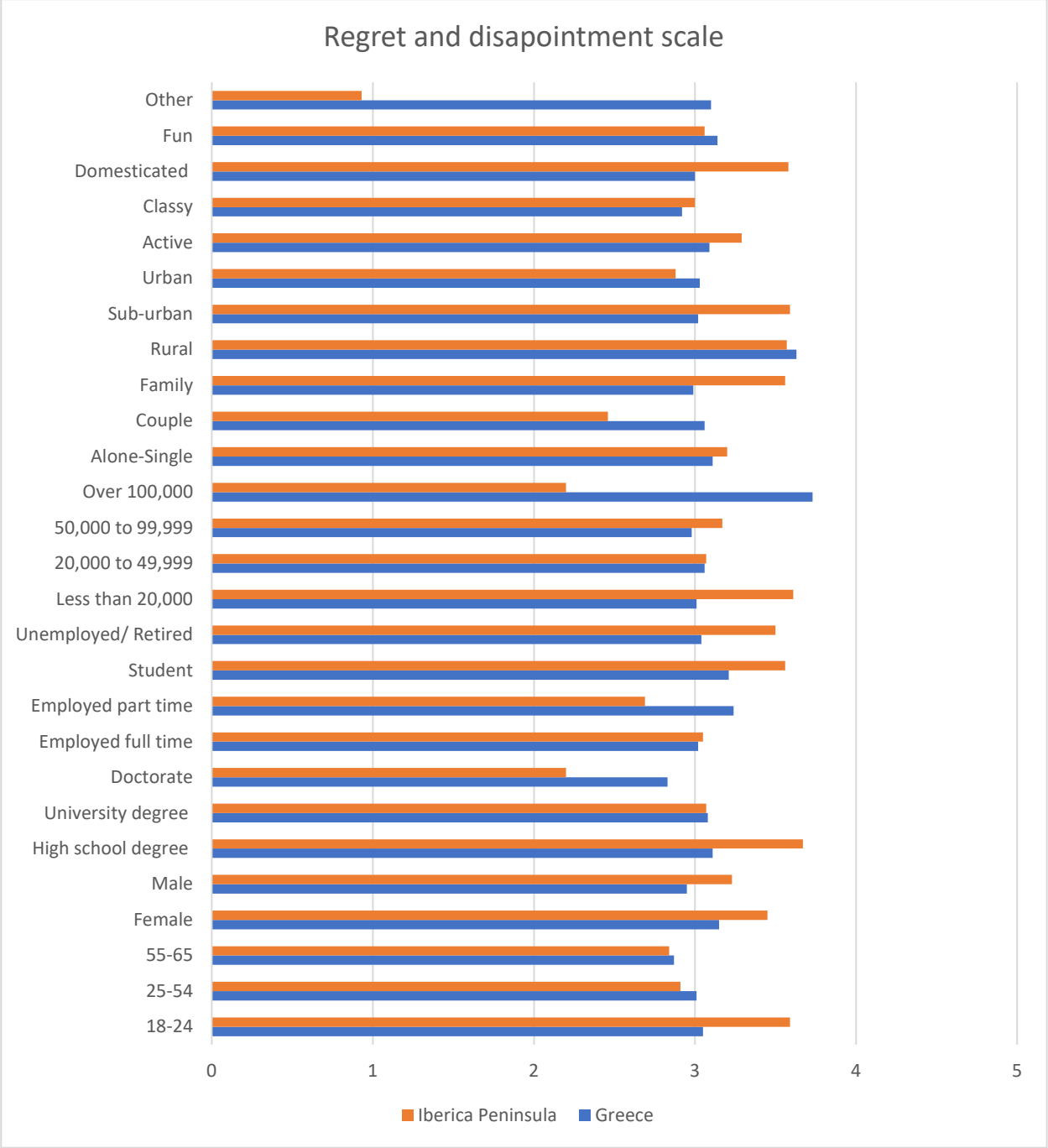


Chart 53: Regret and disappointment scale per sample group

3.5.4 CAR OWNERSHIP AND USAGE

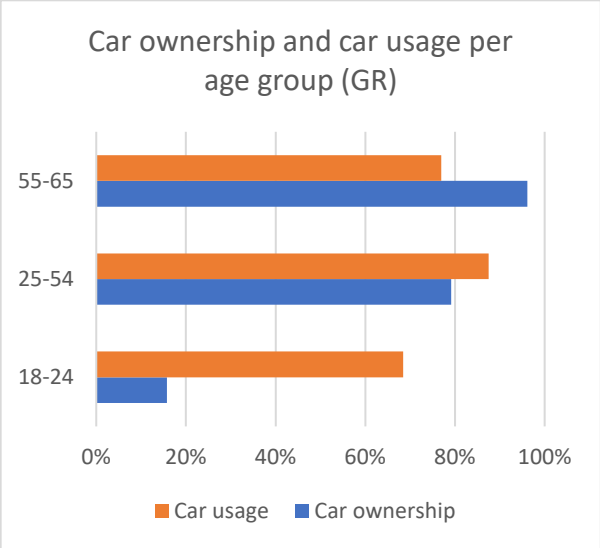
Car ownership and usage are another two interesting topics that have been under research in our survey. It is interesting to see whether all people who have a car also drive a car and vice versa and also correlate this information to the user profiles and later on to the usage of the application. The following table presents the results from the analysis of the car ownership and usage data, giving the absolute and relative frequencies.

Table 7: Car ownership and usage frequencies among the entire sample

	Car ownership				Car usage			
	Greece		Iberica Peninsula		Greece		Iberica Peninsula	
Age	Absolute frequency	Relative frequency	Absolute frequency	Relative frequency	Absolute frequency	Relative frequency	Absolute frequency	Relative frequency
18-24	3	15,79	18	39,13	13	68,42	29	63,04
25-54	133	79,17	17	73,91	147	87,50	13	56,52
55-65	25	96,15	10	90,91	20	76,92	6	54,55
Gender								
Male	91	81,98	12	48,00	95	86,49	14	56,00
Female	74	70,48	20	66,67	87	82,86	18	60,00
Education								
High school degree or equivalent	9	60,00	7	30,43	13	86,67	15	65,22
University degree or equivalent	126	74,56	23	76,67	140	82,84	16	53,33
Doctorate	28	90,32	4	100	29	93,55	2	50
Employment								
Employed full time	146	83,91	24	77,52	147	84,48	20	64,52
Employed part time	9	64,29	5	83,33	13	92,86	4	66,67
Student	3	20	14	34,15	13	86,67	26	63,41
Unemployed/ Retired	5	41,67	2	66,67	9	75,00	2	66,67
Income								
Less than 20,000	42	60,00	14	36,84	57	81,43	22	57,89
20,000 to 49,999	96	85,71	19	65,52	101	90,18	17	58,62
50,000 to 99,999	21	75,00	8	88,89	24	85,71	8	88,89
Over 100,000	2	66,67	6	100	1	33,33	3	50
Living arrangements								
Alone-Single	37	67,26	15	62,50	42	76,36	11	45,83
Couple	51	78,46	9	81,82	52	80,00	9	81,82
Family	74	78,72	23	48,94	87	92,55	30	68,83
Urbanisation								
Rural	3	50	5	41,67	4	66,67	10	83,33
Sub-urban	41	78,85	19	51,35	46	88,46	20	54,05
Urban	120	75,95	22	68,75	133	84,15	19	58,84
Lifestyle								
Active	27	77,14	8	50	32	91,43	8	50
Classy	18	85,71	4	80	18	85,71	4	80
Domesticated	16	45,71	17	54,84	24	68,57	20	64,52
Fun	37	64,91	16	59,26	44	77,19	16	59,26

	Car ownership				Car usage			
	Greece		Iberica Peninsula		Greece		Iberica Peninsula	
Other	16	88,89	2	66,67	15	88,33	2	66,67

The values of interest from the table above are depicted in more detail at the in charts that follow.



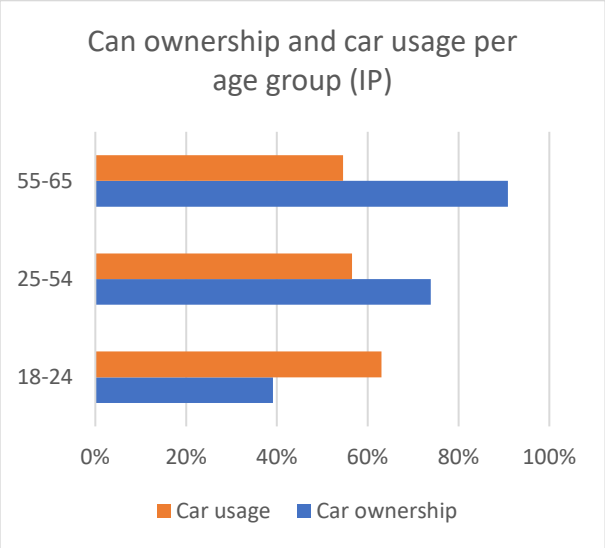
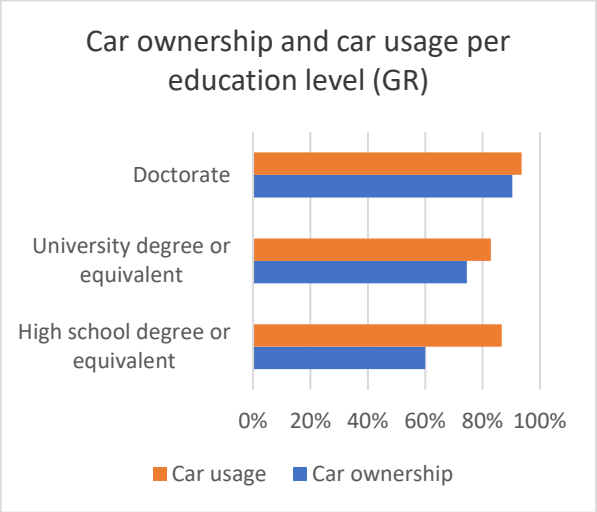


Chart 54: Car ownership and car usage per age group

As expected, young adults have low car ownership and high car usage, since they use their parents' car as drivers or co-drivers. On the contrary, older adults have high car ownership, higher than all other age groups, but lower car usage.



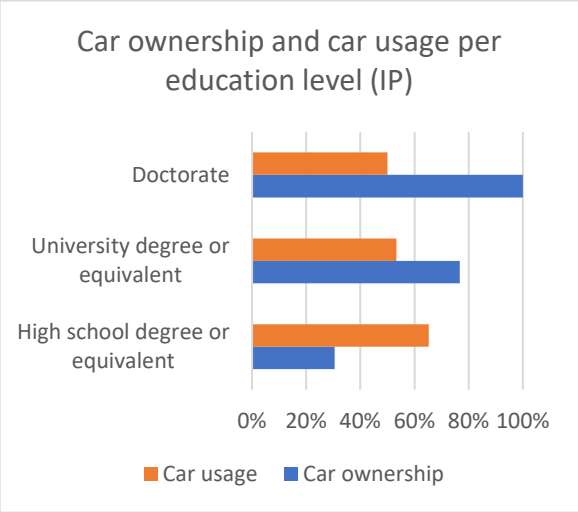
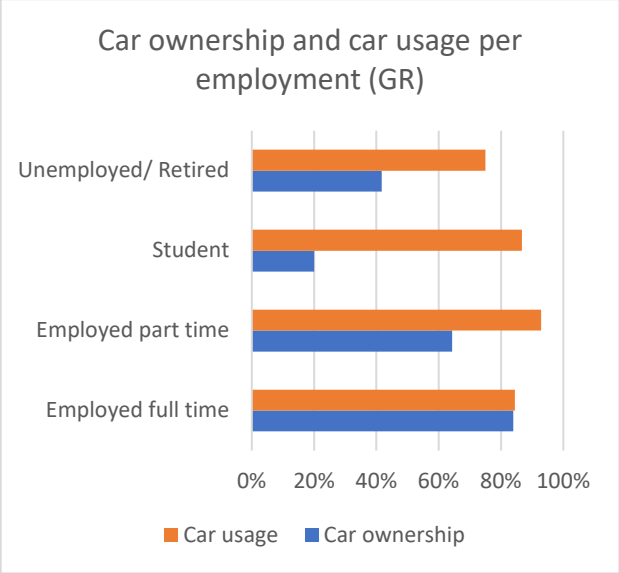


Chart 55:Car ownership and car usage per education level

As expected also, respondents who have high school degree or equivalent, who are usually younger or have low income, have low car ownership and high car usage, since they use others car as drivers or co-drivers.



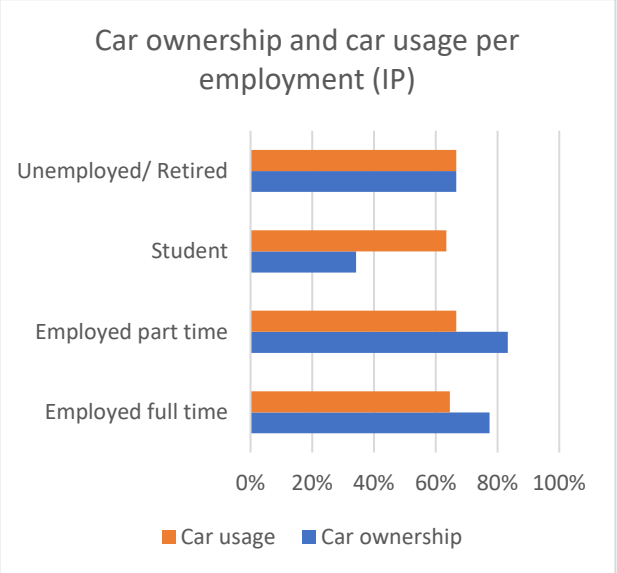
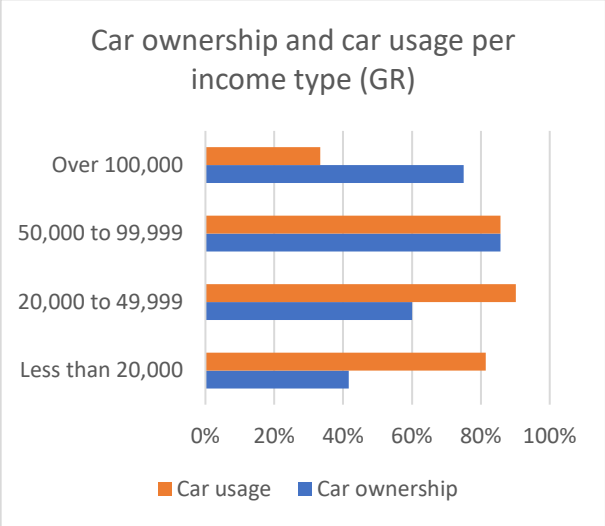


Chart 56:Car ownership and car usage per employment type

Regarding employment type, it is interesting to see that only fully employed respondents have the same level of car ownership and car usage. All the other employment type groups have lower car ownership and higher car usage.



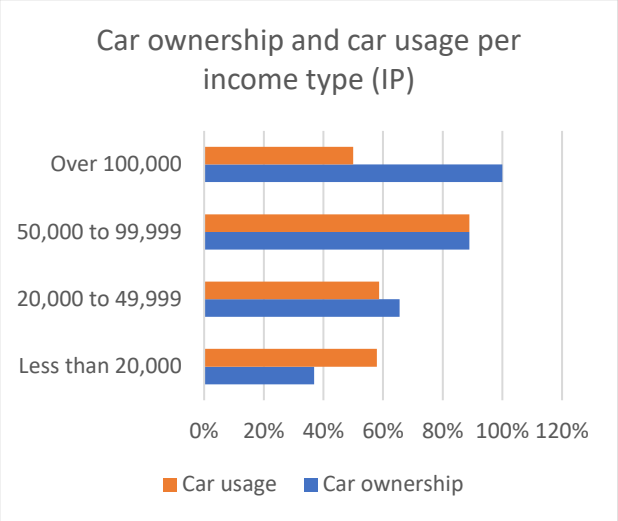


Chart 57:Car ownership and car usage per income type

As expected, respondents with low and medium income have low car ownership and high car usage. On the contrary, as expected also, people with high income have high car ownership and low car usage, the lowest of all income groups.

3.5.5 USER PROFILES

One more element of the survey we performed was to cluster people in different profiles base on the literature. That was realized by using a specific row of questions and based on the users' answers they were placed in a specific profile. These profiles have been inspired from the literature and especially the work of Anable regarding identification of travel behaviour segments using attitude theory (Anable,

2005). The profiles of Anable were reformed to the following to fit the needs of our study and also be mapped with our personas of Section 3.3.

The reformed profiles accompanied by their characteristics follow.

Table 8: User profiles and their characteristics

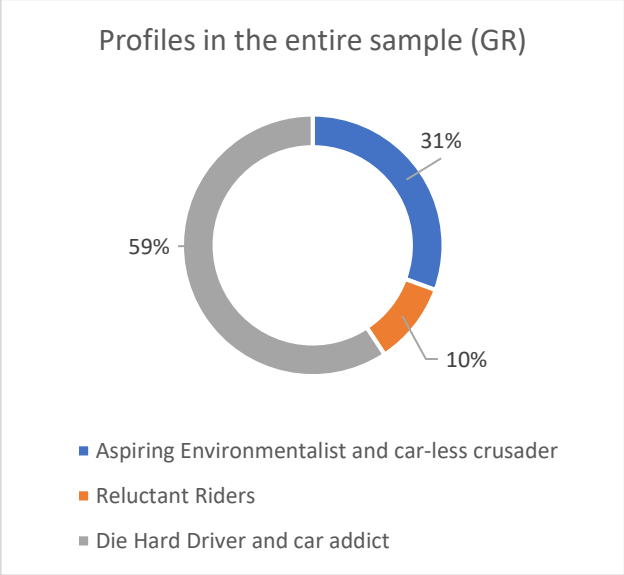
Profiles	**Characteristics, based on Anable** (2005)
Aspiring Environmentalist and car-less crusader	• High moral responsibility to reduce car use • Feelings of guilt when the car is used unnecessarily • Fairly high participation in pro-environmental behaviours • Express a desire to use alternative modes • Do not enjoy travelling by car
Reluctant Riders	• Not particularly motivated by environmental issues • Despite moderately high concern for the negative effects of car use, they • are more reluctant to sacrifice for the sake of the environment • Less content with the use of alternatives that the other non-car owner • Group • Although time constraints are not a particular problem, a high number • perceive many problems with using public transport
Die Hard Driver and car addict	• Do not see many problems with using car use, nor the point of reducing it • Not attempting to limit car use for environmental or any other reasons • Their rejection of alternative modes is less likely • Highest psychological car dependency • Particularly enjoy car travel and believe that all their car use is necessary

.

Table 9: User profiles among the entire sample

	Aspiring Environmentalist and car-less crusaders				Reluctant Riders				Die Hard Driver and car addict			
	Greece		Iberica Peninsula		Greece		Iberica Peninsula		Greece		Iberica Peninsula	
Age	Absolute frequency	Relative frequency	Absolute frequency	Relative frequency	Absolute frequency	Relative frequency	Absolute frequency	Relative frequency	Absolute frequency	Relative frequency	Absolute frequency	Relative frequency
18-24	6	31,58	46	100	1	5,26	8	17,39	12	63,16	23	50
25-54	46	27,38	10	41,67	18	10,71	4	16,67	104	61,90	8	33,33
55-65	13	50,00	4	36,36	3	11,54	2	18,18	10	38,46	4	36,36
Gender												
Male	32	28,83	11	29,73	12	10,81	10	27,03	63	56,76	15	40,54
Female	33	31,43	17	40,48	9	8,57	4	9,52	63	60,00	20	47,62
Education												
High school degree or equivalent	6	40,00	9	25,71	2	13,33	8	22,86	7	46,67	17	48,57
University degree or equivalent	46	27,22	19	45,24	18	10,65	4	9,52	105	62,13	17	40,48
Doctorate	13	41,94	0	0,00	2	6,45	2	50,00	16	51,61	1	25,00
Employment												
Employed full time	52	29,89	14	45,16	20	11,49	4	12,90	102	58,62	12	38,71
Employed part time	3	21,43	2	33,33	1	7,14	2	33,33	10	71,43	1	16,67
Student	8	53,33	12	29,27	0	0,00	8	19,51	7	46,67	20	48,78
Unemployed/ Retired	3	25,00	0	0,00	1	8,33	0	0,00	8	66,67	2	100,00
Income												

	Aspiring Environmentalist and car-less crusaders				Reluctant Riders				Die Hard Driver and car addict			
Less than 20,000	20	28,57	14	36,84%	6	8,57	7	18,42%	44	62,86	16	42,11%
20,000 to 49,999	34	30,36	12	41,38%	16	14,29	5	17,24%	62	55,36	11	37,93%
50,000 to 99,999	11	39,29	1	12,50%	0	0,00	1	12,50%	17	60,71	5	62,50%
Over 100,000	0	0,00	1	25,00%	0	0,00	1	25,00%	3	100,00	1	25,00%
Living arrangements												
Alone-Single	17	30,91	10	43,48	6	10,91	7	30,43	32	58,18	5	21,74
Couple	22	33,85	3	27,27	6	9,23	1	9,09	38	58,46	6	54,55
Family	27	28,72	15	32,61	10	10,64	6	13,04	57	60,64	24	52,17
Urbanisation												
Rural	2	33,33	3	27,27	1	16,67	2	18,18	3	50,00	5	45,45
Sub-urban	13	25,00	15	40,54	4	7,69	9	24,32	35	67,31	12	32,43
Urban	51	32,28	10	30,30	17	10,76	3	9,09	90	56,96	18	54,55
Lifestyle												
Active	13	37,14	4	25,00	0	0,00	5	31,25	22	62,86	6	37,50
Classy	5	23,81	1	20,00	4	19,05	1	20,00	12	57,14	2	40,00
Domesticated	26	74,29	13	41,94	11	31,43	3	9,68	46	131,43	14	45,16
Fun	18	31,58	9	33,33	4	7,02	5	18,52	35	61,40	12	44,44
Other	4	22,22	1	50,00	3	16,67	0	0,00	11	61,11	1	50,00



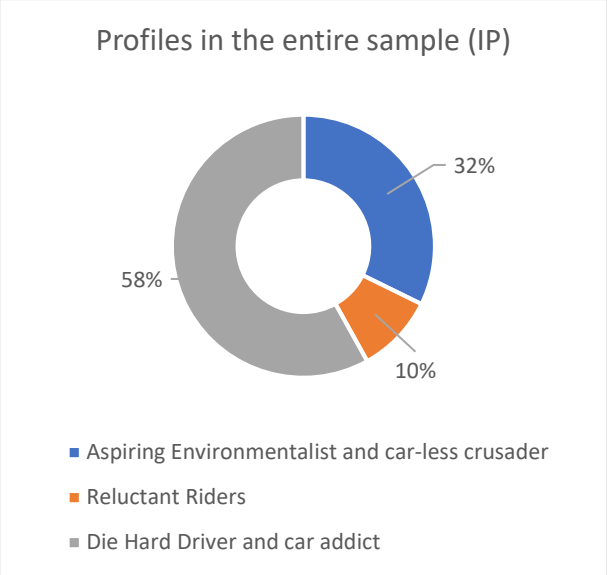
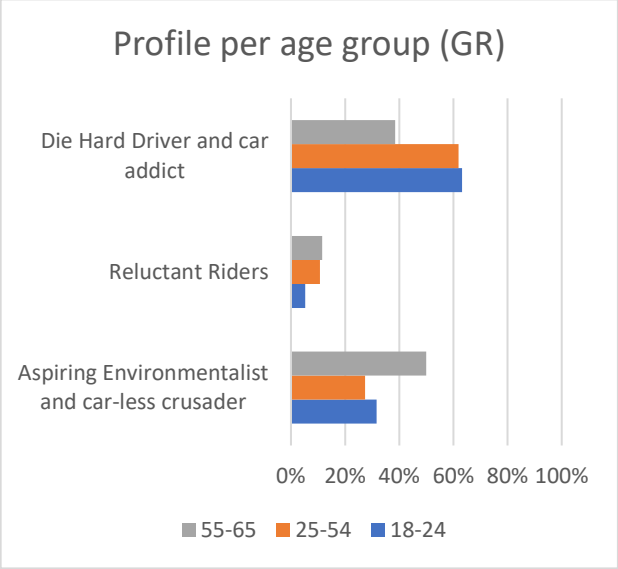


Chart 58: Profile in entire sample.

As we see from the chart above, the majority of our respondents belong to the die-hard driver and car addict profile. The reluctant riders together with the environmentalist ones are yet less in comparison to the die-hard driver and car addict ones.



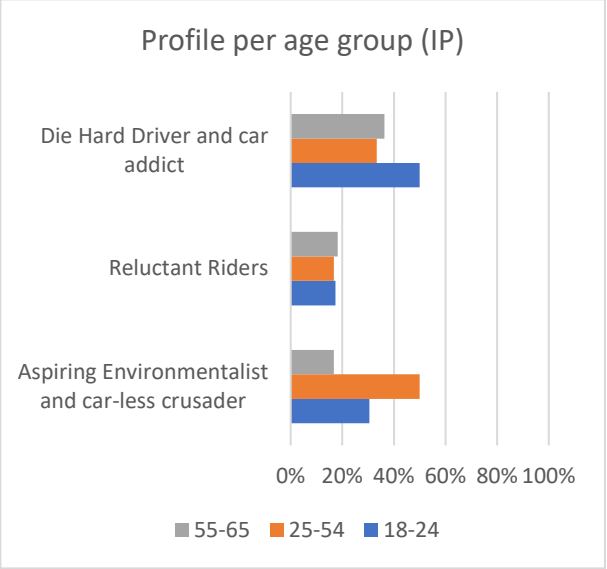
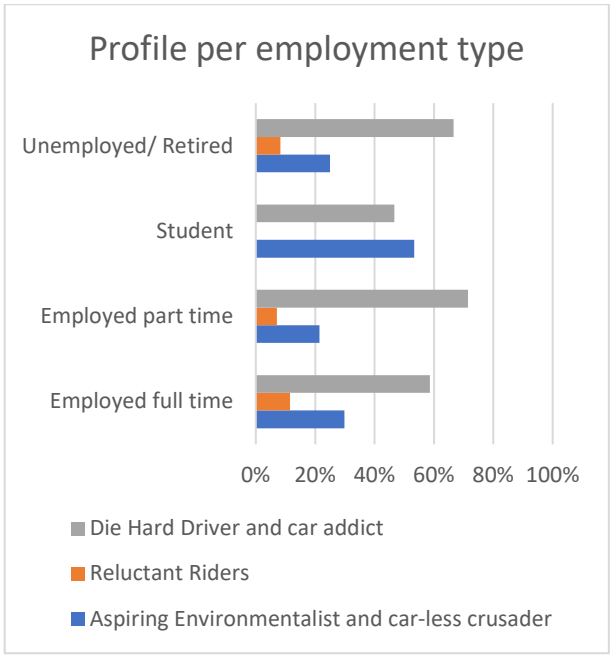


Chart 59: Profile per age group.

Regarding to the Iberica Peninsula respondents, as expected the youngest ones belong to the aspiring environmentalist and car-less crusaders profile. On the contrary, in Greece, the most of the aspiring environmentalist and car-less crusaders are older adults, while the same groups seems to be less addicted to car than the other two, which scored higher in the die-hard driver and car addict profile.



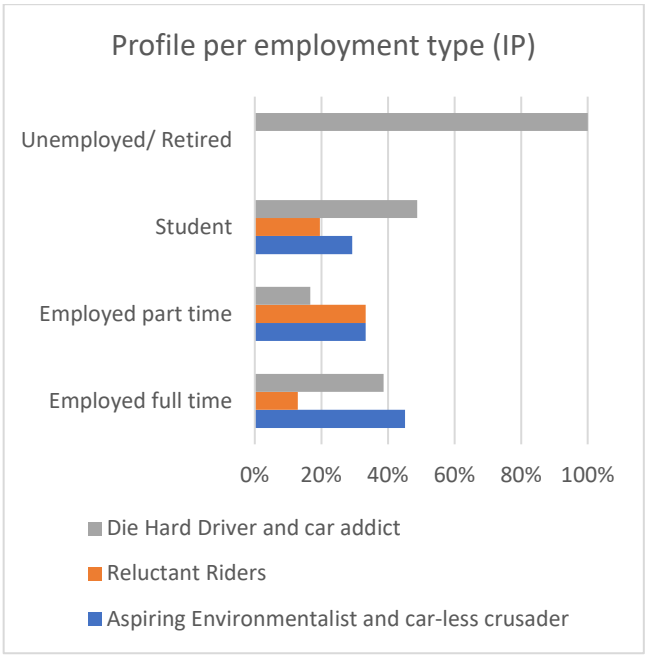
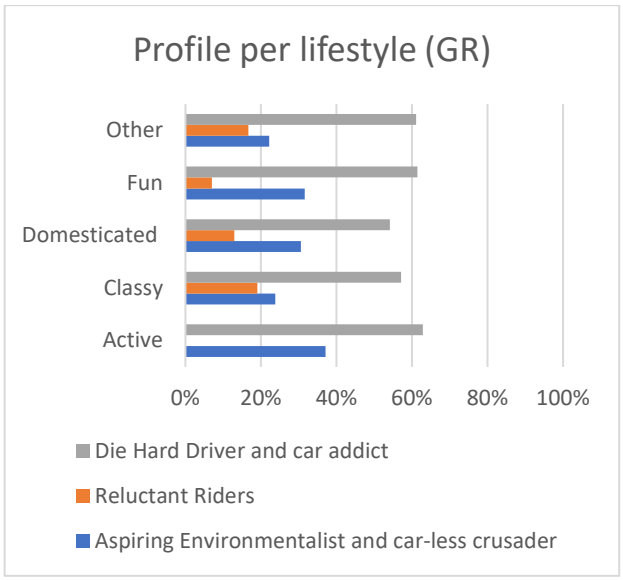


Chart 60: Profile per employment type.

All employment type groups have been identified as die-hard drivers and car addicts apart from the students whose majority seems to belong to the aspiring environmentalists and car-less crusaders profile.



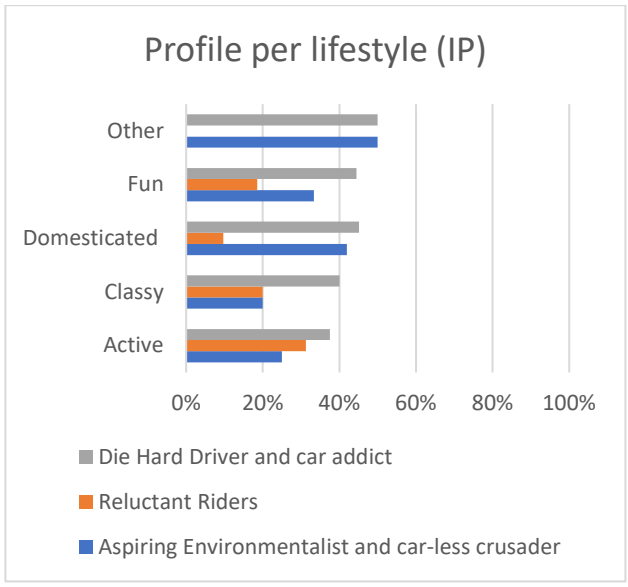


Chart 61: Profile per lifestyle.

Regarding their lifestyle and profile, the majority of the Greek respondents belong to the die-hard drivers and car addicts profile, followed by the aspiring environmentalists and car-less crusaders one. The same stands for the Iberica Peninsula respondents too, but without such great difference.

4 MY-TRAC UX DESIN PRINCIPLES

4.1 PERSUASIVE DESIGN GUIDELINES

"It is now evident that the possibilities through mobile technology are tremendous. It takes a cleverly crafted persuasion strategy to leverage this unique opportunity."

Human Factors International

4.1.1 INTRODUCTION

Up to now designers of mobile applications strive to overcome the fragmented mobile medium and simultaneously reducing the number of clicks, making shallow architecture, designing appropriately for touch screens, planning layouts for a smaller screen size, etc. So they focus on usability through ease of use and simpler User Interfaces. But just because people "can do" does not always mean that they "will do" it. People have to be motivated to be engaged to something and to be persuaded in order to complete a task. Persuasive design is a medium to influence and persuade people through HCI. Through the study of influence focused on human-computer interaction, we know that computing devices have tremendous potential to persuade (Krishan, 2012).

In persuasive design, the product itself includes aspects that influence users' behaviour, i.e. a heating system that provides feedback on energy consumption (Tang & Bhamra, 2008). Thus, technology becomes persuasive when it is provided with qualities and attributes that may increase its perceived credibility, privacy, personalization and attractiveness. Persuasion in HCI is at the crossroads of ergonomics, social psychology, behavioural economics, organizational management and of course the design of user experience.

Fogg, who is an expert on persuasion techniques, defines persuasion as the voluntary change of a person's behaviour: "to embrace the site's cause, register personal information, make purchases, click on ads, complete surveys, or bookmark the site for future visits" (Fogg B. J., 2003). The author admits to be inspired from the ancient Greeks' Aristotle saying, who describes persuasion as changing beliefs or influencing decisions through speech. The basic difference between Aristotle and more contemporary theorists is the persuasive median, not the concept of persuasion itself.

There are some persuasive design principles that already exist and being implemented in the web design. One interesting example can be found in PET Design™ toolkit by Human Factors International. This toolkit guides designers on how to implement persuasion, emotion and trust into their designs. Usability is still the baseline of the design process, but as Eric Schaffer, the Founder and CEO at Human Factors International (HFI), Inc. states "Persuasive design is fundamentally more qualitative, deep, and subtle than usability." (Schaffer, 2009). It is argued that while usability is still important for effective interface design, it is no longer the key differentiator.

4.1.2 BACKGROUND TO PERSUASION AND PERSUASIVE DESIGN

Up to now, there is a vast variety of techniques proposed by researchers in order to persuade users to act upon a task and change their behaviour towards a specific goal. Cialdini (1993) proposes six basic categories of influence that assist in decision making. These include consistency, social proof, liking, authority and scarcity. Fogg (2003) focused on how computers act as a medium towards social actors and

persuaders. In his framework, the functional triad, Foggpostulates that interactive technologies can operate in three ways: tools, media, and as social actors. Inspired from Fogg's research, Oinas- Kukkonen and Harjumaa (2009) adopted and modified Fogg's framework creating a Persuasive System Design (PSD) model based upon seven postulates and listing twenty-eight principles for persuasive system content and functionality. Additionally, Weinschenk (2009) developed the concept of Neuro Web Design, where she employs "neuro-marketing" concepts, which are at the intersection of psychology and user experience, combining motivation, decision-making, and neuroscience to the Web design process. She postulates that there are unconscious reasons for people's actions, arguing on how emotions affect decisions, and a designer should apply the principles of persuasion when designing Web sites to encourage users to click. Lockton et al. (2010), at their design with intent research defined a set of strategies that promote behavioural change based on social and environmental perspectives, combining good design and effectiveness. According to Lockton, design brief is divided into two parts: (i) pre-scription mode and (ii) inspiration mode grouped under six lenses: (i) architectural; (ii) error proofing; (iii) persuasive, (iv) visual, (v) security; and (vi) cognitive. Hsi-Liang et al. (2014)identified a total of 15 persuasive tactics and 9 salient factors from the data of Web site reviews and user interviews.

Persuasive design has been focusing,in lots of studies, on the credibility of content (Jones, 2011).However, researchers are promoting an unbalanced perspective of web persuasiveness that privileges textual content over visual design.As Wroblewski (2002) writes, good information will be more appreciated if given a good presentation. That being said, independent of content, an "attractive" website will be more persuasive than an "unattractive" one. "What is beautiful is good" summarizes the concept of the attractiveness stereotype, or halo effect (Eagjy, Ashmore, Makhijani, & Longo, 1991), a theory of social psychology which states that typically, "people's impressions of attractive people are much more positive than their impressions of unattractive people on a variety of evaluative dimensions" (Zebrowitz, 1982). Attractive people are more likely to be perceived as confident, intelligent, successful, or empathetic. Consequently, it seems reasonable to postulate that a more attractive User Interface will have greater persuasive power than an unattractive one (Fogg B. J., 2003).

Appealing visual design can have just as much impact as useful, usable content.So, the fact that the visual design is not always mentioned and taken into account when designing an interface and the lack of specifics or complete avoidance of this topic is not due to its unimportance. Fogg's own research (Fogg, Marable, Stanford, & Tauber, 2002) has found a significant "connection between design look and perceived credibility". So, finding the right technique to persuade users is a challenge and it is interesting to see that there are examples where the overuse of persuasive techniques has end up to opposite results. Thus, Human Factors International (Krishan, 2012) has created a document of bad and good practices for mobile phones that includes examples to avoid or follow when persuasive design for mobile phones is under discussion.

In My-TRAC as we design the UI, we follow a selection of persuasive design rules, mainly used up to now to web design, in combination with practical recommendations for successful mobile user experience in order to achieve greater users' engagements, as well as better experience when using My-TRAC application.

4.1.3 PERSUASIVE DESIGN PRINCIPLES

In this section we have looked at some possibilities that arise from the mobile application channel which can help build persuasion in the right way and we have defined the ones that we will implement in My-TRAC application.

- **Minimize Cognitive Load**

According to research, people interact with their phones much more than they consciously believe they do, reaching an average of 85 times a day ((Andrews, Ellis, Shaw, & Piwek, 2015), (dscout, 2016)). Additionally, it is being argued that technology use can reduce cognitive capacity and impair attention, productivity and memory, increase stress levels, dampen creative thinking, and lead to "cognitive errors". **So, users' finite capacity for cognitive processing is an influencer that must be taken into account when taking decisions related to their experience.** Given the mismatch between the ubiquitous environmental information and the limited ability to process it, individuals need to be careful in their allocation of attention. In other words, the more choices you present to a user, the more mental effort it takes to compare these options and make a decision and the less possible it is for the user to engage in such an effort allocation.

So, one of the main contributors to the persuasive design is **Simplicity** of the user experience targeting to the minimization of cognitive load. As Antoine de Saint-Exupéry argues, *"A designer knows he has achieved perfection not when there is nothing left to add, but when there is nothing left to take away."*

One way of achieving the minimization of cognitive load is to **cut down the clutter** of the application, since cluttering overloads users with too much information, especially in mobile devices. Every additional button, image or icon makes the screen more complicated and increases the cognitive load need to achieve a task. Adobe (Babich, 2019) also supports to use **flat textures** and make **minimal use of decorative elements** such as gradients and drop shadows to keep the interface light and airy. So, having minimalism in mind is critical when designing a mobile UI. This leads to keeping content, as well as interface elements to a minimum.

Additionally, the cognitive load increases when user effort is required for example when entering data. Typing on a mobile screen isn't the most comfortable experience, so the **user input should be minimized and simplified**. This can be achieved by requesting only the bare minimum of information from the user. Also, **reuse of previously entered data** instead of asking the user to type again the same information, or use already available information to set a smart default should be considered and could be achieved with the use of smart features such as **autocomplete** or **presenting choices dropdown lists** instead of input fields. Additionally, **dynamically validation of field values** helps the user identify where an error occurs and fix it easily.Providing **input masks** using field masking technique also, helps users format inputted text, focus on the required data and notice errors easier. One very important feature that saves a lot of effort in entering data is the **customizable keyboard depending on the data requested**, like including the @ button when asking for an email address or displaying the numeric keyboard when the credit card number is requested.

Having a number of **small, continuous and simple tasks** instead of one extended and complex one also helps in keeping the cognitive load of the user low. So when having a task that contains lots of steps and requires a number of actions, breaking it into smaller blocks helps avoid creating too much complexity for the user at one time. So, each screen should include one thing and one thing only, with no more than one call-to-action.

The **consistency of the UI** is another important element that keeps the user from being baffled from the design of the application. Visual, functional and external consistency is the braches that should be taken into account and building a UI guide that includes all the UI elements used in the interface will help to achieve all three of them.

Besides assessing the choices offered to the users at key stages of the user experience, it's worth assessing the way these options are, as this can have a huge impact on the cognitive effort and the decision-making process. In general, people follow the path of lowest effort. This means **pre-set options** are useful tools for optimizing user behaviour, especially when these defaults actively benefit the user.

- **Provide meaningful rewards and incentives**

In order to develop effective persuasive interfaces, it is important to choose appropriate incentives and to provide users with these incentives in a proper manner. Recently some researches proposed design strategies for meaningful rewards and incentives. For example, Fogg (2003) postulates that punishment even if it is positive should be avoided due to ethical reasons. Additionally, Consolvo et al. (2009) also highlight that offering positive/ negative punishment, or reinforcement in general, should be avoided since it makes users feel too bad and it runs the risk of abandoning the application. On the other hand, again Fogg (2003) argues that providing rewarding messages seems to have a positive impact on the user and declares that "praise is one of the most powerful persuasive uses of language" and that "by offering praise, via words, images, symbols, or sounds, computing technology can lead users to be more open to persuasion." Many examples of praise exist on the internet at the moment. Amazon, for example, who has mastered the art of persuasion refers to the user by his/ her name. Additionally, to keep the user online, the system asks if the recommendations provided are "on target" and to provide more information if they are not.

Cialdini (1993) in his book "Influence: Science and Practice" proposes some basic principle to follow for successful persuasion, the ones that we used in My-TRAC are summarised below.

Principle #1: Reciprocation

"Humans tend to return good deeds: use this social psychology law in user interface design to gain users' trust and motivate engagement with your site or app" said Raluca Budiu for the NN group (Budiu, 2014). What the principle of reciprocation tells us is that if we do something for other people, they want to return the favour. That being said, if users get something useful from you before asking them for anything, it is more possible for them to reciprocate by doing business with you in the long term (Gamberini, Petrucci, Spoto, & Spagnolli, 2007). On the other hand users won't perform the desired behaviour if the cost or resources necessary don't clearly align with resulting value.

A way to apply reciprocation in the UI Design is to give useful information or to offer a useful service to the user away for free.

Principle #2: Social proof

Robert Cialdini said, "Whether the question is what to do with an empty popcorn box in a movie theatre, how fast to drive on a certain stretch of highway, or how to eat chicken at a dinner party, the actions of those around us will be important guides in defining the answer." So, people will do things that they see other people are doing. The principle of social proof evokes that when people aren't sure what to do, they look to the behaviour of others to guide their actions and especially their peers, because people

assume that popular things are the ones that are worthwhile. If we see lots of other people doing something, we tend to view it as the correct and the best behaviour.

Social proof can be promoted when the applications shows users how many other people have visited a specific place. Another way to establish social proof is having high ratings and a large number of reviews for a specific place or activity.

Principle #3: Salience

The salience principle proposes that people's attention is drawn to that which is most relevant to them at that moment. This means that we have to define the why, when and how different elements are "salient" for different individuals. Of course if an element will stand out as salient, or not, will depend on the moment as well as on the context. It is therefore just as important to be able to recognise which moments will create salient elements for the users in order to maximise communication potential.

To satisfy this principle we have to present to the users only the information that are related to their needs and preferences as well as to their specific trip purpose.

Trigger #4: Contrast

The contrast principle tells us that it is more likely to remember what stands out from everything else around it. Designers always seem to be looking for the highest converting colour, but there's no universal colour that' is the best for conversions. Derek Halpern, founder of Social Triggers said, "What stands out gets clicked, what blends in gets ignored." The colour that converts the best is the colour that stands out the most.

So, in My-TRAC we have used a specific colour pallet (see Section 5.2 My-TRAC UI style guide) and we have used the most intense colour (orange) for the items that we needed to stand out.

- **Get users feedback**

Ruchie Goyale reports in Medium (Goyale, 2018) that "For every customer who bothers to complain, nearly 26 others remain silent". So, the only way to be sure that you are able to serve your customers right is by getting their feedback. Users' feedback is also the only way to identify a problem with the application that you might have overlooked in the development process. Users' problems help you identify the areas you need to improve on and understand what you are doing wrong, what is frustrating users and why. Additionally, triggering frequent conversations with users to ask for their feedback gives them a feeling of engagement and makes them feel special.

In My-TRAC we have a structured strategy to get users feedback. First in the duration of the project, by conducting usability testing (field and lab) with actual users in both pilot iterations (D6.1, under development). And second in the final application by asking users framed questions related to their conducted tasks and activities while using the application, using simple feedback form.

- **Trigger behaviour from motivated users**

Another step that encourages desired user behaviour is the presence of actionable, relevant triggers in the paths of motivated users. As Fogg (2003) says "place hot triggers in the path of motivated users." Triggers tend to be external to the user; a reminder to an action that intends to influence what the user does next. A push notification for example is a trigger in this sense, and can be especially effective when it's actionable, personalized, and timely.

Despite the view that push notifications hold for re-engaging users, designers should avoid the following common pitfalls:

- Sending the same push notification messaging. Never send the same push notification twice.
- Push notifications sent at non appropriate times. Or containing content irrelevant to the user's context.
- Don't over-rely on push notifications to drive user action. App habits are ultimately formed when the user proactively engages with your content without needing a prompt to do so.

So push notification have to be just-in-time which means that they have to be sent whenever the person is open to positive changes, and receptive (Nahum-Shani, et al., 2014).

- **Focus on visual appeal**

Physical attractiveness has an important impact on persuasiveness. According to Fogg (2003), all else being equal, attractive people are more persuasive than those who are unattractive. Psychologists do not a consensus on why attractiveness is so important in persuasion, but it is possible that attractiveness produces a "halo effect". The halo effect can impact products, organizations and all things that have a user interface, as well as peoples' judgments towards other people. So, if someone is physically attractive, people tend to assume he/ she also has other positive qualities, such as intelligence and honesty. Similarly, physically attractive UIs are potentially more persuasive than unattractive products. If an interface, device, or a product is attractive, it may benefit from the halo effect and make users assume that this interface, device, or product is also trustworthy, reliable, capable, and credible.

So, the overall UI design of a product must still feel consistent and clear, but it should certainly be handsome too, since great designs communicate first and are beautiful second instead of the other way around (Shedroff, 2001). But visual design, is more than "pretty pictures" it helps convey the message.

One way to create visual appealing UIs is to establishing a mood through the use of colour (See for example Trigger #4: Contrast above). Another way is by using Gestalt principles (or principles of grouping) to organize elements in a way that increases coherency and readability (Wroblewski, 2002). This consistency in the design exudes professionalism and verifies the trustworthiness of a UI, helping to establish credibility. Finally, visual design can increase the enjoyment of a UI. As Norman says (2004) "a usable design is not necessarily enjoyable to use," and in fact, some research suggests that an attractive design makes a product (or website) more usable.

An additional feature that is also used to enhance the visual appeal of a UI is a coach mark (a transparent overlay of UI hints) or a tutorial shown on the first launch. While the presence of such instructional screens is often unnecessary, there are times when it is helpful to the user to get a nudge in the right direction. Such an assistance has been implemented in My-TRAC in the form of a wizard which is presented and reported in D4.3 (in progress).

4.1.4 PERSUASIVE DESIGN IN MY-TRAC

The aforementioned design principles have been taken into account when designing the UI components of My-TRAC application as they are presented in Section5.2My-TRAC UI style guide and in Section 5.3My-TRAC Interface Look & Feel.

4.2 INCLUSIVE DESIGN GUIDELINES

The power of the Web is in its universality. Access by everyone regardless of disability is an essential aspect.
- Tim Berners-Lee

4.2.1 INTRODUCTION

The number of people with a disability worldwide is not small. According to the World Health Organization (WHO), there are 285 million people with visual impairments (WHO, Blindness and vision impairment, 2018), 39 million of whom are blind, as well as more than 360 million people who have disabling hearing loss (WHO, 2018) worldwide.

Some may have a wrong perception that persons with disabilities, especially those who have visual impairments, are unable to use mobile phones and applications. On the contrary, mobile phones have a central role in providing a novel degree of autonomy to individuals with these and other types of disabilities. In fact, more and more persons with disabilities are using touch screen mobile devices nowadays. As a matter of fact, Georgia Tech's Wireless Engineering Rehabilitation Research Centre realised a study in 2013 that revealed that 92% of people with disabilities use a "wireless device such as a cell phone or tablet" (RERC, 2011) and many of them use a screen reader (WebAIM, 2015).

So, embedding accessibility into mobile applications functionality and design is critical. Building a mobile app in such a way that is accessible can help unlock great potential, a potential to reach and serve a greater number of people. Furthermore, society in general is becoming increasingly used to highly personalized, customizable user experiences, and accessibility is a part of this, providing the possibility to reach a broader audience in a variety of circumstances.

4.2.2 UNDERSTANDING THE DIFFICULTIES ENCOUNTERED BY PERSONS WITH VISUAL DISABILITIES

There are many different types of disabilities. Based on WHO all disabilities fall into four general categories; visual impairment, physical impairment, hearing impairment and cognitive impairment. When using mobile devices and mobile applications, different techniques are required by persons with different types of disabilities. This Section describes the difficulties encountered by people with disabilities when using a mobile application. In My-TRAC we are focusing on people with visual impairments and especially people to low vision.

Persons with visual impairment who have low vision, colour blindness or colour deficiency, do not have the ability to see the screens and controls of mobile applications. Due to these visual constraints, they cannot see the buttons and use a touch screen to access and navigate the mobile application functions. Most people with severe visual impairment rely on a screen reader to operate computers or mobile devices, like blind people do. But this is not always the case. People with low vision impairments can also see the controls of the mobile application without having to use screen reader, as far as the UI is being changed according to their needs. In more detail, people with low vision need the following accessibility features:

- Adjustable font sizes - Enlarge the font size of the mobile applications.
- Screen magnifier - Enlarge the screen display.
- Adjustable brightness /contrast controls - Change the foreground/background colour of the screen as well as the brightness.

- Backlit display - Change contrast of the screen to allow better viewing in poor lighting or outdoors conditions.
- Text alternatives for non-text elements provided – Provide meaningful and concise text alternatives for non-text elements like form fields, buttons, selection bars and images, etc.
- Avoid poor navigation - Easy navigation which is consistent across multiple screen pages.

To understand better what accessibility means for UX design, World Wide Web Consortium (W3C) uses the abbreviation POUR – Perceivable, Operable, Understandable, Robust – to explain the characteristics of an accessible UI. These four principles are the top layer of guidance that provide the foundation for Web accessibility:

- **Perceivable** – Information and UI components must be presentable to users in ways they can perceive. There are ample alternatives for experiencing content, such as text-alternatives to audio content for hearing impaired.
- **Operable** – UI components and navigation must be operable. Users can actually use the product without time or functionality restraints. Operable designs entail complete keyboard functionality and content that remains sensitive to people with epilepsy.
- **Understandable** – Information and the operation of UI must be understandable. Content must be readable and the product functions consistent.
- **Robust** – Content must be robust enough that it can be interpreted reliably by a wide variety of user agents, including assistive technologies.

Satisfying these four principles means designing with disabled users in mind. While the goal is to design universally, it helps to understand the common disabilities associated with accessibility, and their unique requirements.

4.2.3 MOBILE ACCESSIBILITY STANDARDS

According to World Wide Web Consortium (W3C), an international community where member organizations, a full-time staff, and the public work together to develop web standards, "mobile accessibility" refers to making websites and applications more accessible to people with disabilities when they are using mobile phones and other devices. The standards for making a mobile website accessible are covered by existing W3C WAI accessibility standards/ guidelines and more specifically by Web Content Accessibility Guidelines (WCAG), version 2.0 (W3C, Web Content Accessibility Guidelines (WCAG) 2.0, 2008).

WCAG 2.0 is the same standard for desktop websites and for mobile apps. But while people understand that WCAG 2.0 applies to websites, they frequently look for different standards for mobile applications. However, WCAG 2.0 was designed to be technology neutral and written to evolve with changing technologies. That being said, WCAG 2.0 is not simple to apply to mobile apps because there are no code examples or demonstrations for accessible native apps in W3C documentation, but it exists there as a standard and it is possible to be used.

There are two official documents from the W3C Web Accessibility Initiative group that explain how to apply WCAG 2.0 to mobile, as well as to any non-web information communication technology. The first is the "Guidance on Applying WCAG 2.0 to Non-Web Information and Communications Technologies" (W3C, 2013) and the second is "Mobile Accessibility: How WCAG 2.0 and Other W3C/WAI Guidelines Apply

to Mobile" (W3C, 2015). The first document addresses also video and audio elements, which are frequently part of mobile apps.

4.2.4 INCLUSIVE DESIGN IN MY-TRAC

Inclusive design in My-TRAC has been one of the first thing that we wanted to include. In this first version of the UI it was difficult to include a lot of impairments so, we chose to have one example of inclusive interface designed for the chronic condition that appears to be more "popular" based in the survey realised (see Section 3.5My-TRAC User Profiles) which is the visual impaired people. Inclusive design principles have been taken into account when designing the UI components of My-TRAC application as they are presented in Section 5.4My-TRAC Interface Look & Feel; the accessible version.

4.3 AFFECTIVE DESIGN GUIDELINES

Good design touches you, great design touches your soul.
-M. Cobanli

4.3.1 INTRODUCTION

People have unspoken needs, which can be revealed by **probing their emotions**. The logic of emotion is how it deals with the urges, instincts, andrequirements people have, by creating a mental connection with the limbic system. Therefore, incorporating emotion into applications' design has become an essential strategy for increasing competitiveness in the consumer market (Chang & Wu, 2007). The emotional or affective design has become increasingly crucial in applications' design, as well as in human factors (Helander, Khalid, & Peng, 2007). Nowadays designers have started to expand the semantic approach, by incorporating it to their designs, trying to utilize affective design parameters. This semantic approach implies that each designed object has a meaning that goes beyond its functional requirements (Krippendorff, 2006), a recognition that emotions are essential for design (Norman D. , 2004).

However, the affective design has many barriers. First of all, it requires that the designer understands and knows how to implement the affective design components. Additionally, it demands to develop a mechanism to understand the source of these emotions and try to predict their connections with the design features for each user. Applications today, are designed considering the maximization of utility, covering in such a way only some of the users' needs. But, besides usability and functionality, emotion is equally crucial in application development.

There has been a lot of research done regarding **affective computing** over the past few years including web design (Koutsabasis & Istikopoulou, 2013), product design (Desmet, 2003), media communication (Cao, et al., 2014), fashion design (Sokolova & Fernández-Caballero, 2015), computer game (Yannakakis, Isbister, Paiva, & Karpouzis, 2014), human computer interaction (Park & Zhang, 2015) and service development (Morris & Guerra, 2015). Using a more recent example of affective design of mobile design, surveys have shown that mobile phones that were equipped with more attractive interface designs helped promote the product, although the phones are generally developed with similar functions (Kim & Lee, The User Experience of Smart-Phone Information Hierarchy and Screen Transition Patterns, 2016).

From the literature, we can see that affective user needs can be captured using various concepts. The most used ones are the **Kansei** and the **Citarasa** methodologies. Kansei Engineering techniques support emotional product design by linking customer needs mathematically to the technical characteristics of

the product (Birge, 2003). Citarasa, on the other hand, expresses the emotional intent, needs, and taste of the user. Unfortunately, affectiveelements are challenging to identify. They vary over time, and users often have difficulties in explaining what their conditions are. They may say "I like it" which is a statement with a very high level of abstraction and not useful for design. We need to break down to lower levels of abstraction, where design elements can be identified such as preferred shape, color, font, and so forth (Helander, Khalid, & Peng, 2007).

4.3.2 BACKGROUND TO AFFECTIVE DESIGN

Humans perceive reality in, at least two ways; one is **emotional** (intuitive and experiential), and the other is **rational** (analytical and cognitive) (Epstein, 1994). Formal decision making relies on analytical and cognitive abilities, which are quite complex and make this mode really slow. On the other hand, the affective (experiential) system runs much quicker. When a person seeks to respond to an event, there will be an automatic search and matching with one's experiential system, including its emotional contents (Epstein, 1994). Emotions do not cause thinking to be non-rational. Rational thinking entails feelings, and affective thinking entails rationality. Cognition thought is more precise, comprehensive, and insightful than emotional thinking. However, it is also emotional. Figure 12 shows the cross-coupling of emotions and cognition.

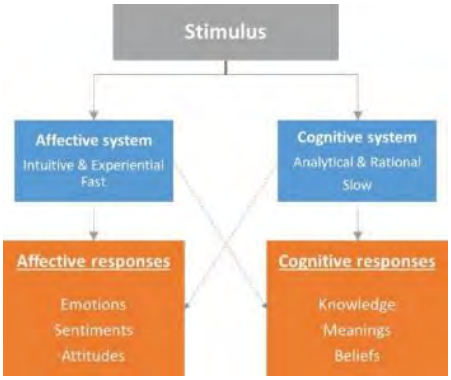


Figure 12: Coupling emotions and cognition.

In Figure 12, emotions are used to validate and assess, while cognition is used to describe objects, and understand the user (Norman D. , 2004). Cognition refers to the "head" to denote thinking, while affect refers to the "heart" to denote feeling. Thus, **cognition and emotions are unified and work conjointly** and equally in the control of thought and behaviour (LeDoux, 1995). Additionally, cognition contributes to the adjustment of emotion.

Thus, emotions have a critical role in dual-process theories of thinking, information processing, and decision making. When making decisions, both the positive and negative feelings, either consciously or unconsciously associated with the mental representations of the objects, are employed as cues for judgments (Slovic, Finucane, Peters, & MacGregor, 2002). **Without affect and emotions, people are unable to consider and make a decision between alternatives**. Russell (2003) introduced the concept of core affect, combining the affect dimension with physiological arousal into a circular two-dimensional model, as shown in Figure 13. Plutchik (Plutchik & Conte., 1997) evolved this two-dimensional model into a three-dimensional form, in Robert Plutchik's Emotion Wheel theory where he proposes a psycho-evolutionary classification approach for general emotional responses, also shownin Figure 13.

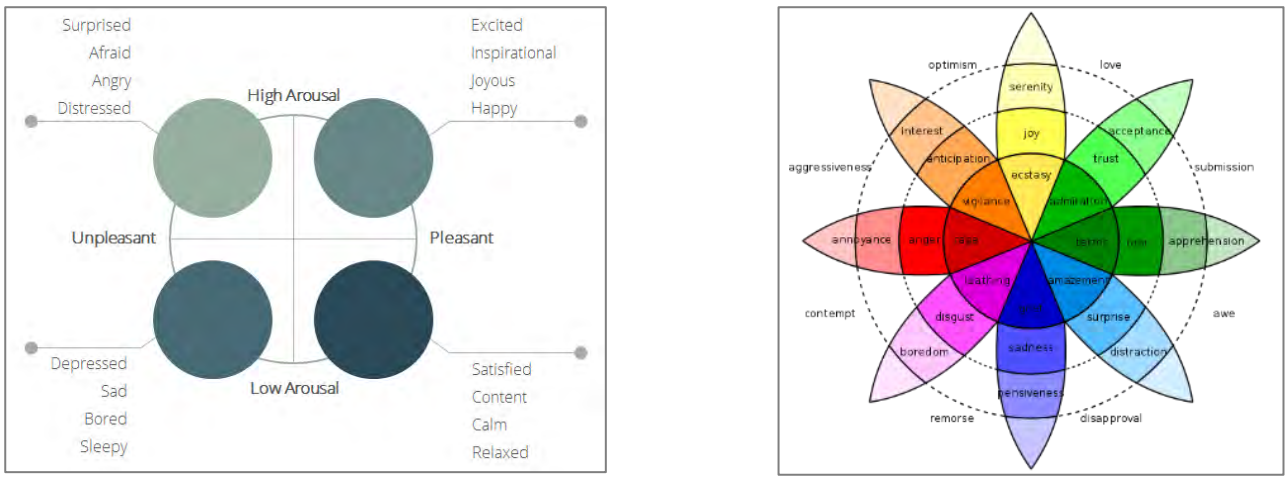


Figure 13: Circumplex Model of Core Affect with Relevant Emotions (Russell, 1980) and Plutchik's Emotion Wheel theory (Plutchik, 1980)

In both models, the horizontal axis represents **demeanor** (from unpleasant to pleasant), and the vertical axis represents **activation** (from high to low arousal). The various positions indicate affective responses that can be experienced in user-application interaction. However, the relationship between the design of an application and the user emotions elicited is not one-to-one, which means the same application can induce significantly different feelings in a different context with different people. Even for the same application, evaluated by the same person, it may receive different emotions under different circumstances.

Today, users look beyond functionality in the products they purchase and the applications they use. They desire products and applications that can satisfy both aesthetic and emotional needs. This provides a challenge to designers in designing applications that not only fit the purpose but also embody the image and convey the meaning that users seek in timeless elegance or exciting newness, depending on the personal life values of each user. While styling in itself can give pleasure, the pleasure is diminished if the appearance of the application bears no relationship to its function. In other words, **good design works, but a successful design induces pleasure**((Norman D. , 2004), (Norman D. A., 2007). For a successful design to be achieved, a systematic method has to be developed that includes the typical usability parameters, but also affective design has to be taken into account.

In 1943, Abraham Maslow proposed a theory of the hierarchy of human needs. He posited that humans have basic needs that must be met before other advanced needs can be addressed. His theory states that humans flourish when the top tier of needs are fulfilled. The **pyramid of needs** translated into emotional product design, as presented in Figure 14, can be a great checklist and can also help the designers to have a better understanding of the way the users work. According to the model, emotional design elements belong to the pleasurable/ delightful top icing.

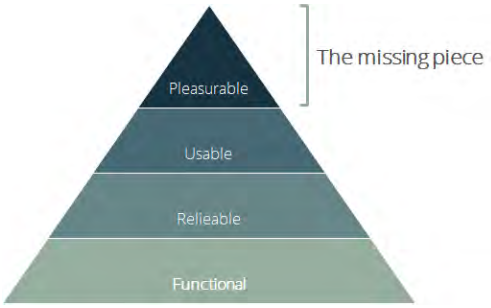


Figure 14: Emotional design missing piece.

4.3.3 AFFECTIVE DESIGN IN APPLICATION CONCEPTUALISATION

As postulated in the previous section, by using affective design processes, designers can transform **affective users' needs into features of an application**. Before application conceptualization, designers need to understand user requirements, which are classified in our research as functional and affective. This presupposes that users emotions are involved in the application usage and the design must therefore also address users' affective needs.

Creating flexible and agile process guides, having the **user in the centre of the procedure**, is the core of developing the methodology of application design. Whether being internal or external, empathy for users' needs is the key driver to the design process. The goal is to create transformative experiences which are user focused providing full user experience lifecycles.

Thus, the relationship among the user and the designer is bilateral; first, the user perceives, responds, and evaluates the application; second, the designer achieves the detailed design solutions successfully by satisfying the user's true needs, including both **affective** and **functional requirements**. Designer communicates and negotiates with the users to arrive at optimal design solutions. A good designer will ensure that a system image of the application matches the target user's model (Norman D. , 2004). The relationship between the user domain (understanding user needs) and the designer domain (application features, look and feel) is illustrated in the following figure.

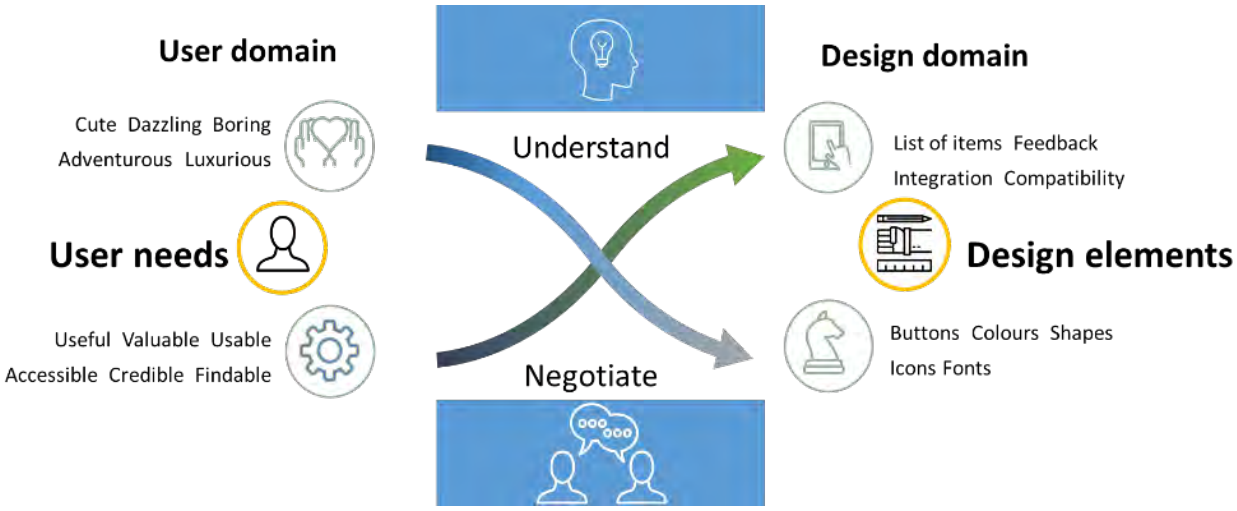


Figure 15: Affective design process.

When start conceptualizing a new application design, the designer has to define the design information and constraints, as well as to formulate the design equations. This is the modelling of the design, which in our case includes all the application design components that can be modified to achieve personalization of the interface. The second step is to conduct a user's survey using elicitation techniques. The survey is the main source for a gathering of affective users' needs. One questionnaire was developed, and it is presented in the next Section to elicit user needs around routing applications. The survey measured users' demographics, experience, expertise, affective needs, and design requirements. The survey provided data about users' desires, application usage, strengths and limitations of current application design, and requirements of application design. The figure below, depicts the way the emotions are coupled with cognition and also maps this coupling with the modelling process methodological framework.

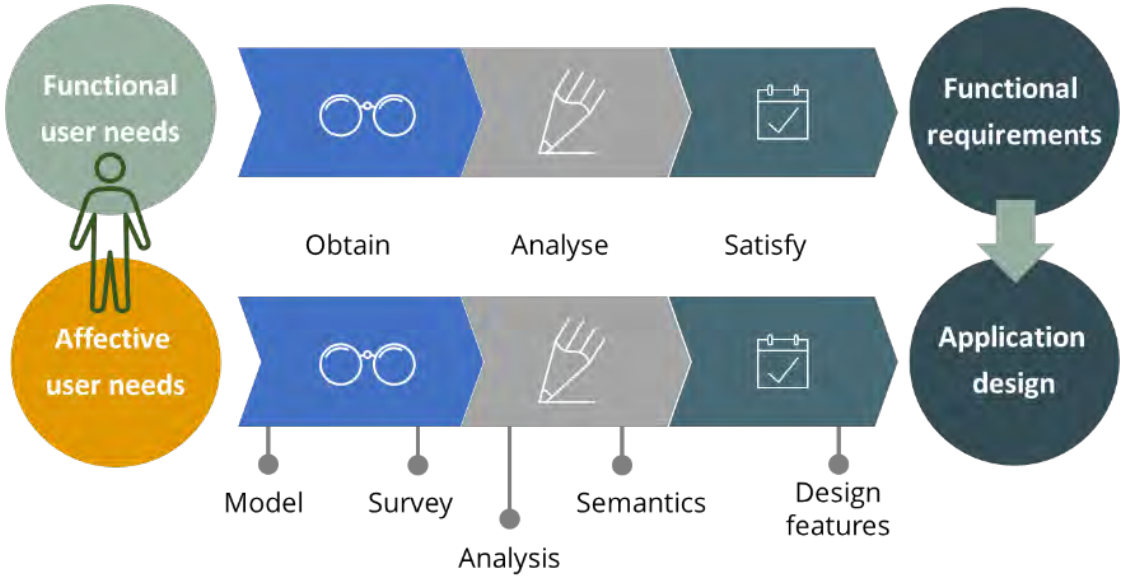


Figure 16: Coupling emotions and cognition into a methodological framework.

4.3.4 AFFECTIVE DESIGN IN MY-TRAC

Design must seduce, shape and perhaps more importantly, evoke an emotional response.
-April Grieman

User needs, especially affective ones tend to be imprecise and ambiguous due to their linguistic origins. Therefore, it is necessary to elicit the latent user needs so as to know why some needs are important, and how they can be denoted using explicit expressions that are describing them properly. The acquisition stage involves understanding latent user needs and developing of component descriptors to address these needs. The technique used in the study for extracting user needs is survey-based. Specifically, web survey methods were employed to document user needs.

Before conducting the web survey, an analytical conceptual model was developed to identify the design elements in the application ecosystem that might help satisfied users affective needs. The scope is to identify the mapping relationship between affective needs and design elements so as to quantify, later on, user satisfaction with respect to the corresponding affective needs.

In order to model the affective requirements of the users into application design components we use Design matrices, and we, therefore, provide a brief explanation of how the matrices work (Suh N. P., 1990). Axiomatic design is a systems design methodology which uses matrices to manage interactions between elements of the design and functional requirements – and in our case also affective requirements ((Suh N. , Axiomatic Design: Advances and Applications, 2001), (Suh & Lee, 2006)). Axiomatic design is a valuable generic design framework for designing complex systems. Many studies in the last decade have persuasively shown the benefits of Axiomatic design in solving a variety of design problems. Axiomatic design principles have been used for software and quality system design (Kim & Lee, 2016).

In new application development projects, it is noted that some design attributes considered in affective design could be identical to some functional requirements considered in the determination of the application specifications. However, emotional design and the determination of functional specifications are conducted separately. Thus, the settings of functional requirements and design attributes of a new

application based on existing practice could be different and may not lead to the maximum customer satisfaction to be obtained for the new application. Therefore, it is desirable to have a framework or a methodology that considers affective design and the determination of functional specifications simultaneously in determining the settings of user requirements and design attributes (Jiang, Kwong, Liu, & Ip, 2014). Axiomatic design provides us with a method that allows to take both functional and affective requirements into count during the design process.

Axiomatic design problems are separated into four different domains: User domain, functional domain, physical domain, and process domain. Associated with each domain are the design elements: user attributes (CAs) or needs which are satisfied by selecting an appropriate set of functional requirements (FRs) and constraints (Cs), which in turn are embodied into design parameters (DPs). The axiomatic design principal concepts are summarized as follow:

- Design domains are used to group similar types of design attributes.
- Decision making is perceived as a mapping process between two adjoining domains, such as functional requirements and design parameters.
- Design equations are used to represent the mapping between domains.

According to Suh (1990), at each level of the design hierarchy, the relationships between the FRs and the DPs can be written in the form of "a design equation" as:

$\{FR\} = [A] * \{DP\}$, where the design matrix [A] characterizes the application design.

Functional requirements {FRs} represent design goals based on user requirements, or in other words what a user wants to have. Design parameters {DPs} represent design elements, or how the designer plans to fulfill the user needs.

The matrix of a design with three FRs and three DPs looks like the following:

$$[A] = \begin{matrix} A_{11} & A_{12} & A_{13} \\ A_{21} & A_{22} & A_{23} \\ A_{31} & A_{32} & A_{33} \end{matrix}$$

Conventionally the values of A_{xx} in a design matrix will be either "X" or "0", where "X" represents a mapping between the corresponding vector components and "0" signifies no mapping.

The design process starts with identifying user needs, which are translated into functional requirements and Affective requirements {ARs}. The design parameters {DPs} corresponding to specific FRs or ARs must be selected. This process of mapping is repeated until all the design parameters have been broken down to a convenient level. The gathered ARs and FRs can be mapped onto design parameters through the design matrix. The *Design matrix* refers to the relationships between ARs, FRs, and DPs at a given level of design hierarchy. The design equation is then written as follows.

$$\begin{matrix} FR_1 \\ FR_2 \\ AR_1 \end{matrix} = \begin{matrix} x & 0 & 0 \\ x & x & 0 \\ 0 & 0 & x \end{matrix} * \begin{matrix} DP_1 \\ DP_2 \\ DP_3 \end{matrix}$$

Where:
FR = Functional Requirements
AR = Affective Requirements
DP = Design Parameters
X = Mapping

The main purpose of this design process is to prompt the designer to consider both affective and functional requirements of the user when conceptualizing the design of the application. It gives the designer the possibility to be aware of the importance of affective design and instruct them sometimes to make trade-off decisions that can promote affective design.

Summarizing the Axiomatic design principles with our methodological framework, the following design model emerges.

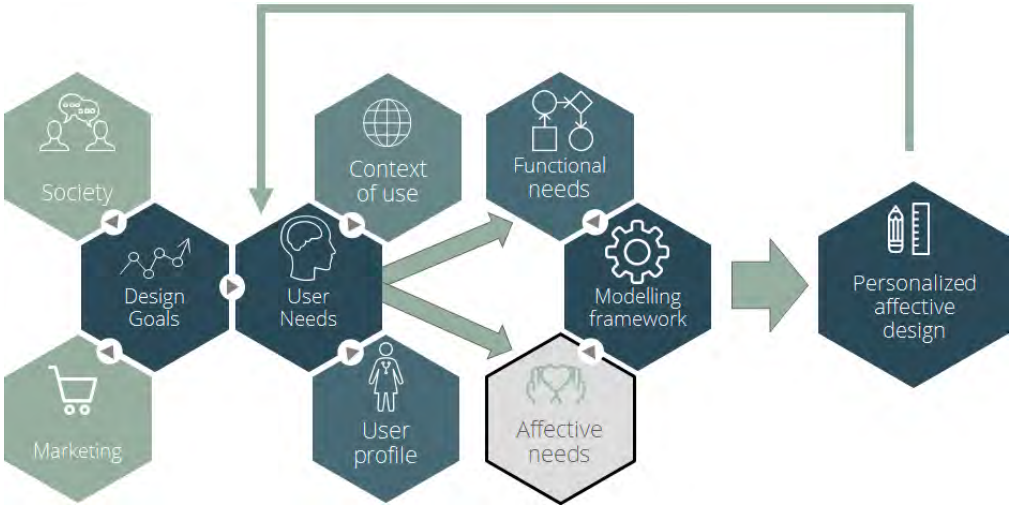


Figure 17: Affective design modelling framework.

The left part of the affective design framework depicted above is related to the designer goals, information, and constraints, as well as to the user needs elicitation. To put it in Axiomatic design terms, this part is related to the design constraints (Cs), as well as the user attributes (CAs). The mid part is related to the Formulation of Design Equations for Analysis and Decision making based on the appropriate set of functional requirements (FRs) and affective requirements (ARs). Finally, the right part presents the results of the modelling framework which is a personalized interface according to the user's individual needs and preferences.

4.3.4.1 AFFECTIVE REQUIREMENTS WEB SURVEY

The scope of the web survey was to gather the affective needs of the users, defining specific descriptors for the interface components and mapping them to specific user profiles. The design of the questionnaire (Annex A My-Trac user preferences questionnaire) was driven by modelling framework described in the previous section. The questionnaires existed in two forms: manual and electronic. They were developed in English and then translated in to Greek, Spanish, Catalan, and Portuguese.

This survey is a tool comprised primarily by close-ended questions related to users' demographic data, identity/ personality features and habits, as well as transportation patterns (stated preferences) and application design (Use Interface) preferences.

The questionnaire is separated into two parts:

Part I: Demographic data and identity attributes

This part deals with the users' personal data and information that will create his/ her profile, based on the demographic data, as well as his/ her lifestyle, personality, social norms, and habits. None of the questions records user name or contact details as the information remains anonymous.

Part II: Application design requirements

This part deals with questions related to the connection of the users' affective requirements to the UI elements of the applications. Starting with questions that define the users' experience with using such applications and concluding with questions related to the user's preferences on the UI elements according to specific affective factors.

4.3.4.1.1 USER CHARACTERISTICS

As we have already seen in our Personas chapter (Chapter 3My-TRAC), in My-TRAC we have used a group personalisation concept. This concept is enhanced from the literature which suggests that people have similarities and we tend to think similar with people that we believe that are similar to us (Fogg B. J., 2003). The scope of this part of the questionnaire is to gather feedback from people and put them in groups based on commonalities (See Chapter 3.5My-TRAC User Profiles). The characteristics that have been captured from this survey are the following.

- **Demographic characteristics**

Demographic characteristics aim to gather simple and basic, but yet critical information about the population sample that participated in the survey. So they include classifiable characteristics of the given population. Demographic characteristics help us know our users better and allow us to classify their characteristics based on some demographics commonalities that they might have. The demographic profile of a My-TRAC user consist of the following information:

  - **Nationality**- Nationality effects the cultural differences users might have.
  - **Age** -Age has a major effect on users' behaviour. Users' needs change as they grow older. Age leads to changes in lifestyle, personal values, transportation needs and UI requirements. Age also defines market segments in regards to technology.
  - **Gender** - Males and females have entirely different needs and preferences that affect their selections of lifestyle products and fashion.
  - **Education** - The level of education influences users' perceptions of the things around them and affects the degree of research before making a decision.
  - **Employment status** - The consumer's occupation plays a major role in the products they buy. Their jobs give insights into the type of person they are.
  - **Income** - Income has a significant effect on users' behaviour and product decisions. Middle-income users consider high utility of money while buyers with higher incomes prefer luxury items, vacations, jewellery and expensive cars.
  - **Living arrangement** – The living characteristics of users effect their decision mind-sets.

- **Physio-Characteristics**

Physio-characteristics concern the physical bodies of people, the way that they use their bodies and how their bodies exist in physical environments. Traditional human factors has often concerned itself with the physiocharacteristics of products (e.g. automotive ergonomics), but traditionally, information designers concern ourselves very little with the physical aspects of our designs. In Jordan's model, designers should concern themselves with multiple physical aspects, the most important of which are briefly outlined below for designers of informational products.

- **Special disadvantages –** Special disadvantages concern the chronic conditions that leave people either permanently or temporarily at a physical disadvantage. Obvious examples include physical handicaps such as blindness or deafness, but might also include the effects of age.

- **Urbanisation and physical environment** - People always operate in a specific physical environment that includes ambient light, sound, temperature, etc. Regarding transport their urbanisation status is important regarding the availability of specific modes.

- **Ideo and socio characteristics**

People prefer to use products that they believe reflect their own personalities, understanding the attributes of self-image seems paramount in the design process. Additionally, socio characteristics are also importance since they reveal the ways that people relate to others and how individuals fit within social groups. Socio-characteristics also include self-images through which people define their identities with or against certain groups of people. Ideo-characteristics, much like the socio-characteristics, speak to the way we view the world and how we choose to operate in it. Our value sets, which derive from our membership in communities of various types, impose themselves upon how we interact with products and how we expect products to be constructed. Consequently, this approach examines not only people's actions reveal their memberships and relationships, it also considers a person's perceived (or desired) personal and social status. Ideo and sociocharacteristics in My-TRAC involve the following elements:

- **Lifestyle** – This attribute refer to the way people live their lives. The lifestyle status, isn't only related to material wealth, but can include cultural status such as being seen as "cool", “active” or “classy”. For example, some people may choose to live environmentally conscious lives and enjoy being outdoors. Others may prefer a more industrial and urban lifestyle. Information products designed for each audience might differ, for example, in colour palettes and the language might be more reflective for the environmentalist and perhaps more terse for the car addict.
- **Personality traits** - This set of characteristics concerns relatively stable attitudes that comprise a person's overall personality, not momentary moods or states of arousal. Users’ personality traits have been gathered using a short version of the BIG five inventory (John & Srivastava, 1999)and specifically the BFI-2 (XS) (Lang, John, Lüdtke, Schupp, & Wagner, 2011)in combination with the regret and disappointment scale (Marcatto & Ferrante, 2008). What is important is to connect these personality traits to UI elements, saying, for example, that "this is a friendly UI," or "this app is cool".
- **Personal ideologies** - Ideologies, although often unconscious, serve as a basis for many of the decisions we make in our daily lives. Personal ideologies outcomes are based on literature user profiles. Is the user an “aspiring environmentalist” or a “die-hard driver”? If a person held the values above this determines how he/ she will interact with the application as well.

4.3.4.1.2 APPLICATION DESIGN COMPONENTS

The second part of the questionnaire is relate to the aesthetic values of the users. Aesthetic values are often believed to be individual, "beauty is in the eye of the beholder" however, what people find

attractive evolves largely from our social environment and our values, as they derive from the first part of the survey.

Formal and experiential application features can be subdivided into multiple categories including colour, form, graphics, materials, sounds, and interaction design. In Part II of the questionnaire, a set of application design components was presented to the users. These interface components are postulated to have the greatest affective power over an application design. Additionally, the selection of a set of components, instead of all of them, allowed avoiding great workload of the respondents and on the other hand, simplifying the work of the designer.

A representation of the specific components appears below.

- **Colour**

Colour can arouse very strong associations. Additionally, it is particularly powerful because people see colour before other characteristics of an application. Itten (1961), argues that colour can be manipulated to achieve desired affects. Colour has been used code elements. It can increase the velocity of comprehension, and it can establish a unique identity for elements. Also, colour can be used to guide a user's attention; it can be used as a locator signal and can liven up an application. Thus, we can postulate that colour adds an affective dimension to user experiences, by "colouring" them and impacting user moods. Colour, as this brief review suggests, although a very subtle cue that is most often processed pre-attentively or unconsciously, carries enormous importance for the formal aspects of an application and when used carefully within cultural expectations, can become a very powerful informational tool.

- **Form**

The term form is about an object's shape, its overall presence in three dimensions that combines different shapes into a single design. Form further extends to the way a component is used, such that it can be clicked using one finger, and how its shape alerts people to the proper use of an interface component. The role of form in application design seems highly neglected. However, most application designers can demonstrate significantly different forms that provide a different experience to the user and satisfy specific needs. For example, people with specific motor abilities, need buttons with a bigger shape so as to be able to click on them easily.

- **Graphics**

Graphics will occur in most applications, and their careful use requires significant attention. Icons, for example, pose particular challenges, because very few symbols have reached universal acceptance. Following a similar line of reason, a culturally sensitive visual design practice that takes into account the national origin of readers is also very important. Beyond revealing the information that users need to know, though, graphics play an important role in carrying the affective values associated with applications. One particularly powerful graphic element is typography, since one typeface might be "elegant" while another can be "direct," and a third is "friendly". Consequently, the experiential properties of graphics are not limited only to icons, drawings or photographs, but extend to the typeface we use to present verbal text.

- **Interaction Design**

Interaction design has received much attention from usability and human factors experts, and an entire field of interaction design has evolved alongside and sometimes in competition with information design.

In other words, interaction design means thinking through the actions that users will take with an information application to enable that action.

4.3.4.1.3 PILOT STUDY

The questionnaire was piloted using actual users in Greece in March 2019. The results highlighted those questions that were difficult, and/or ambiguously worded that required rephrasing. The results also identified potential answers that could be used for creating response categories.

The pilot study also allowed us to elicit the appropriately associated descriptors. Selected descriptors were selected from the literature review and were incorporated into the questionnaire. After the pilot's realization, changes, were made to the questionnaire so as to include associated descriptors that were related to routing applications and were fully understood from the users. From the results, five descriptors were highly selected by participants and were used in the Web survey. These descriptors are highly connected to the profile of the user extracted from Part I of the questionnaire.

Respondents were asked to rate several images based on selected descriptors from the literature review. They also ranked their preferred images. There were five images with specific differences that were used. The users did not clearly understand the differences between some of them, which increased a lot their workload. Thus in the final questionnaire only three, out of five, images were used. Those were the images that had the most profound differences according to the respondents.

4.3.4.2 MY-TRAC USER SURVEY RESULTS

The results of My-TRAC web survey are two-folded. On the one hand the user profiles, as presented in Section 3.5My-TRAC User Profiles, and on the other hand the affective requirements of the users. The scope of this section is to present the affective requirements as extracted from the survey and to map specific affective requirements to each user profile segment.

The target of this survey was mainly people who already use mobile routing applications. Nevertheless, we are interested to see also the affective needs of people who do not use mobile routing applications yet. The majority of our sample, as expected, uses mobile applications (87% in Greece and 57% in Iberica Peninsula). The minority (13% in Greece and 43% in Iberica Peninsula) who do not use mobile routing applications is mainly because they believe that they do not need it, either because their daily trips are short or because they feel they know the transportation network very well.

From respondents who use mobile applications, the vast majority uses google maps, as presented in the following chart. The next service that is used is OASA telematics, which is not a mobile application and it can be taken into account. The third most used application is the iphone maps, followed by a number of other apps like Moovit, Nokiea Here, Waze etc.

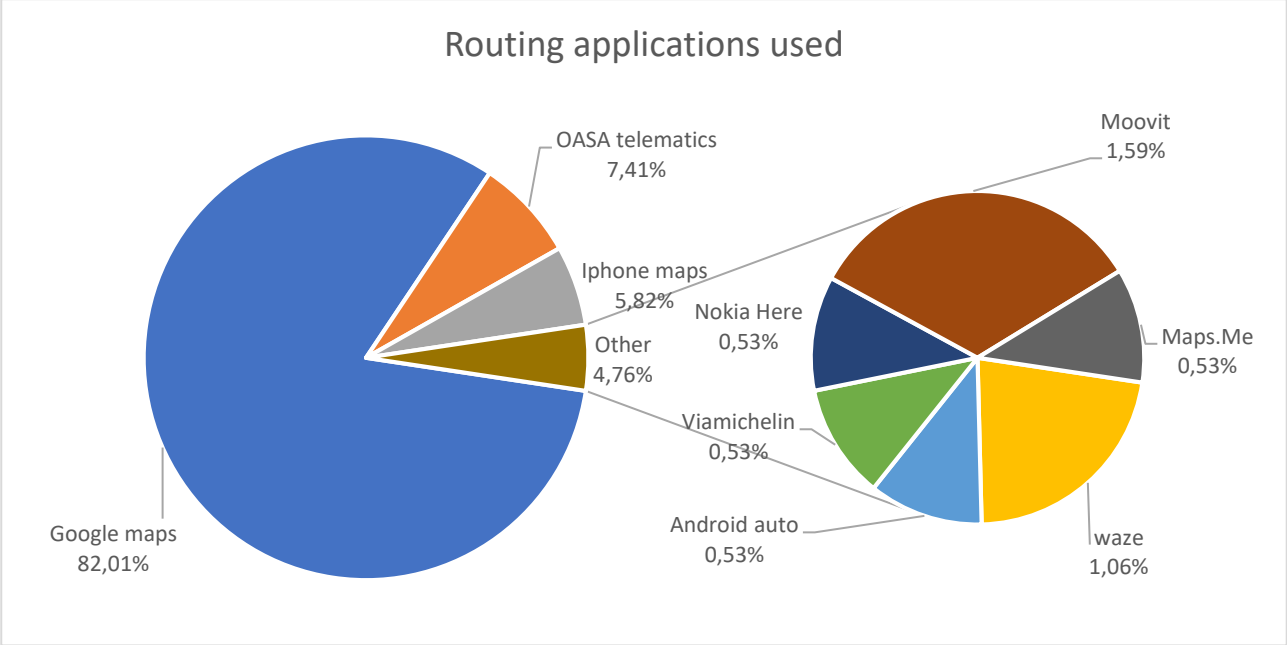


Chart 62: Routing applications used from the respondents.

The next question was regarding routing application usage timing. Most users in both countries (50% in the Greek sample and 48% in the Iberica Peninsula sample) use it before trip to plan their route, then 33% of respondents from Greece and 28% onf the respondents from the Iberica Peninsula, use the routing application during and before trip. Finally, 15% of respondents from Greece and 21% onf the respondents from the Iberica Peninsula use the application only during their trip (see Chart 63).

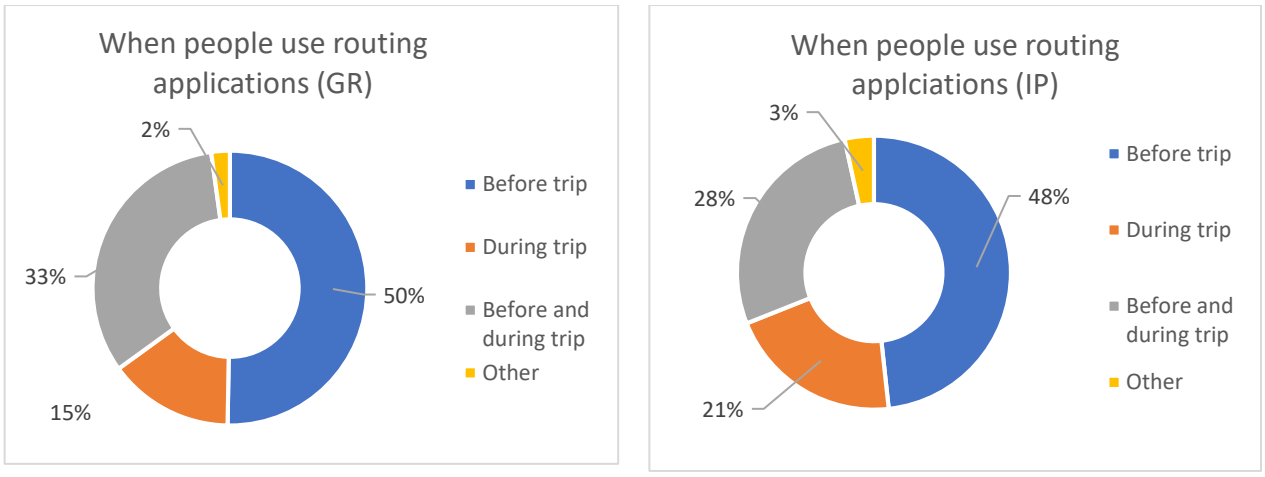
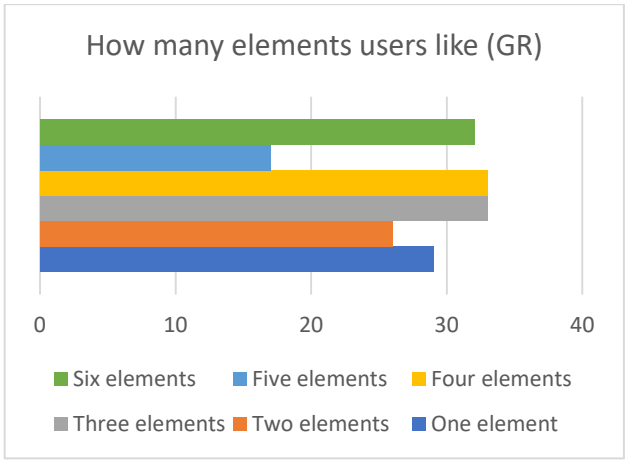


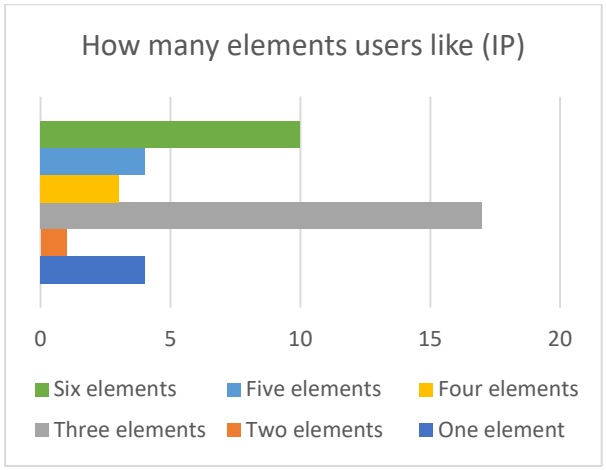
Chart 63: When people use routing applications.

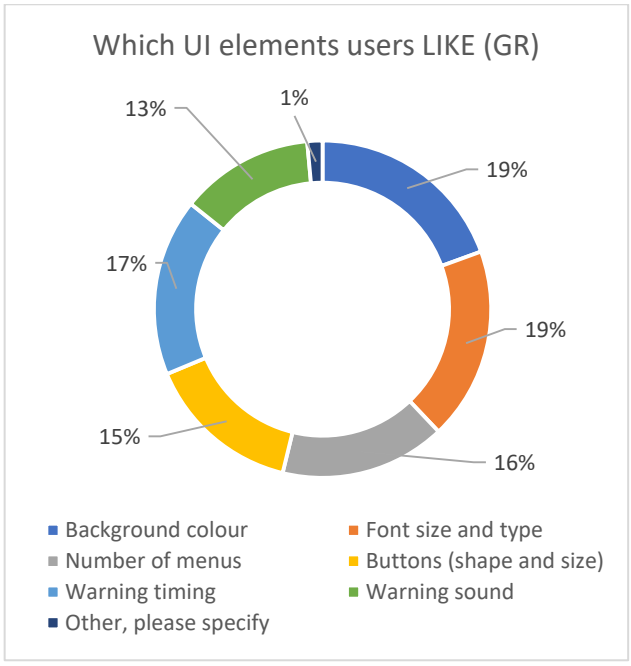
Most respondents, in both countries, use the routing application when they use car for their transportation, followed by those who use bus or train. When people use bicycle they do not usually use routing applications. We have to consider though at this point that the survey was not realized in countries where bicycle is frequently used as transportation mode. So this statement stands only for countries where bicycle is generally under-used.

Chart 64: Use of routing application per mode type.

Regarding the UI elements of the routing applications the respondents already use, they seem to be quite happy with them, since the majority of them likes all UI elements under research, namely background colour, font size and type, number of menus, buttons (shape and size), warning timing and warning sound. This is also revealed from the chart below where we see that the users do not have a specific preference towards one specific element from the application they already use, but they like them all more or less. And this is the case in both countries.







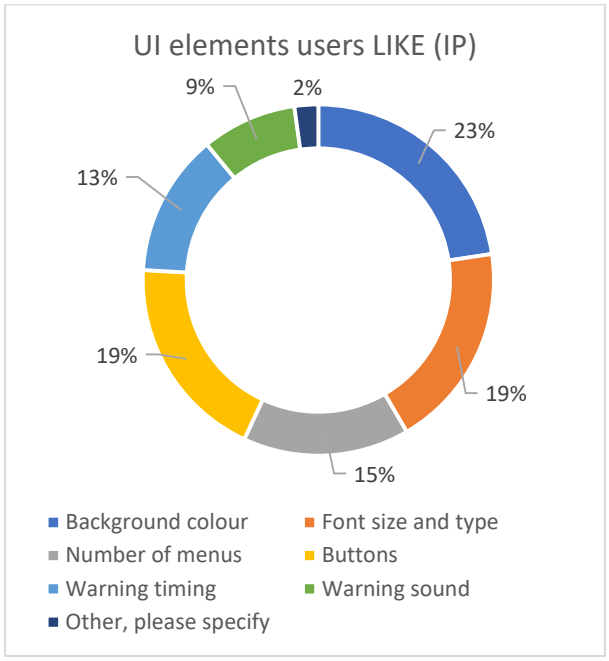


Chart 65: How many and which elements do users like in the routing application they already use.

Things are more clear regarding the UI elements of the routing applications the respondents use already, that they don't like. Especially in Greece, the majority of the respondents don't like only one element of the application they already use which is either number of menus they have to go through to complete an action or the buttons (shape and size). Respondents from Iberica Peninsula seem to be more undecisive. Most of them they don't like 3 elements of the application they already use, which mainly are again againumber of menus they have to go through to complete an action or the watning timing. These will be considered as lessons learned from the users when designing My-TRAC UI.

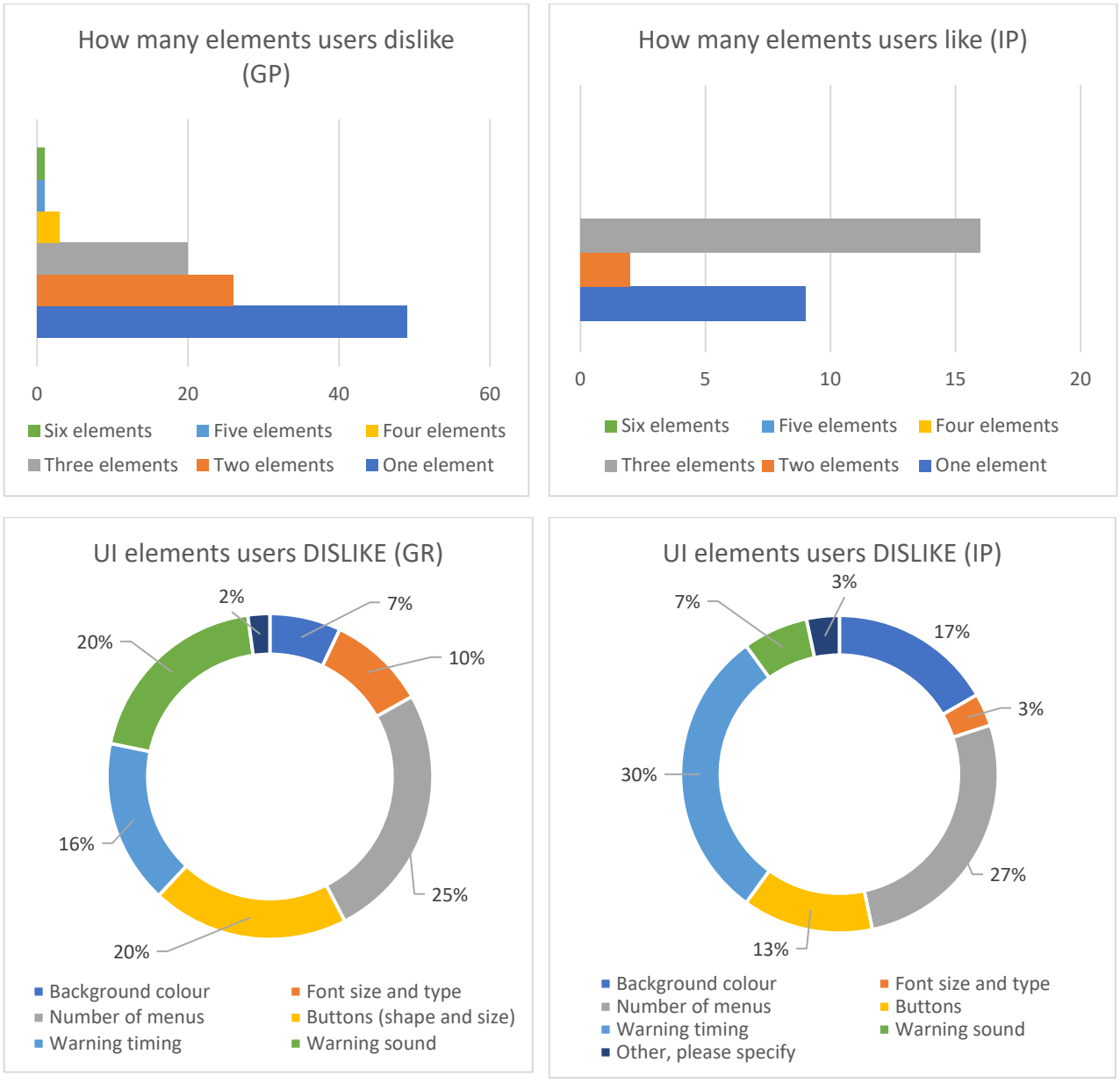
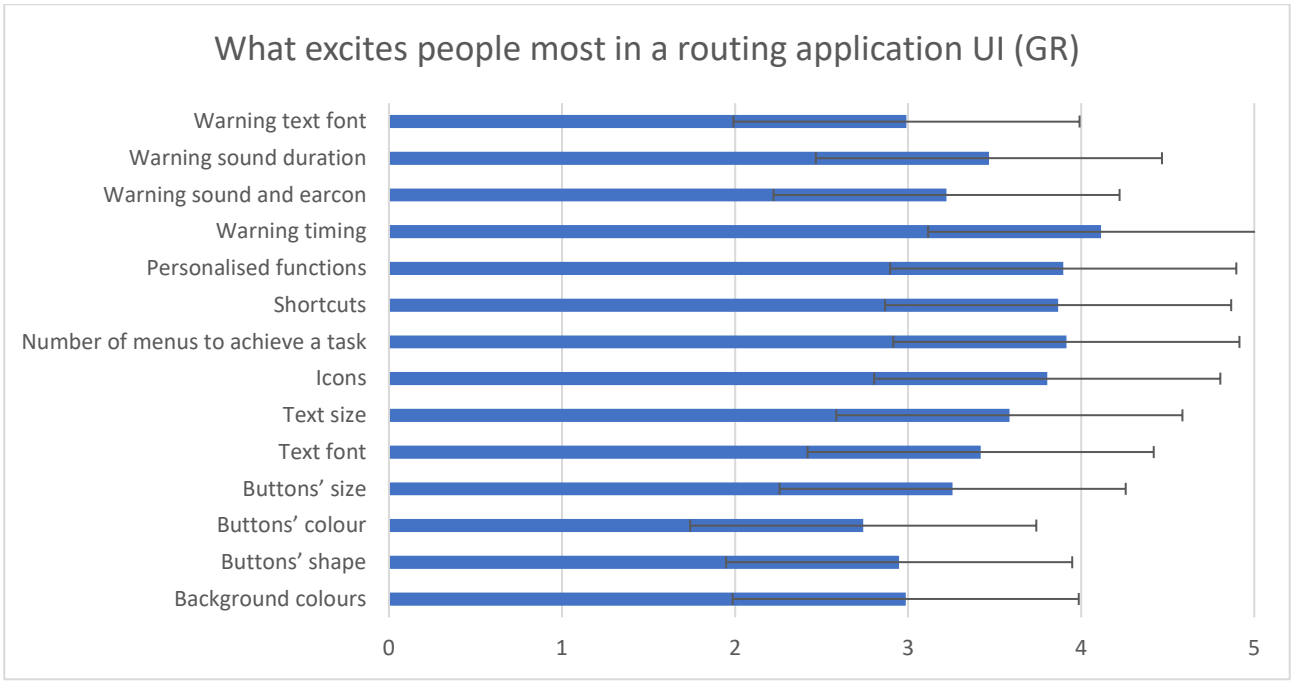


Chart 66: How many and which elements do users dislike in the routing application they already use.

Moving a step forward from the routing application they already use, the users had to answer some questions regarding a hypothetical routing application. An interesting finding is what excites respondents more regarding a routing application. Here respondents had a wider set of elements to choose from and we see that most of them, regarding the Greek sample are excited from the warning time, which means that they do not wish to have disturbing or out of time warnings. This is followed by the personalised functions and the number of menus to achieve a task. In the Iberica Peninsula sample, the top three elements that the users are excited from are the shortcuts, the number of menus to achieve a task and the personalised funcions. All these have been taken into account when desining the wireframes for the pilots.



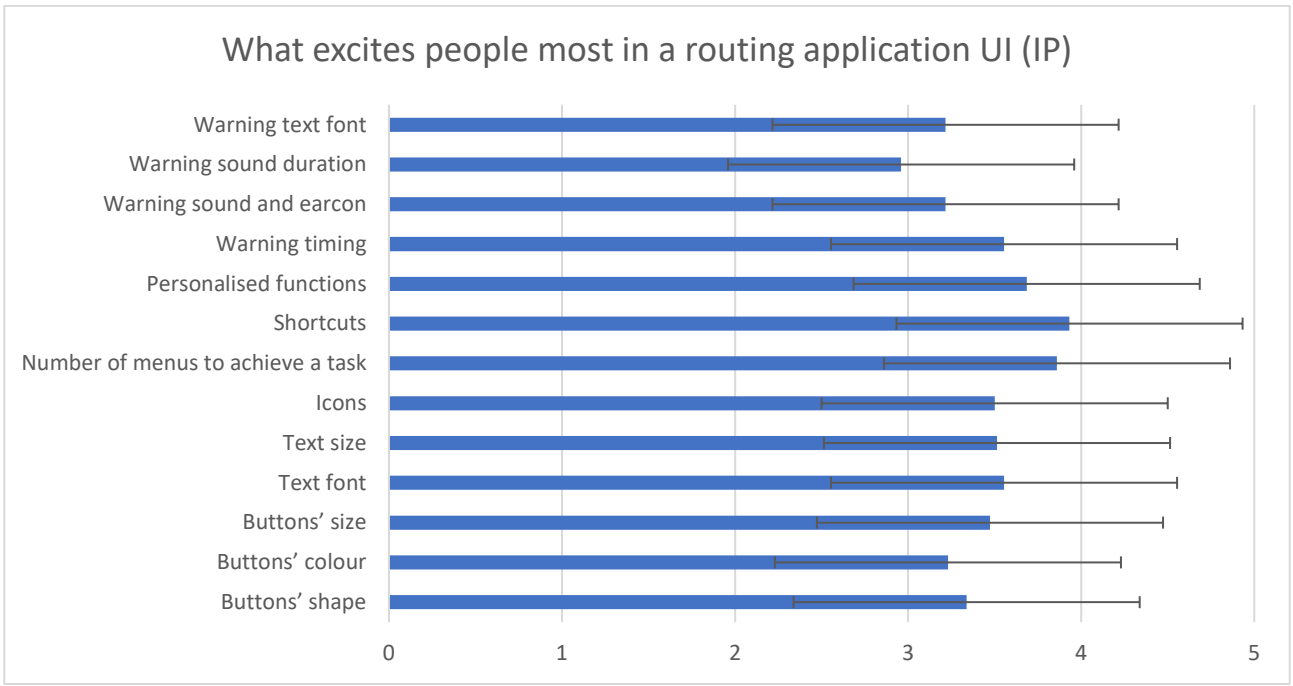


Chart 67: How many and which elements do users dislike in the routing application they already use.

Then the users were presented with 3 different possible options for My-TRAC application UI (Figure 18: Options for My-TRAC UI.).

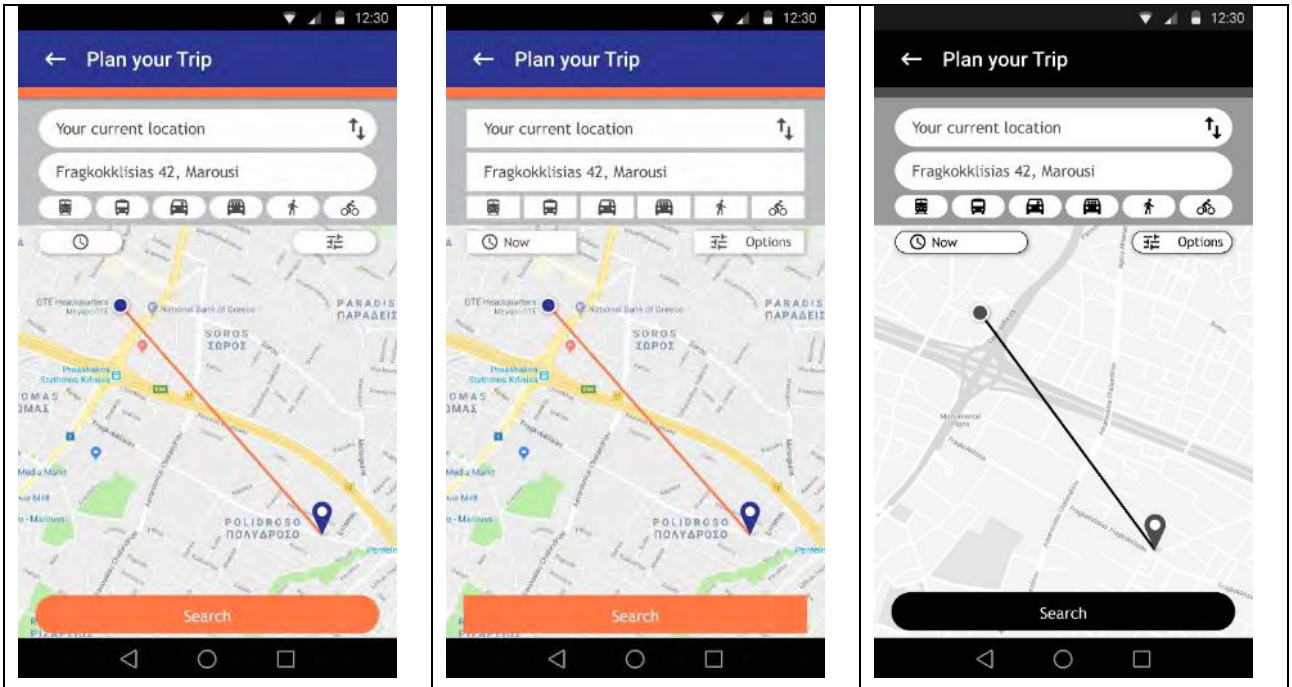


Image 1	Image 2	Image 3

Figure 18: Options for My-TRAC UI.

First of all they were asked to define who much they like or dislike each of the images above in a 5 point Likert scale. Image 1 seems to be more favourable from the majority of the respondents in both countries.

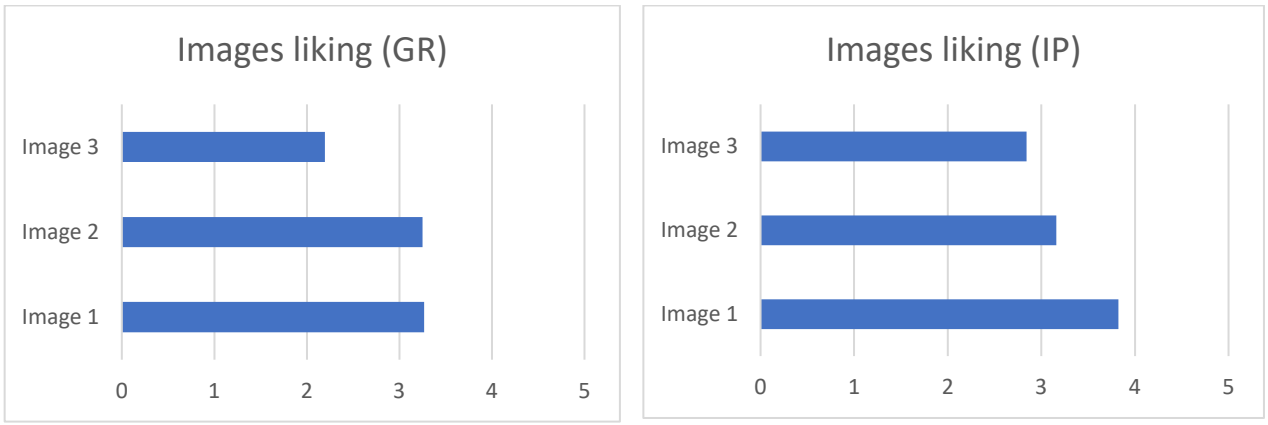
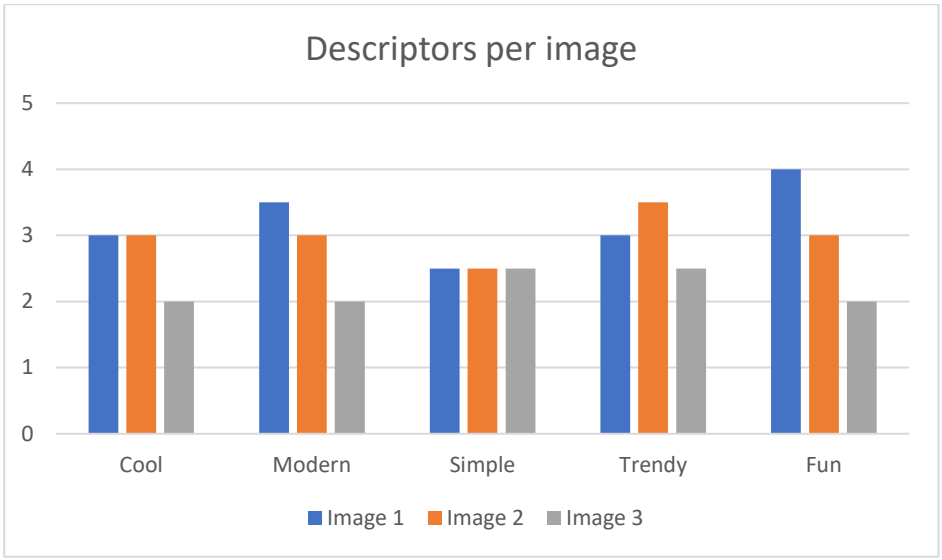


Chart 68: Favourable UI options

The majority of respondents in both countries would characterise Image 1 as fun, cool and modern, image 2 as trendy and image 3 as simple.



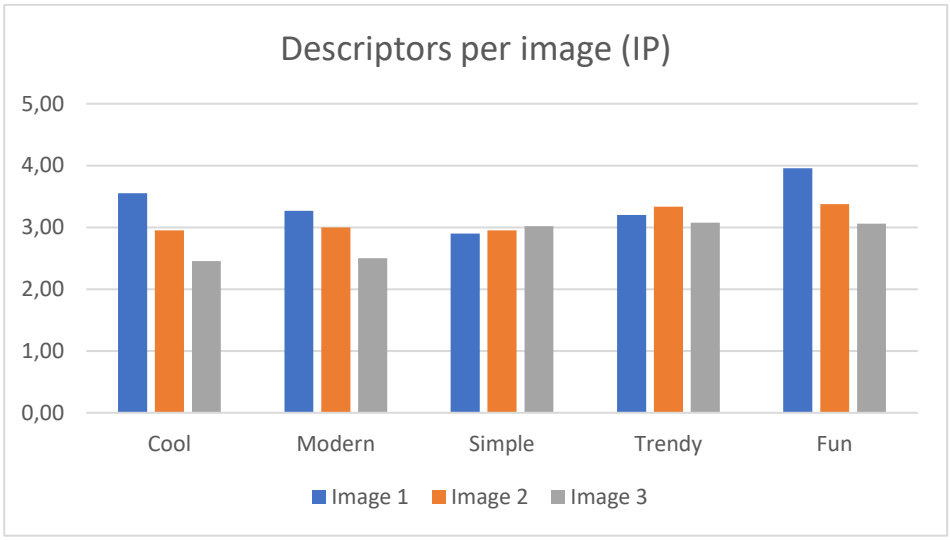


Chart 69: Affective descriptions per UI option

5 My-TRAC UI DESIN

Design is not just what it looks like and feels like. Design is how it works.

–Steve Jobs

5.1 INTRODUCTION TO UI DESIGN REQUIREMENTS

Designing a successful application is not an easy process. There are some main principles that need to be followed based on the literature, but of course, as we said before in Section 3, users are the ones that have the final word. Nevertheless, designing without the basic principles in mind most possibly will end up having a design that does not respond either to specific user needs. So, in My-TRAC UI design, we followed the seven UX elements defined in the "user experience honeycomb" (Morville, 2004). The user experience honeycomb is the following diagrammed reminder that explains the seven basic facets of user experience design.

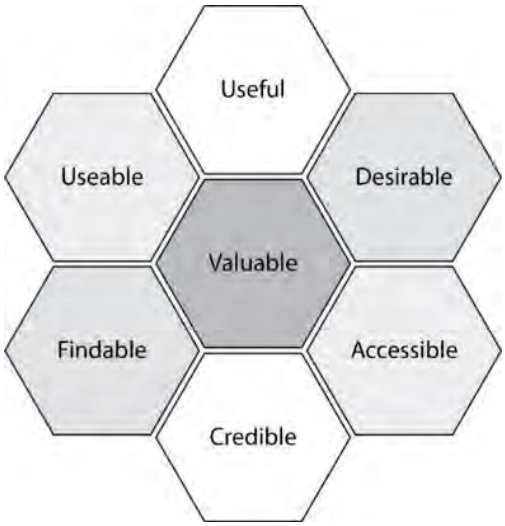


Figure 19: UX honeycomb, by Peter Morville.

All equally important, each facet of user experience design can be defined by this diagram as such:

1. **Useful** – Does the product solve the right problem?

The most important thing for a successful UX is to be useful and serve a user's need. The other principles don't matter at all unless people are willing to use the application to solve a problem. In fact, some studies showed that usefulness is about 1.5 times more important than usability (Davis, 1993). If the product or service is not useful or fulfilling user's wants or needs then there is no real purpose for the product itself. To fulfil this requirement we have captured user needs in WP2 and WP5 – D5.1 (Antoniou, Guisado-Gámez, Stroumpou, & Papacharalampous, 2018)) and we also created My-TRAC personas as presented in Section 3.

2. **Usable** – Is the app easy to use?

So, you have an application that solves someone's problem. Is it simple and easy to use? Applications should be designed in a way that is familiar to the user and easy to understand. The learning curve a user must go through should be as short and painless as possible. To identify the usability of My-TRAC application we have developed a usability testing protocol reported in D6.1 (under development).

3. **Desirable** – Is the product enjoyable to use?

The visual aesthetics of the application need to be attractive and easy to translate. We should not forget that beautiful-looking products are preferred over usable-but-not-beautiful ones since users are strongly influenced by the aesthetics of any given interface, even when they try to evaluate the underlying functionality of the system (Norman D. , 2004). To make My-TRAC application desirable we will incorporate in the next version of the app, the design parameters that comply with the affective requirements of the users based on Section 4.3.4.2My-TRAC User Survey Results.

4. **Findable** – Can users find relevant content easily?

The application has to be easy to navigate and the information needs to be findable. If there is a problem, the user should be able to quickly find a solution. Also, the navigational structure should be set up in a way that makes sense and it is not complex nor requiring deep digging. These requirements have been taken into account when designing the basic User Interface of My-TRAC application reported in D4.1 (under development).

5. **Accessible** – Is the product usable by people of varying abilities and disabilities?

The application should be designed so as all users, the ones with disabilities included, can have the same user experience. In this context, accessibility is the how of universal design: a product must be accessible to be considered universal. Accessibility of My-TRAC UI has been one of the exceptional elements that was taken into account, presented in Section 4.2Inclusive Design Guidelines and Section 5.4My-TRAC Interface Look & Feel; the accessible version.

6. **Credible** – Does the product feel trustworthy and reliable?

NN Group in a recent study (Nielsen, 2011), revealed that users will leave your site within 10-20 seconds unless you can prove your worth. Thus, designers just can't expect the users to trust them with blind faith, they have to prove their trustworthiness and they have to do it fast. A good practice regarding trustworthiness of our application is consistency which is also strongly linked to reliability. To achieve consistency of our UI we have developed a thorough UI Style guide, presented in Section5.2My-TRAC UI style guide. Additionally the credibility of the application in terms of functionality will be checked before the first pilot phase, during technical validation test among the Consortium partners.

All the above were taken into account during the development phase of the design of My-TRAC UI, reported in D4.1 (under development) as well as for the design of the final application design, as depicted in the following Sections (Section 5.2My-TRAC UI style guide and Section 5.4My-TRAC Interface Look & Feel; the accessible version).

5.2 My-TRAC UI STYLE GUIDE

UI Style Guides are a tool for the designer and the developer that brings cohesion to a digital product's user interface (UI) and experience (UX). At their core, UI Style Guides:

- Record all the design elements and interactions that occur within a product
- List key UI components such as buttons, typography, colour, etc.
- Include essential components for the users' experience like dropdown lists, animations, etc.

The benefits of using UI Style Guides are the following

1. A Style guide Makes Designs Concrete and Clear

A style guide provides guidance and documentation for reference to the design. A robust design should be able to solve a single problem in one situation, as well as a pervasive problem on other screens of the application.

2. A Style guide Makes the Design More Consistent

A style guide provides a dictionary of sorts for the UI design language. The added value of this is that you can use the same terminology when you want to communicate something you've already expressed before.

3. A Style guide Makes the App Faster to Develop in the Long Run

When the designers' team is developing a common component for a screen, they're developing a solution that they will also use elsewhere. This saves development time and could mean saving as much as 10x the person-hours required to build a new screen.

4. Reusing the Same System Components Makes the App Easier to Use

A style guide provides consistency to the application. One component that has already been understood by the user in one screen, it will be familiar to them, when used again in a different context. And since the topic under discussion is the user interaction, this consistency improves the overall usability of the product.

5. A Style guide Facilitates Production Efficiencies and Innovation

Creating a style guide makes designs more accessible and readily available to the rest of the team. Developers and designers can prototype an idea faster and more easily.

In My-TRAC the UI elements that were decided to be used in the version of the application where the ones that were assessed more positively from our user survey (see Section 4.3.4.2My-TRAC User Survey Results). Displayed below is the visual user interface guidelines for My-TRAC application. They are to be followed and executed as shown below without any variation from these guidelines.

Color Palette

Typography

We are using **Roboto**fonts

Roboto	Sit amet, lorem ipsum dolor
Roboto bold	**Sit amet, lorem ipsum dolor**
Roboto italics	*Sit amet, lorem ipsum dolor*
Roboto bold italics	***Sit amet, lorem ipsum dolor***
Roboto light	Sit amet, lorem ipsum dolor
Roboto thin	Sit amet, lorem ipsum dolor
Roboto black	**Sit amet, lorem ipsum dolor**

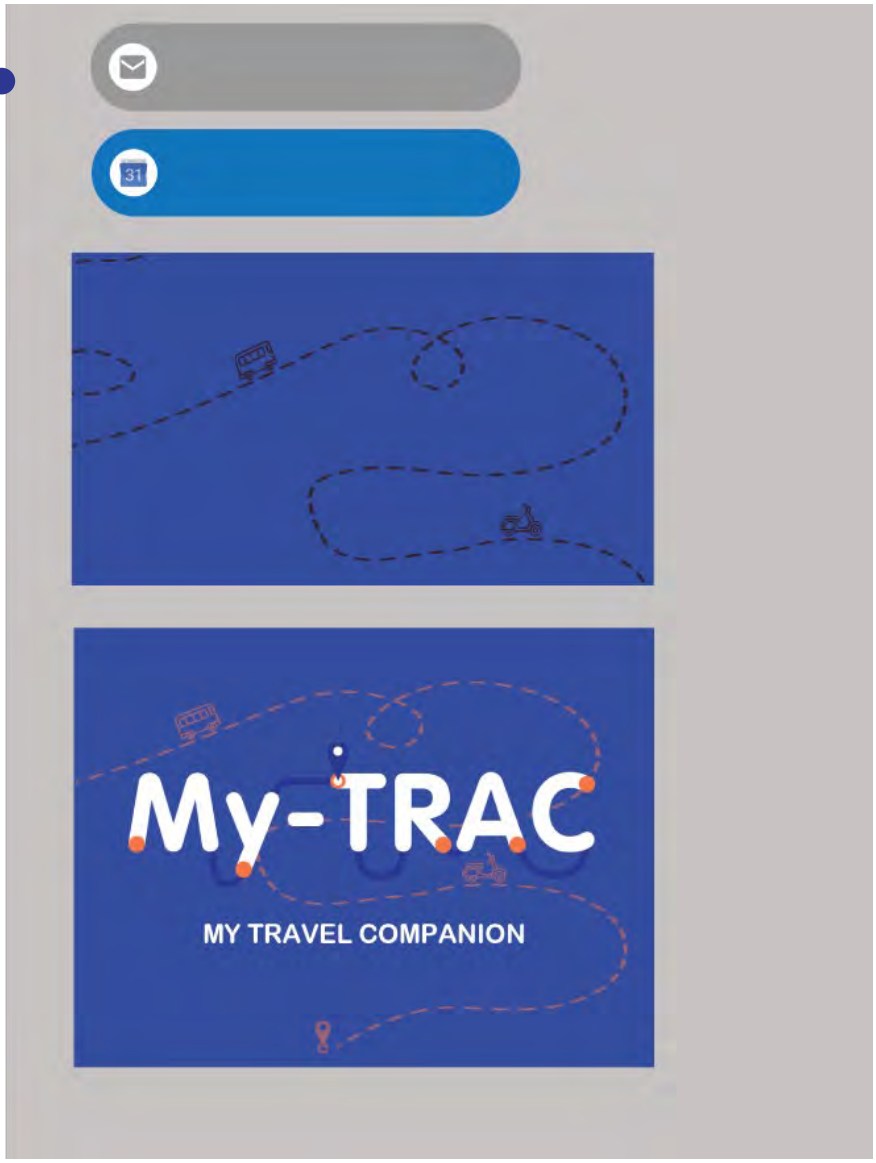
Iconography

Shown on the right the entire icon set for My-TRAC application, which includes a few variation of colors that represent different statuses and hover states within the app.

GUI elements

Shown on the right is a variety of differentbuttons, formsand boxes.

GUI elements (continue)



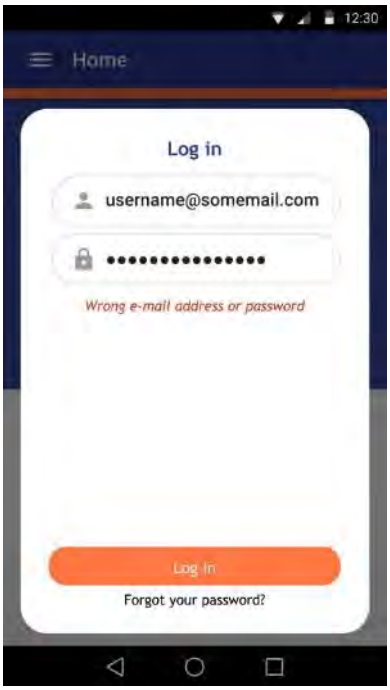
5.3 MY-TRAC INTERFACE LOOK & FEEL

The wireframes below show the application User Interface, as it was given to WP5 for development. The wireframes below depict only the Use Cases that were selected from WP5 to be shown to the Users during the pilots' phase 1. Some inconsistencies may exist between the following wireframes and the actual application that has passed in testing with users in phase 1 tests. This is part of the User centred design process, since there have been updates from the developers deriving from the functional testing during phase 0 of the pilots.

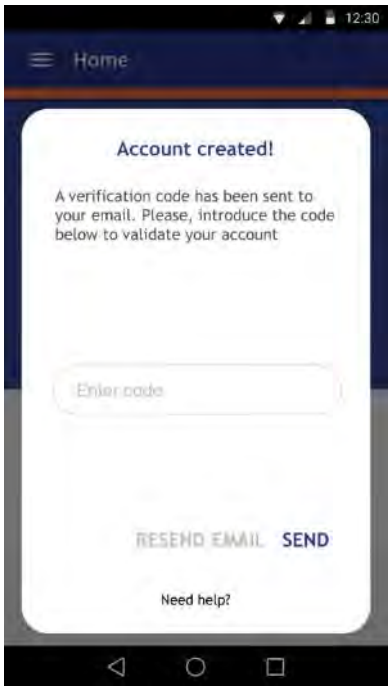
The wireframes below correspond to a number of Use Cases that were chosen to be demonstrated and used during the phase 1 of the pilot tests. The wireframes related to the rest of the Use Cases will be designed after the end of the phase 1 of the pilot tests and will incorporate the changes that will emerge from the usability testing.

Use Case ID: #T1, Traveller's Registration

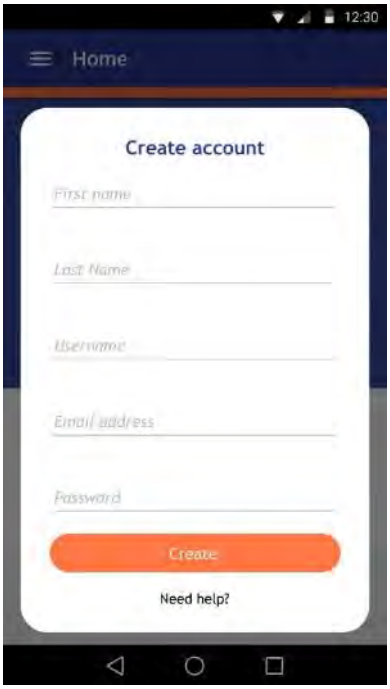
Login with email



Wrong email or password

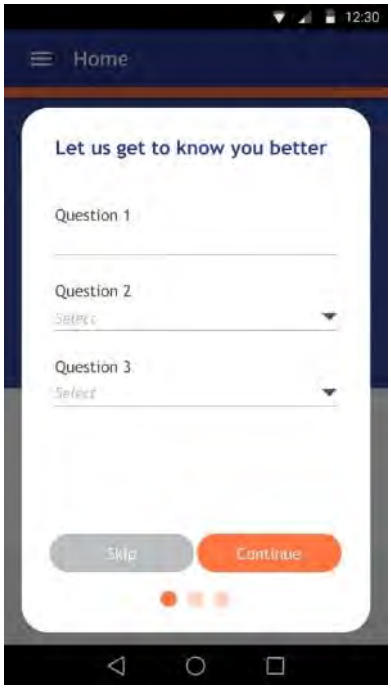


Email verification

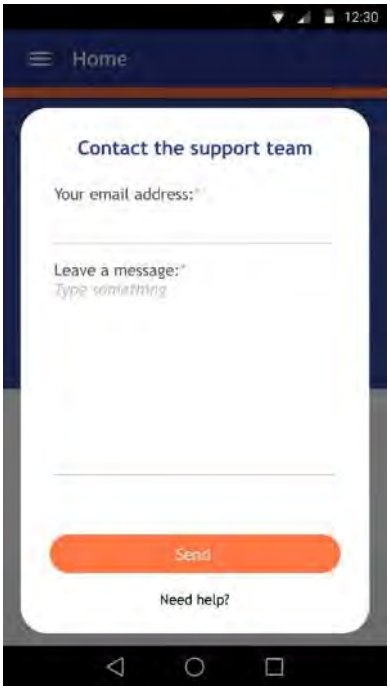


Creating and account

Terms and conditions

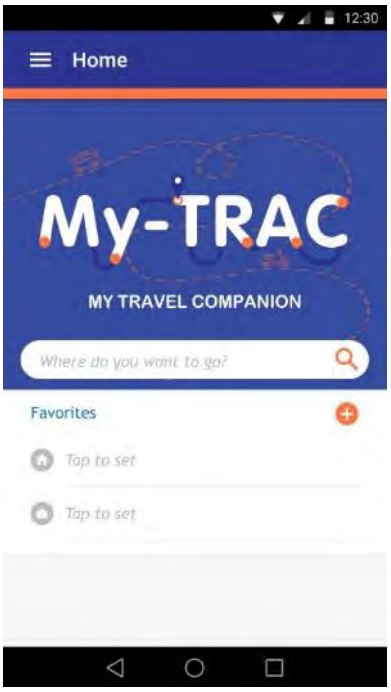


Log in questionnaire

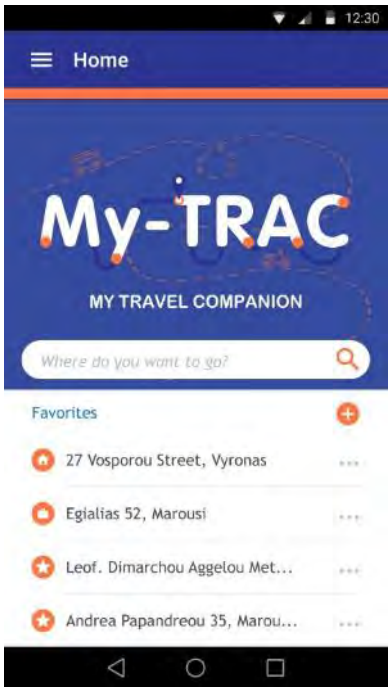


Contact support form

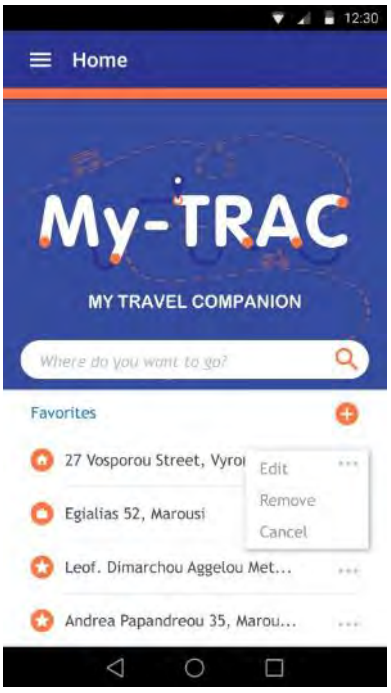
Use Case ID: #T2.1, Trip Creation



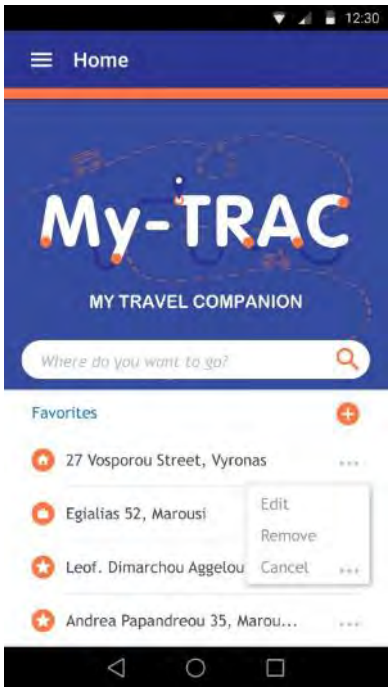
Main screen



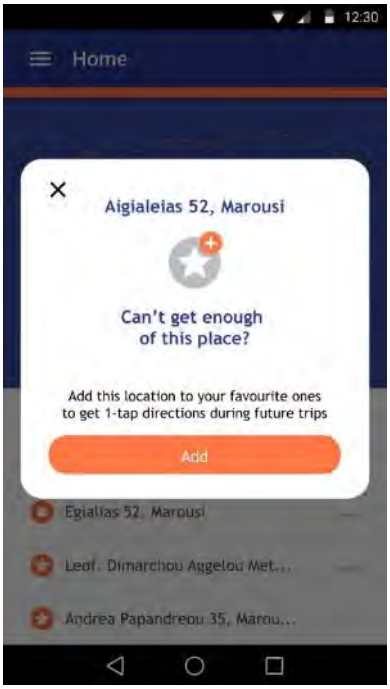
Main screen with favorites



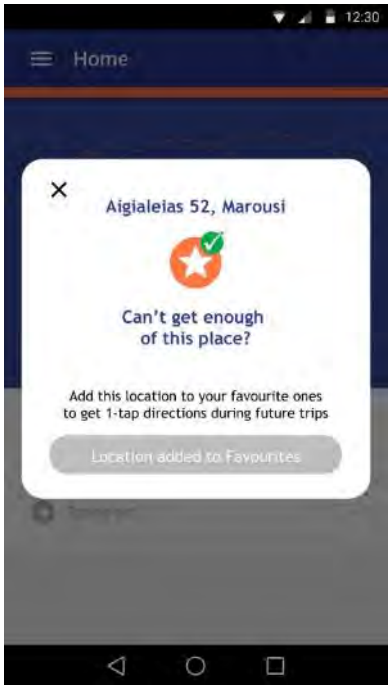
Main screen with favorites' details 1



Main screen with favorites' details 2

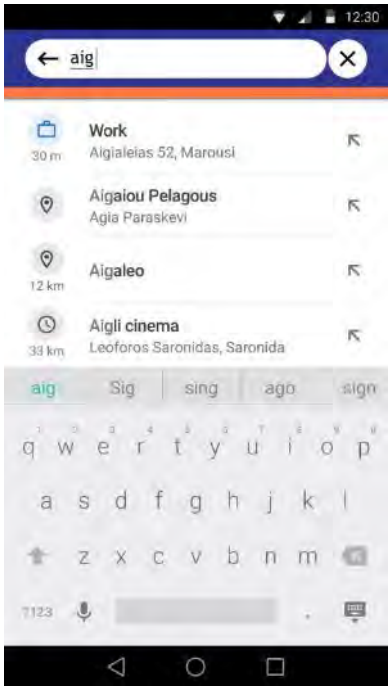


Add to favorites pop up

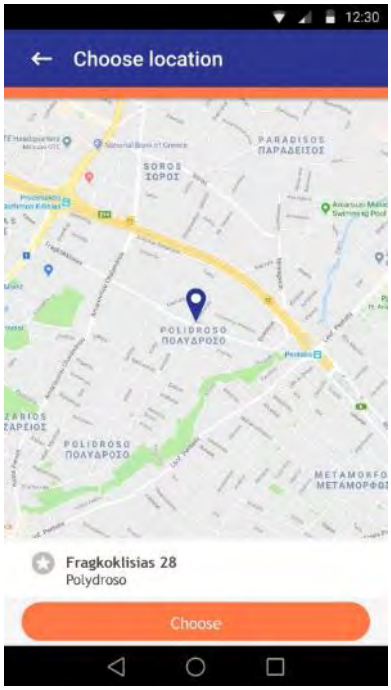


Added to favorites pop up

Search destination

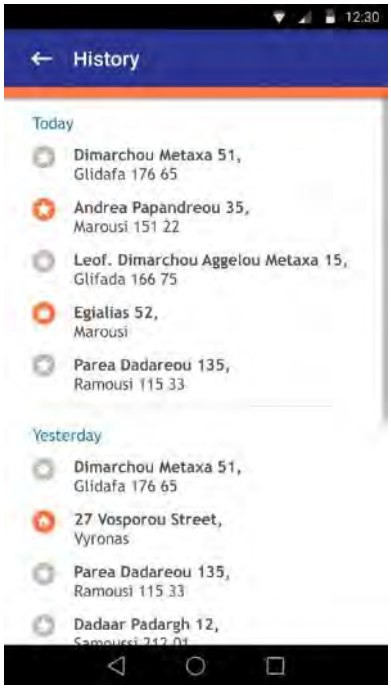


Search destination



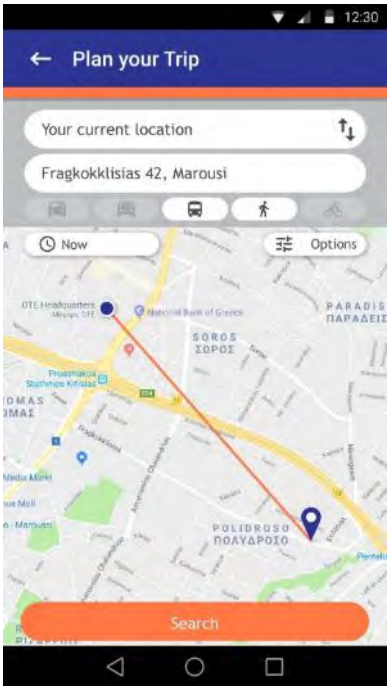
Select destination

Choose on the map



History

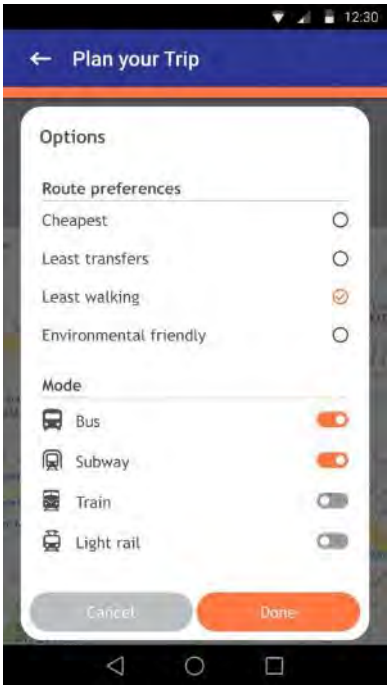
Trip planning all modes



Trip planning selected modes

Trip planning details 1

Trip planning details 2

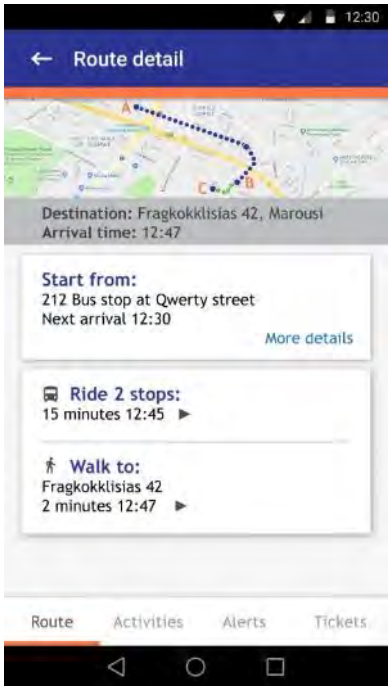


Trip planning options

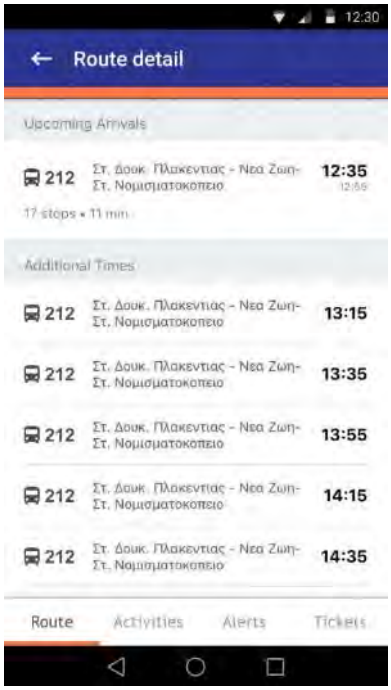
Route alternatives

Route alternatives shortening

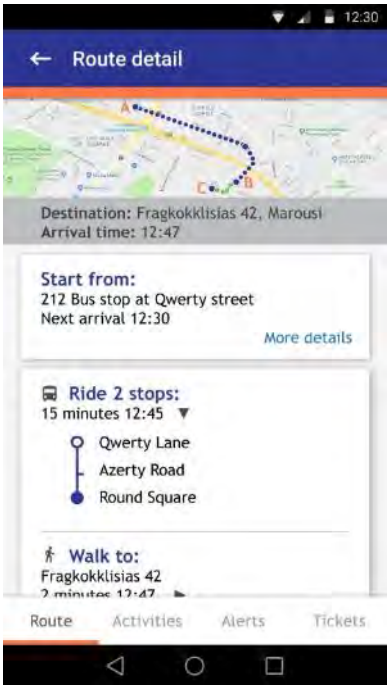
Route alternatives shortening pop-up



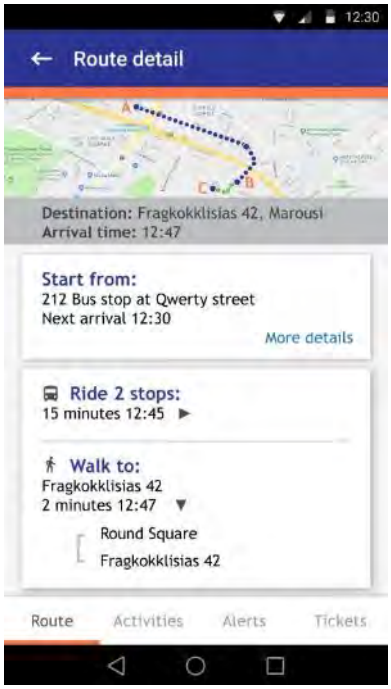
Route details



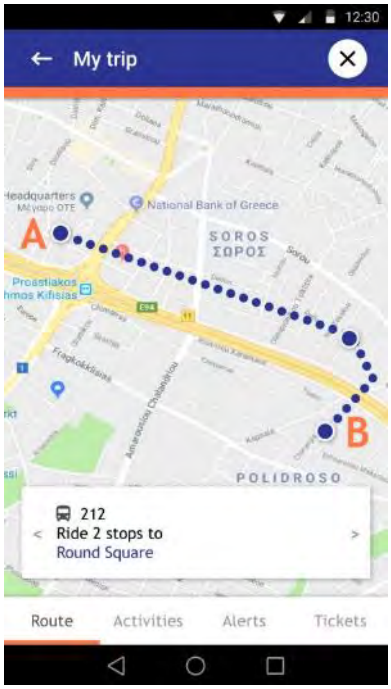
Route details PPT time schedule



Route details stops

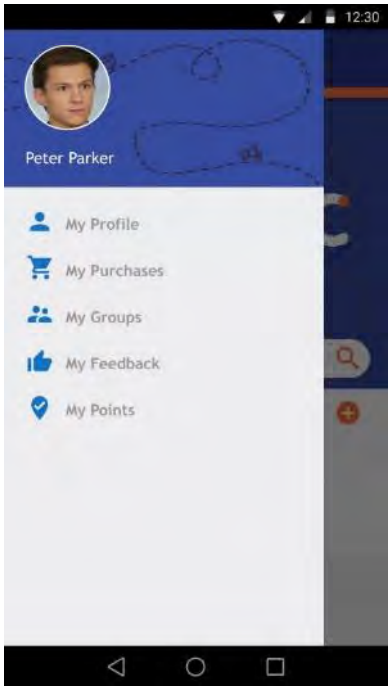


Route details walk direction



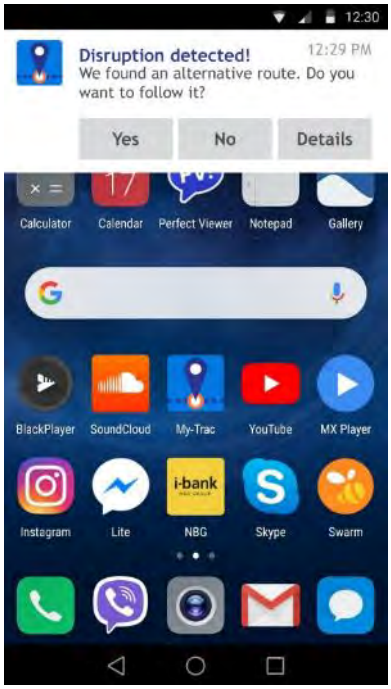
Current trip directions

Location turned off warning

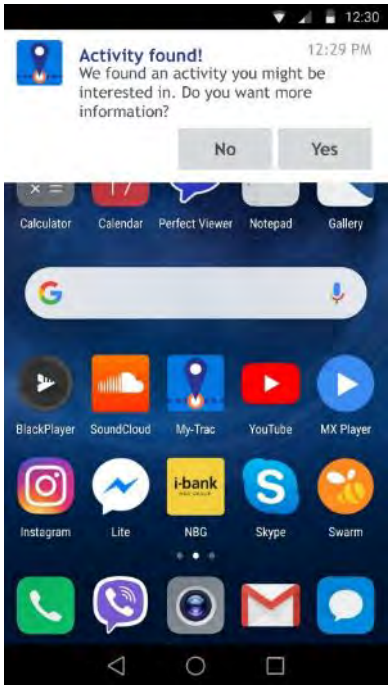


Main screen, expanded

Transfer reached notification

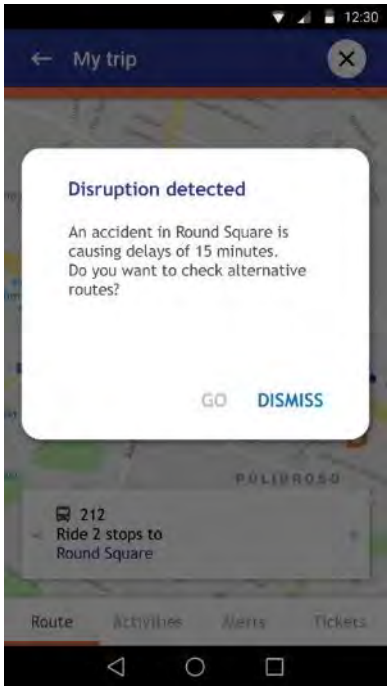


Disruption detected notification

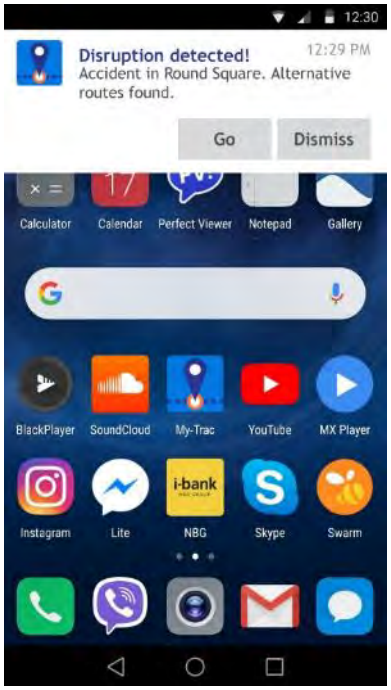


Activity found notification

Use Case ID: #T2.2, Activities' proposition

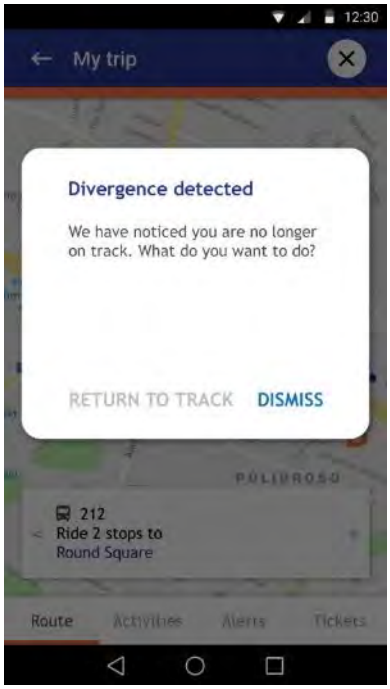


Disruption. In-app

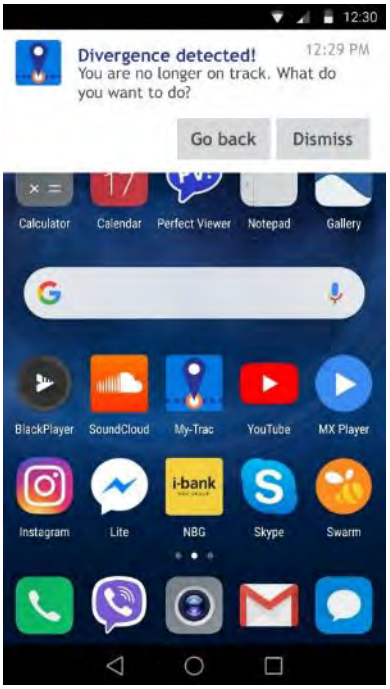


Disruption. Notification

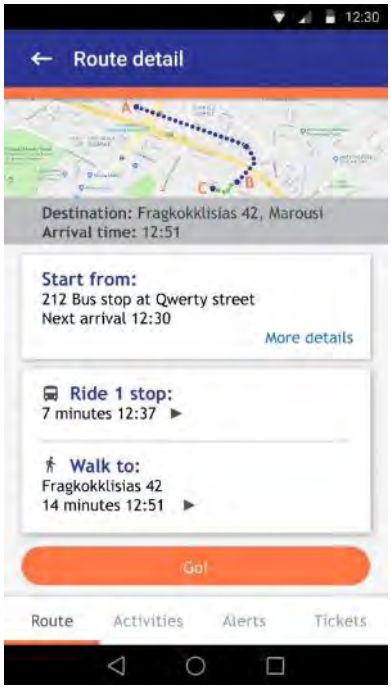
Disruption. New routes



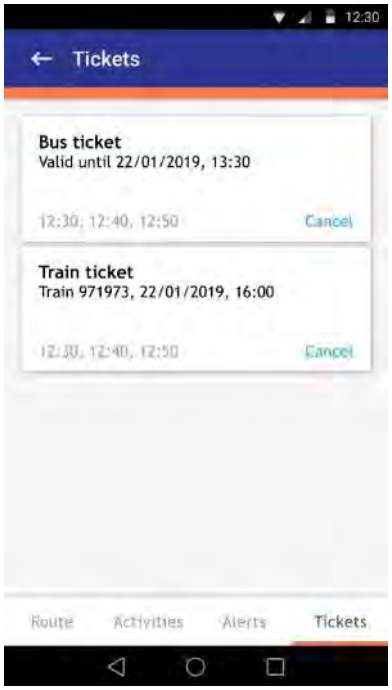
Divergence. In-app



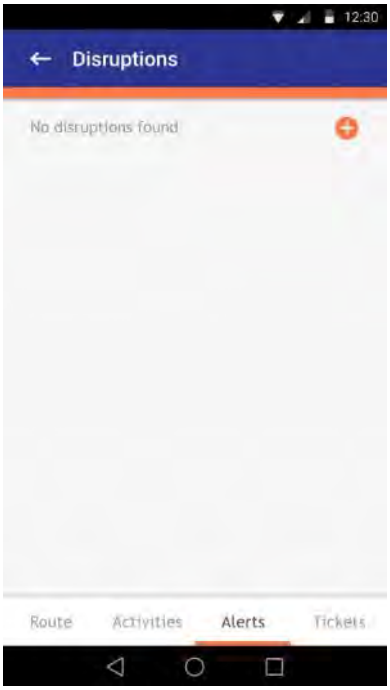
Divergence. Notification



Divergence. In-app

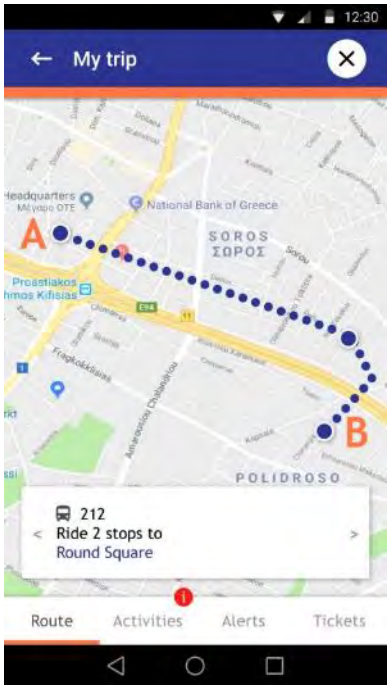


Tickets return



Create new disruption

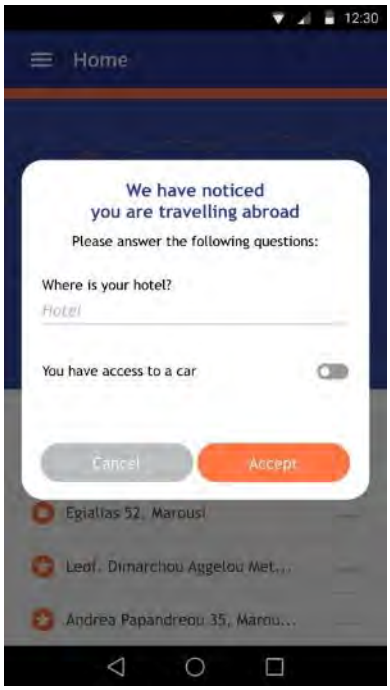
Send new disruption



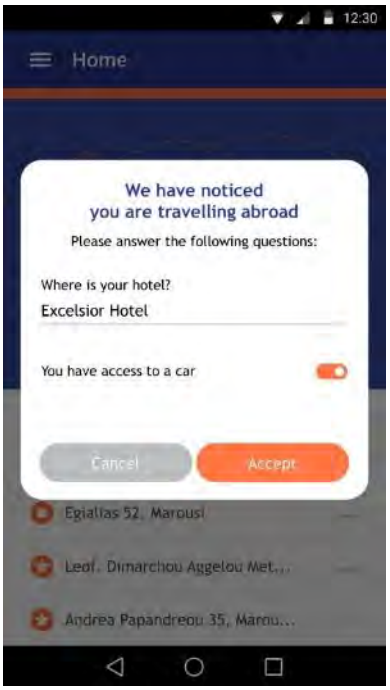
New activities notification

Activities

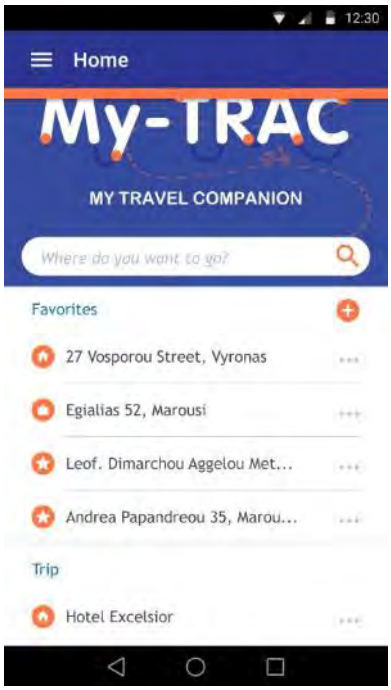
Use Case ID: #T2.5, Travelling abroad



Travelling abroad notification 1

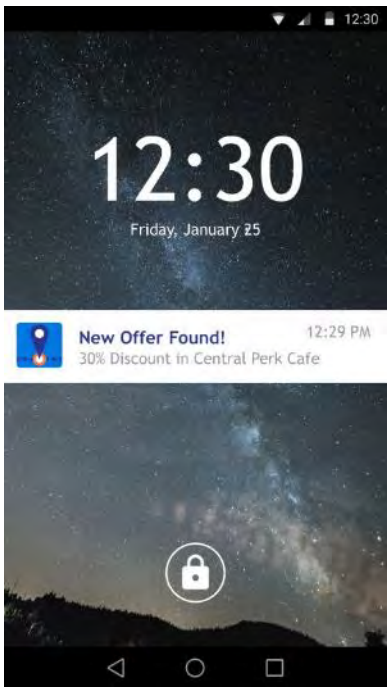


Travelling abroad notification 2

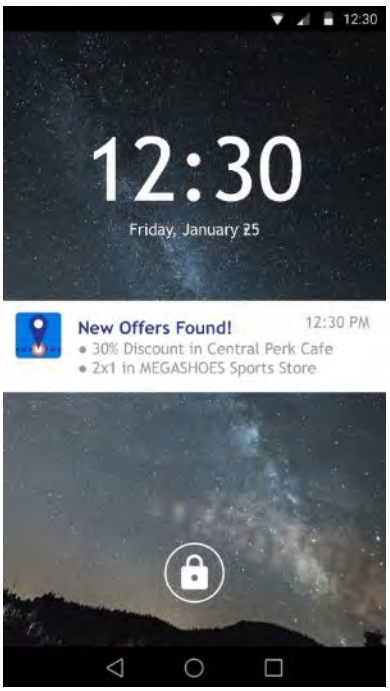


Main screen with hotel

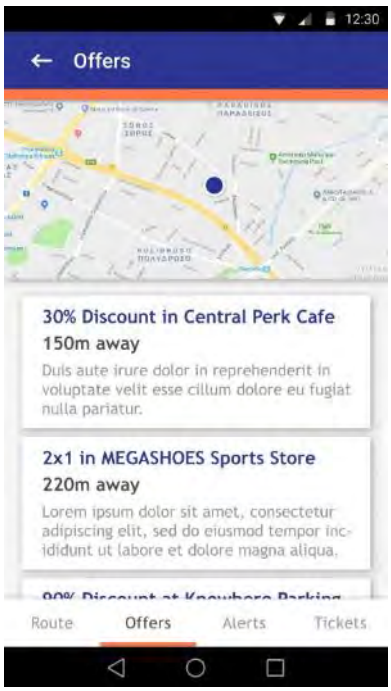
Use Case ID: #T3.1, Service providers' notifications



Single offer notification

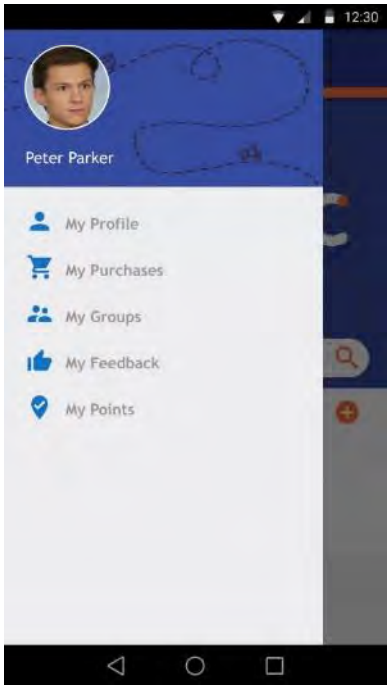


Offers notification

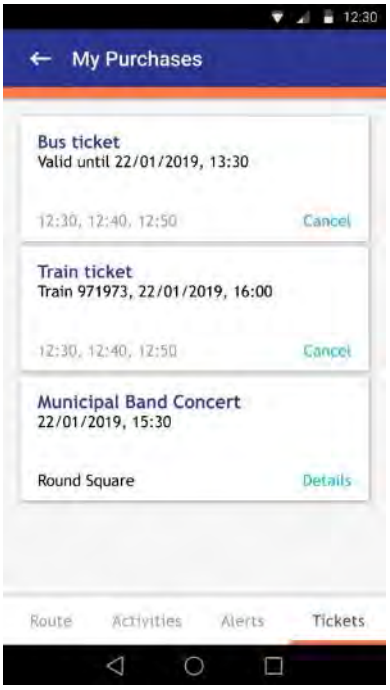


Offers list

Use Case ID: #T4.1, Purchase

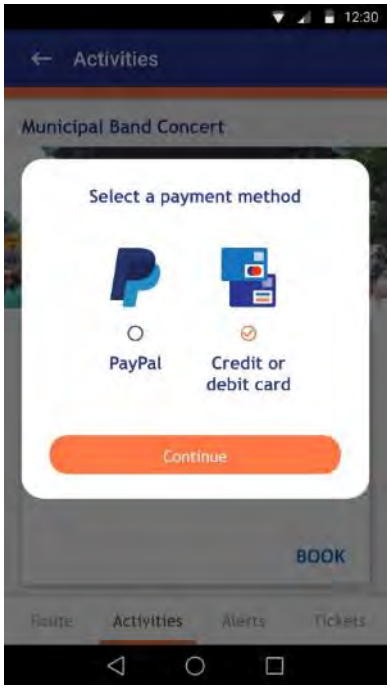


Main screen-expanded

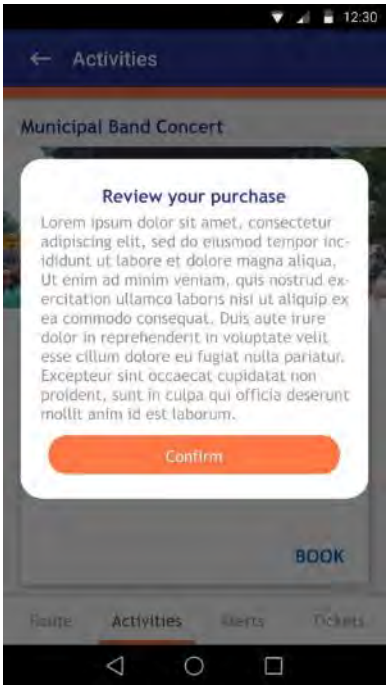


Offers list

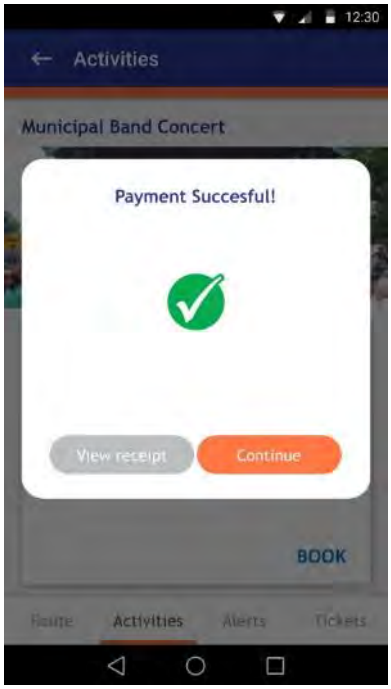
Purchase activity



Payment method selection

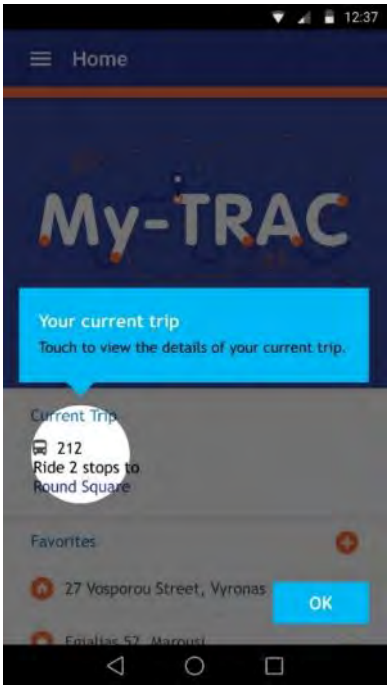


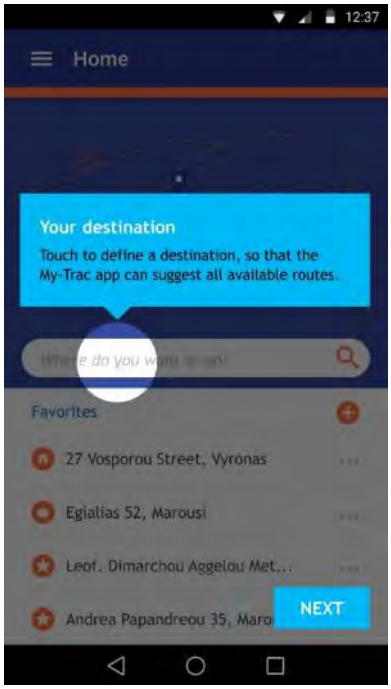
Confirm payment

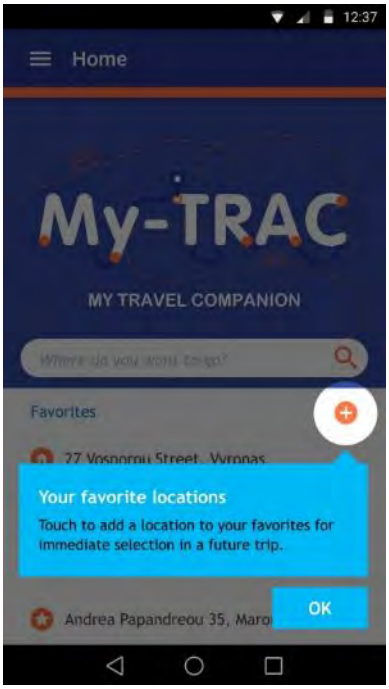


Payment successful

Wizard examples (No relevant Use Case)







5.4 My-TRAC Interface Look & Feel; the accessible version

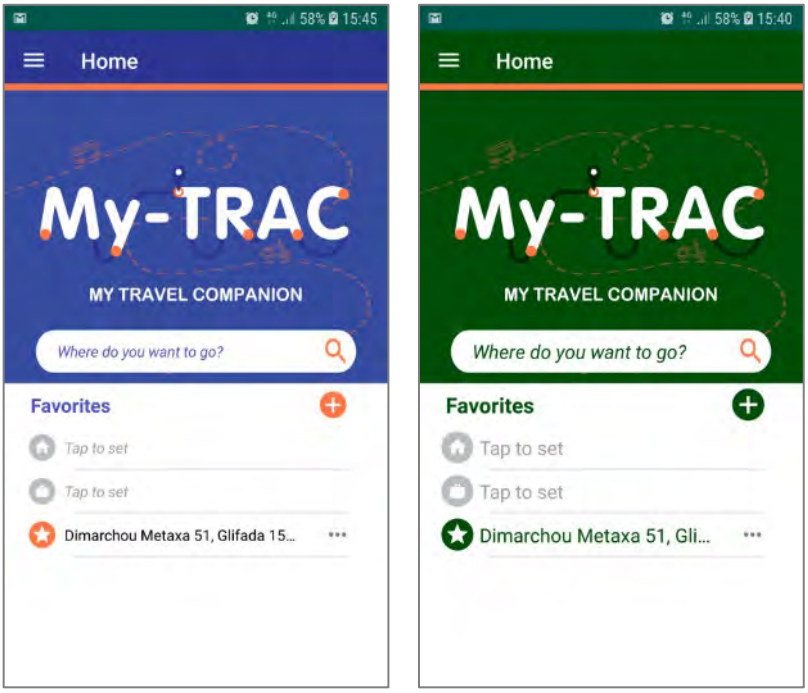
The first version of My-TRAC application provides accessibility support for people with low vision. It was decided to focus on people with low vision considering the answers provided on our survey. Most of

these people had some kind of chronic condition which was related to their vision. The Guidelines that we implemented are the Web Content Accessibility Guidelines (WCAG) 2.0 and WCAG 2.1, as mentioned in Section 4.2.3, which we adapted to mobile applications.

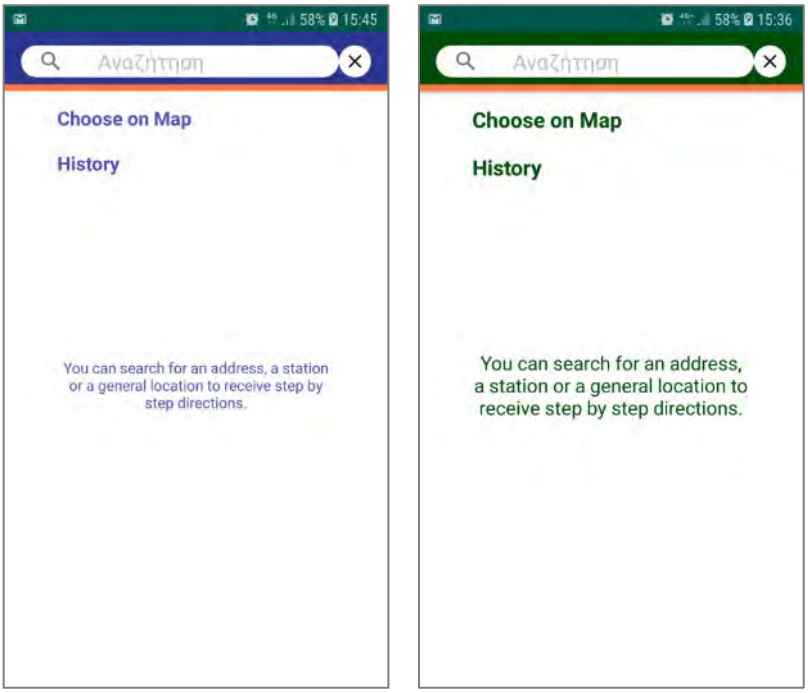
The accessibility implemented guidelines are the following.

1. Easy to read text
    1. Scale up text size
    2. Appropriate colour contrast
2. Provide content description for non-text contents
    1. buttons, pictures, icons, photos and images have text description so that can be read by the screen readers
3. Scale up buttons, links and icons (clickable objects)
4. Consistent and uniform user interface among different versions

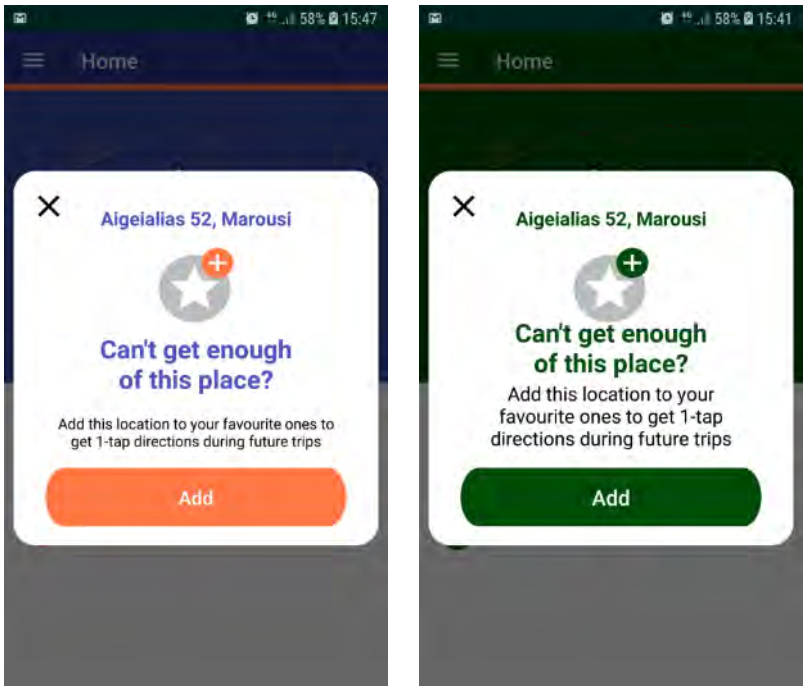
Below are some examples of the actual wireframes and the wireframes for people with low vision.



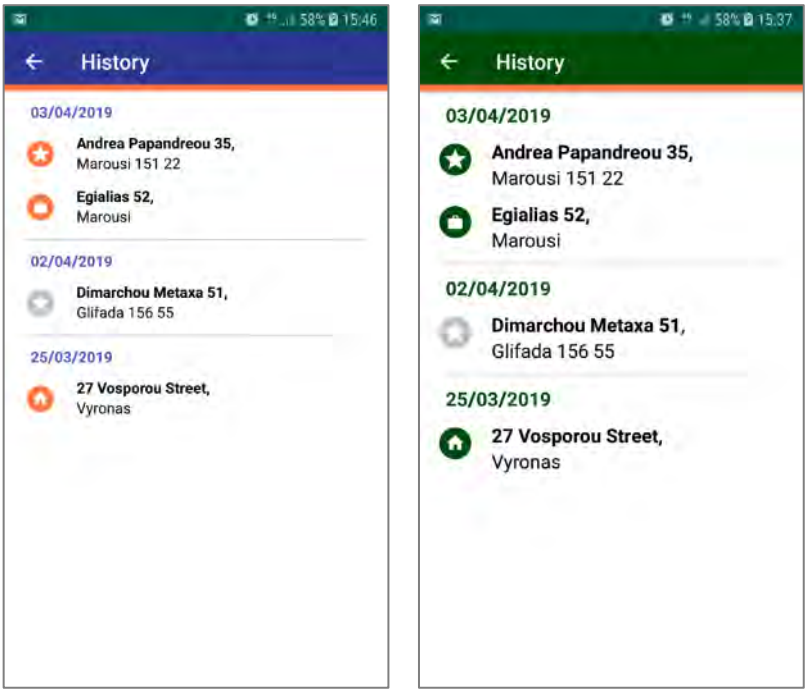
Main screen



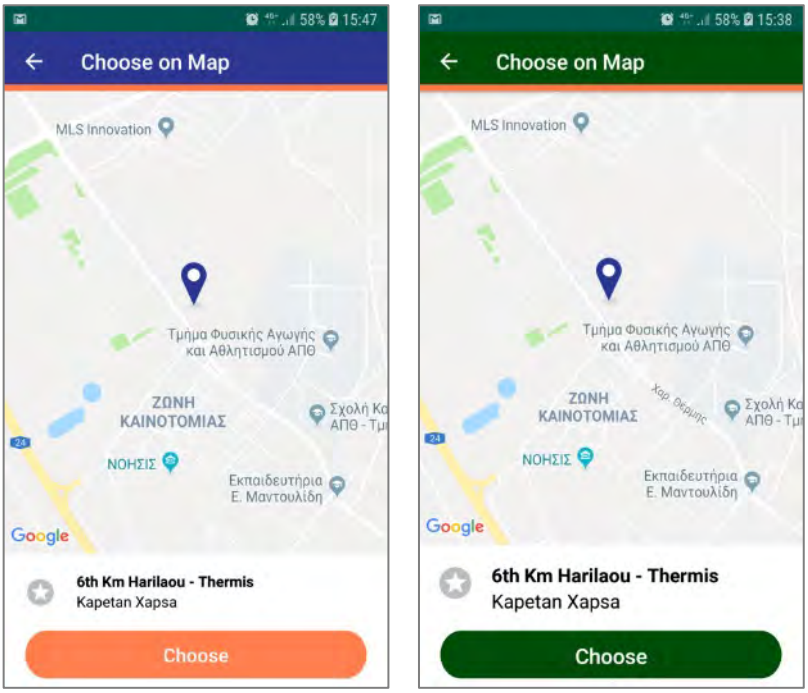
Favourites' screen



Add to Favourites' screen



History screen



Map screen

To realize all the above we have implemented two different Android Themes (one for the default user and one for the low visibility user). The new Themes have been based on the new resource attributes that we have introduced. A part of the Android Theme that has been built for the low vision users can be found below. In most cases the items used in the proposed theme have been defined in our new attrs.xml file. Thus, when a low vision user logs in to the application, the corresponding theme is loaded while the other users have a different "UI look and feel", since the default theme is loaded.

```
<style name="LowVisionTheme" parent="Theme.AppCompat.Light.NoActionBar">
    <item name="colorPrimary">@color/colorPrimary</item>
    <item name="colorPrimaryDark">@color/colorPrimaryDark</item>
    <item name="colorAccent">@color/colorAccent</item>
    <item name="mainColor">@color/colorLowVision</item>
    <item name="btnMainColor">@color/colorLowVision</item>
    <item name="android:textViewStyle">@style/LowVisionTextViewStyle</item>
    <item name="editTextStyle">@style/LowVisionEditTextStyle</item>
    <item name="graphHeaderIcon">@drawable/graph_header_low_vision</item>
    <item name="graphMainbgFixedIcon">@drawable/graph_mainbg_fixed_low_vision</item>
    <item name="graphDrawerbgFixedIcon">@drawable/graph_drawerbg_fixed_low_vision</item>
    <item name="dialogAddIcon">@drawable/ic_dialog_add_low_vision</item>
    <item name="dialogFavState1Icon">@drawable/ic_dialog_fav_state1_low_vision</item>
    <item name="dialogFavState2Icon">@drawable/ic_dialog_fav_state2_low_vision</item>
    <item name="fieldUserIcon">@drawable/field_user_low_vision</item>
    <item name="fieldPassIcon">@drawable/field_pass_low_vision</item>
    <item name="btnWideIcon">@drawable/btn_low_vision_wide</item>
    <item name="titleLarge">22sp</item>
    <item name="titleMedium">20sp</item>
    <item name="titleSmall">18sp</item>
    <item name="textLarge">20sp</item>
    <item name="textMedium">18sp</item>
    <item name="textSmall">16sp</item>
    <item name="btnTextLarge">20sp</item>
    <item name="btnTextMedium">18sp</item>
    <item name="btnTextSmall">16sp</item>
    <item name="favoritesAddIconDimension">30dp</item>
    <item name="favoriteIconDimension">30dp</item>
    <item name="favoriteIconLargeDimension">35dp</item>
</style>
```

Figure 20: Part of the low vision theme

Moreover, the software implementation considered to support assistive technologies while these may be enabled by the user. Talkback screen reader is one of the most well-known assistive technologies. Some of the recommendations that were followed are mentioned below.

Table 10: Accessibility Recommendations

Recommendation	Reason
Use android:contentDescription="@string/string_value“ in .xml layouts	To enable screen readers to read the names of components out loud
Do not write the UI control type or state in the android:contentDescription e.g. “Button”, “selected”, “touched”.	The majority of assistive technologies mention the type or state of the UI control
Grouping using focusable containers	E.g. in a RealtiveLayout or in a LinearLayout
Provide good colour contrast	According to Material design
Follow Android Visual Design Tips	According to Material design
Custom views	Similar to “Grouping using focusable containers”
Consider accessibility Android Services (Android Assistive Technologies)	E.g. TalkBack

6 CONCLUSIONS AND NEXT STEPS

The work presented in this Deliverable corresponds to the description Task 4.2 **"Personalised Interface Concepts"** from My-TRAC project DoA. Regarding this task, My-TRAC Travel Companion will offer personalised capabilities to its users by means of an improved UX using an overall UI concept that will support the interaction between each user group with the companion and its modules. A key factor of the Travel Companion, that is also the scope of this report, is the personalization aspects throughout the companion services, which will be achieved through information/service adaptation (WP2/ WP3), content personalization (WP2/ WP3) and UI personalization (WP4, D4.2).

My-TRAC has to provide to the users innovative interfaces and methods that will allow them to interact with the application in a customized and personalized manner. That being said, users are of the greatest importance when starting to conceptualise My-TRAC traveller companion app UI. Starting from the users, one of our greatest concerns based also to the UCD methodology that we use (Section 2.3), was to create empathy for them. In order to do that we started with a very powerful tool for us designers; personas. Personas allowed us to make the design process less complex since they guide the ideation processes and help us achieve the goal of creating a good UX for the target users. Thanks to personas, we were able to work in a more mindful way keeping users at the heart of everything we did. Thus, after realised a focus group with designers and users, we ended up having 5 personas; Martha, an aspiring environmentalist and car-free chooser; Jose, a Die Hard Driver and car addict; Sofia, a Reluctant Rider; João, a Routine Freak and Maria, a commuter with accessibility needs.

To empower the research validity of our fiction archetypes (personas) we conducted a user survey with actual users. The scope of this user survey was tow fold; from the one hand was to elicit the user affective needs (we will speak about this a bit later) and to gather information about users demographic and personality characteristics. In our survey we had around 300 respondents from Greece and Iberica Peninsula. The results of this survey have been used in order to define the user profiles and to correlate them later on with affective requirements.

After knowing our users really well, we had to move forward to defining our application design principles that cover our users' needs. **Persuasive**, **Inclusive** and **Affective** design principles from the literature have been studied and the ones that correspond to the needs of our users and our application have been identified. Especially regarding the persuasive and the affective principles of our users, the latest as derived from our user survey, they have been implemented when designing the first draft of My-TRAC UI. Additionally the inclusive guidelines have been also implemented in this first draft of My-TRAC UI design, for one specific disability group, which from our survey salient and this was the visual impairments.

Knowing our users and having our principles defined allowed us to create the first version of My-TRAC UI. A thorough UI design style guide has been developed that present the colours, typography, iconography and GUI elements of My-TRAC UI. Furthermore, the wireframes that have been designed for the specific Use Cases that will developed from WP5 for the sake of the 1st phase of the pilots are depicted in the current report. These are accompanied by their accessible version for people with low vision, which were designed following WCAG 2.0 and WCAG 2.1 guidelines.

The reported UI will be tested regarding usability, and user experience during the 1st phase of My-TRAC pilot tests. The results will come back to designers' team who will implemented the changes and create a second version of My-TRAC UI which will be tested again in the 2ndMy-TRAC pilots trail.

7 BIBLIORAPHY

Albers, M. (2003). Introduction. In M. a. Albers, *Content and Complexity: Information Design in Technical Communication.* Mahwa: NJ: Erlbaum.

Albers, M., & Mazour, B. (2003). *Content and Complexity: Information desing in software developement and documentation.* Mahwah, NJ: Lawrence Erlbaum Associates.

Anable, J. (2005). 'Complacent Car Addicts' or 'Aspiring Environmentalists'? Identifying travel behaviour segments using attitude theory. *Transport Policy 12*, 65–78.

Andrews, S., Ellis, D. A., Shaw, H., & Piwek, L. (2015). Beyond Self-Report: Tools to Compare Estimated and Real-World Smartphone Use. *PLoS One, 10 (10)*, 1-9.

Antoniou, E., Guisado-Gámez, J., Stroumpou, I., & Papacharalampous, A. E. (2018). *Elicitation of Requirements document for My-TRAC.*

Babich, N. (2019, January 02). *10 Do's and Don'ts of Mobile UX Design.* Retrieved from Adobe blog: https://theblog.adobe.com/10-dos-donts-mobile-ux-design/

Barry, A. M. (1997). *Visual Intelligence: Perception, Image, and Manipulation in Visual Communication.* New York: State U of New York P: Albany.

Birge, B. (2003). PSOt - A Particle Swarm Optimization Toolbox for Use With Matlab. *IEEE 2003 Swarm Intelligence Symposium*, (pp. 182-186).

Bland, D. (2016, April 21). *Agile Coaching Tip: What Is an Empathy Map?* Retrieved from Solutions IQ: https://www.solutionsiq.com/resource/blog-post/what-is-an-empathy-map/

Budiu, R. (2014, February 16). *The Reciprocity Principle: Give Before You Take in Web Design*. Retrieved from Nielsen Norman Group: https://www.nngroup.com/articles/reciprocity-principle/

Cao, H., Cooper, D. G., Keutmann, M. K., Gur, R. C., Nenkova, A., & Verma., R. (2014). CREMA-D: Crowd Sourced Emotional Multimodal Actors Dataset. *IEEE Transactions on Affective Computing 5 (4)*, 377–390.

Chang, W.-C., & Wu, T.-Y. (2007). Exploring Types and Characteristics of Product Forms. *International Journal of Design 1(1)*, 3-13.

Chu, H.-L., Deng, Y.-S., & Chuang, M.-C. (2014). Persuasive Web Design in e-Commerce. In F. F.-H. Nah (Ed.), *HCIB/HCII 2014* (pp. 482–491). Heraklion, Crete, Greece: Springer.

Cialdini, R. B. (1993). *Influence: Science and practice.* New York: Harper Collins College Publishers.

Consolvo, S., McDonald, D. W., & Landay, J. A. (2009). Theory-driven design strategies for technologies that support behavior change in everyday life. *SIGCHI Conference on Human Factors in Computing Systems* (pp. 405-414). New York: ACM.

Davis, F. D. (1993). User acceptance of information technology: system characteristics, user perceptions and behavioral impacts. *International Journal of Man-Machine Studies, 38*(3), 475-487.

Desmet, P. (2003). A Multilayered Model of Product Emotions. *The Design Journal, 6:2*, 4-13.

dscout. (2016, June 16). *Mobile Touches: dscout's Inaugural Study on Humans and.* Retrieved from dscout: https://blog.dscout.com/hubfs/downloads/dscout_mobile_touches_study_2016.pdf

Eagjy, A. H., Ashmore, R. D., Makhijani, M. G., & Longo, L. C. (1991). "What is Beautiful is good, But…: A Meta-Analytic Review of Research on the Physical Attractiveness Stereotype. *Pyschological Bulletin 110.1*, 109-128.

Epstein, S. (1994). Integration of the cognitive and psychodynamic unconscious. *American Psychologist, 49 (8)*, 709-724.

Fogg, B. J. (2003). *Persuasive technology.* San Francisco: Morgan Kaufmann.

Fogg, B., Marable, L., Stanford, J., & Tauber, E. R. (2002). *How Do People Evaluate a Web Site's Credibility?* New York: Consumer Reports WebWatch.

Gamberini, L., Petrucci, G., Spoto, A., & Spagnolli, A. (2007). Embedded persuasive strategies to obtain visitors' data: comparing reward and reciprocity in an amateur, knowledge-based website. In d. K. Y., I. W., M. C., E. B., & F. B.J., *Persuasive Technology* (pp. Lecture Notes in Computer Science, vol 4744.). Berlin: Springer.

Garm Lucassen, F. D. (2016). The use and effectivenes of user stories in practice. Utrecht, The Netherlands.

Goyale, R. (2018 , May 2). *Are you asking for customer feedback?* Retrieved from Medium: https://uxdesign.cc/are-you-asking-for-customer-feedback-3bd1597ce5d8

Gray, D., Brown, S., & Macanufo, J. (2010). *Gamestorming – A playbook for innovators, rulebreakers and changemakers.* Sebastopol : O'Reilly Media, Inc.

Groves, R. M. (1989). *Survey errors and survey costs.* New York: John Wiley.

Helander, M., Khalid, H., & Peng, H. (2007). Citarasa – A framework for affective design and evaluation. *8th International Conference of Work with Computing Systems (WWCS 2007).* Stockholm: KTH.

IDEO. (2011). *The field guide to human-centered design : design kit.* San Fransisco: IDEO.

ISO. (2010). *ISO 9241-210:2010. Ergonomics of human system interaction -Part 210: Human-centred design for interactive systems.* Retrieved from International Organization for Standardization: https://www.iso.org/standard/52075.html

Itten, J. (1961). *The art of color.* New York: Van Nostrand Reinhold Co.

Jiang, H., Kwong, C., Liu, Y., & Ip, W. (2014). A methodology of integrating affective design with defining engineering specifications for product design. *International Journal of Production Research, 53:8*, 2472-2488.

John, O. P., & Srivastava, S. (1999). The Big-Five trait taxonomy: History, measurement, and theoretical perspectives. In L. A. John, *Handbook of personality: Theory and research* (pp. 102–138). New York: Guilford Press.

Jones, C. (2011). Clout: The Role of Content in Persuasive Experience. In A. Marcus (Ed.), *HCII 2011 and DUXU 2011, Part II. LNCS, vol. 6770* (pp. 582–587). Heidelberg: Springer.

Jordan, P. (2000). *Designing Pleasurable Products.* New York: Taylor and Francis.

Kapoor, N. (2016, June 29). *7 UX Design Trends*. Retrieved from UX Magazine: https://uxmag.com/articles/7-ux-design-trends

Kim, S. H., & Lee, Y. J. (2016). The User Experience of Smart-Phone Information Hierarchy and Screen Transition Patterns. *International Journal of Multimedia and Ubiquitous Engineering 11 (4)*, 293–302.

Kim, S. H., & Lee, Y. J. (2016). The User Experience of Smart-Phone Information Hierarchy and Screen Transition Patterns. *International Journal of Multimedia and Ubiquitous Engineering 11 (4)*, 293–302.

Koch, A. (1998). When "more" isn't "better": Response rates and sample biases in general population surveys. *ZUMA-Nachrichten*, 66–90.

Koutsabasis, P., & Istikopoulou, T. G. (2013). Perceived Website Aesthetics by Users and Designers: Implications for Evaluation Practice. *International Journal of Technology and Human Interaction (IJTHI) 9(2)*.

Krippendorff, K. (2006). *The Semantic Turn: A New Foundation for Design. Boca Raton: CRC/Taylor & Francis.* CRC Press.

Krishan, A. (2012). *Mobile Phone: A Persuasion Channel?* Fairfield: Human Factor International.

Lang, F. R., John, D., Lüdtke, O., Schupp, J., & Wagner, G. G. (2011). Short assessment of the Big Five: robust across survey methods except telephone interviewing. *Behav Res*, 548-567.

Law, E. L.-c., & Schaik, P. v. (2012). To measure or not to measure UX: An interview study. *I-UxSED*.

LeDoux, J. E. (1995). Emotion: clues from the brain. *Annual Review of Psychology, 46*, 209-235.

Lockton, D., Harrison, D., & Stanton, N. (2010). The design with intent method: a design tool for influencing user behavior. . *Appl. Ergon. 41 (3)*, 382-392.

Marcatto, F., & Ferrante, D. (2008). The Regret and Disappointment Scale: An instrument for assessing regret and disappointment in decision making. *Judgment and Decision Making, Vol. 3, No. 1*, 87–99.

Morris, E. A., & Guerra, E. (2015). "Mood and Mode: Does How We Travel Affect How We Feel? *Transportation 42*, 25–43.

Morville, P. (2004, June 21). *User Experience Design*. Retrieved from Semantic Studios: http://semanticstudios.com/user_experience_design/?source=post_page----------

Nahum-Shani, I., Smith, S. N., Tewari, A., Witkiewitz, K., Collins, L. M., Spring, B., & Murphy, S. (2014). Just in time adaptive interventions (jitais): An organizing framework for ongoing health behavior support. *Methodology Center technical report*, 14-126.

Nielsen, J. (2011, September 12). *How Long Do Users Stay on Web Pages?* Retrieved from NN group: https://www.nngroup.com/articles/how-long-do-users-stay-on-web-pages/

Norman, D. (2004). *Emotional Design: Why We Love (or hate) Everyday Things.* New York: Basic Books.

Norman, D. A. (2007). *The Design of Future Things.* New York: Basic Books.

Oinas-Kukkonen, H., & Harjumaa, M. (2009). Persuasive Systems Design: Key Issues, Process Model, and System Features. *Communications of the Association for Information Systems 24(1)*, 485–500.

Osterwalder, A., & Pigneur, Y. (2013). *Business Model Generation.* Rio de Janeiro: Alta Books Editora.

Park, T. S., & Zhang, B. T. (2015). Consensus Analysis and Modeling of Visual Aesthetic Perception. *IEEE Transactions on Affective Computing 6 (3)*, 272–285.

Plutchik, R., & Conte., H. R. (1997). *Circumplex Models of Personality and Emotions.* Washington, DC, US: American Psychological Association.

RERC. (2011, September 16). *SUNspot – Use of Wireless Devices by People with Disabilities.* Retrieved from Wireless RERC: http://www.wirelessrerc.org/sites/default/files/publications/sunspot_2013-01_wireless_devices_and_people_with_disabilities_final1.pdf

Rodde, T. (2018, April 16). *21% of Users Abandon an App After One Use*. (localytics) Retrieved July 15, 2019, from http://info.localytics.com/blog/21-percent-of-users-abandon-apps-after-one-use

Russell, J. A. (2003). Core affect and the psychological construction of emotion. . *Psychological Review, 110 (1)*, 145-172.

Schaffer, E. (2009, January 26). *Beyond Usability: Designing Web Sites for Persuasion, Emotion, and Trust*. Retrieved from UXmatters: https://www.uxmatters.com/mt/archives/2009/01/beyond-usability-designing-web-sites-for-persuasion-emotion-and-trust.php

Schriver, K. (2001). Response in 'What's in a Name. *Design Matters*, 5-8.

Shedroff, N. (2001). *Experience Design.* New Riders.

Slovic, P., Finucane, M., Peters, E., & MacGregor, D. G. (2002). The affect heuristic. In D. G. T. Gilovic, *Intuitive Judgment: Heuristics and Biases* (pp. 397- 420). Cambridge: MA: Cambridge University Press.

Sokolova, M. V., & Fernández-Caballero, A. (2015). A Review on the Role of Color and Light in Affective Computing. *Applied Sciences 5 (3)*, 275–293.

Soto, C. J., & John, O. P. (2017a). The next Big Five Inventory (BFI-2): Developing and assessing a hierarchical model with 15 facets to enhance bandwidth, fidelity, and predictive power. *Personality and Social Psychology, 113*, 117-143.

Soto, C. J., & John, O. P. (2017b). Short and extra-short forms of the Big Five Inventory–2: The BFI-2-S and BFI-2-XS. *Research in Personality, 68*, 69-81.

Sproll, S., Peissner, M., & Sturm, C. (2010). From product concept to user experience: exploring UX potentials at early product stages. *6th Nordic Conference on Human-Computer Interaction: Extending Boundaries* (pp. 473-482). ACM.

Suh, N. (2001). *Axiomatic Design: Advances and Applications.* New York: Oxford University Press.

Suh, N. P. (1990). *The Principles of Design.* New York: Oxford University Press.

Suh, N., & Lee, D. (2006). *Axiomatic Design and Fabrication of Composite Structures.* New York: Oxford University Press.

Tang, T., & Bhamra, T. (2008). Changing energy consumption behaviour through sustainable product design. *DESIGN 2008, the 10th International Design Conference* (pp. 1359-1366). Dubrovnik: Marjanovic, D et al.

Tiongson, J. (2015, May). *Mobile app marketing insights: How consumers really find and use your apps*. Retrieved from Think with Google: https://www.thinkwithgoogle.com/consumer-insights/mobile-app-marketing-insights/

Väänänen, K., Väätäjä, H., & Vainio, T. (2009). Opportunities and Challenges of Designing the Service User eXperience (SUX) in Web 2.0. In *Future Interaction Design II* (pp. 117-126). Springer.

Vermeeren, A. P., Law, E. L.-C., Roto, V., Obrist, M., Hoonhout, J., & Väänänen-Vainio-Mattila, K. (2010). User experience evaluation methods: current state and development needs. *Proceedings of the 6th Nordic Conference on Human-Computer Interaction: Extending Boundaries*, (pp. 521-530). Reykjavik.

W3C. (2008, December 11). *Web Content Accessibility Guidelines (WCAG) 2.0.* Retrieved from W3C: https://www.w3.org/TR/WCAG20/

W3C. (2013, September 5). *Guidance on Applying WCAG 2.0 to Non-Web Information and Communications Technologies (WCAG2ICT).* Retrieved from W3C: https://www.w3.org/TR/wcag2ict/

W3C. (2015, February 26). *Mobile Accessibility: How WCAG 2.0 and Other W3C/WAI Guidelines Apply to Mobile.* Retrieved from W3C: https://www.w3.org/TR/mobile-accessibility-mapping/

WebAIM. (2015, August 28). *Screen Reader User Survey #6 Results.* Retrieved from Web Accessibility In Mind: https://webaim.org/projects/screenreadersurvey6/

Weinschenk, S. (2009). *Neuro web design: what makes them click?* Berkeley : New Riders.

WHO. (2018, October 11). *Blindness and vision impairment*. Retrieved from World Health Organization: https://www.who.int/en/news-room/fact-sheets/detail/blindness-and-visual-impairment

WHO. (2018, March 15). *Deafness*. Retrieved from World Health Organisation: https://www.who.int/news-room/facts-in-pictures/detail/deafness

Williams, S. D. (2007). User Experience Design for Technical Communication: Expanding Our Notions of Quality Information Design. *IEEE International Professional Communication Conference*, (pp. 1-13). Seattle.

Wright, P., & Mccarthy, J. (2008). Empathy and experience in HCI. *Human Factors in Computing Systems* (pp. 637-646). ACM.

Wroblewski, L. (2002). *Site Seeing: A Visual Approach to Web Usability.* New York: Hungry Minds.

Yannakakis, G. N., Isbister, K., Paiva, A., & Karpouzis, K. (2014). Special Issue on Emotion in Games. *IEEE Transactions on Affective Computing 5 (1)*.

Zebrowitz, M. L. (1982). Judging a Book By Its Cover: A Cognitive Analysis of the Relationship Between Physical Appearance and Stereotyping. In A. H. Isen, *Cognitive Social Psychology.* (pp. 149-21). New York: Elesvier.

ANNEX A MY-TRAC USER PREFERENCES QUESTIONNAIRE

Part I: Demographic data and identity attributes

1. What is your Nationality?
   - ☐ Dutch
   - ☐ Greek
   - ☐ Portuguese
   - ☐ Spanish
   - ☐ Other. Please specify: _____

2. What is your Age (years)?
   - ☐ 18-24
   - ☐ 25-54
   - ☐ 55-65
   - ☐ 65 plus

3. What is your Gender?
   - ☐ Male
   - ☐ Female

4. Do you have a long-lasting or chronic condition (physical, visual, auditory, cognitive or mental, emotional, or other) that substantially limits one or more of your major life activities (your ability to see, hear, or speak; to learn, remember, or concentrate)?
   - ☐ Yes
   - ☐ No

   If yes please specify _____

5. What is your current Education?
   - ☐ Basic
   - ☐ High school degree or equivalent
   - ☐ University degree or equivalent
   - ☐ Doctorate

6. What is your current employment status?
   - ☐ Employed full time (40 or more hours per week)
   - ☐ Employed part time (up to 39 hours per week)
   - ☐ Homemaker

- ☐ Student
- ☐ Unemployed/ Retired
- ☐ Unable to work

7. What is your current household income status (in Euro)?
- ☐ Less than 20,000
- ☐ 20,000 to 49,999
- ☐ 50,000 to 99,999
- ☐ Over 100,000

8. What is your current living arrangement status?
- ☐ Alone-Single
- ☐ Couple
- ☐ Family – with parents/children/relatives

9. How would you describe your status of urbanization?

1 Rural	2	3 Sub-urban	4	5 urban
☐	☐	☐	☐	☐

10. How would you describe your lifestyle?
- ☐ Active - outdoor, sports-oriented, adventurous
- ☐ Classy - elegant, luxurious, trendy
- ☐ Domesticated - family-based, homely
- ☐ Fun - pleasure seeking, sociable
- ☐ Other, please specify _____

11. How would you describe yourself as a person?

	1 Strongly Disagree	2 Disagree a little	3 Neutral; no opinion	4 Agree a little	5 Strongly agree
Tend to be quiet	☐	☐	☐	☐	☐
Compassionate, with a soft heart	☐	☐	☐	☐	☐
Tend to be disorganized	☐	☐	☐	☐	☐
Worries a lot	☐	☐	☐	☐	☐
Fascinated by art, music, or literature	☐	☐	☐	☐	☐

	1 Strongly Disagree	2 Disagree a little	3 Neutral; no opinion	4 Agree a little	5 Strongly agree
Dominant, acts as a leader	☐	☐	☐	☐	☐
Sometimes rude to others	☐	☐	☐	☐	☐
Having difficulty getting started on tasks	☐	☐	☐	☐	☐
Tend to feed depressed, blue	☐	☐	☐	☐	☐
Have little interest in abstract ideas	☐	☐	☐	☐	☐
Full of energy	☐	☐	☐	☐	☐
Assume the best about people	☐	☐	☐	☐	☐
Reliable, can always be counted on	☐	☐	☐	☐	☐
Emotionally stable, not easily upset	☐	☐	☐	☐	☐
Original, come up with new ideas	☐	☐	☐	☐	☐

12. How would you describe yourself as a person?

	1 Completely Disagree	2	3	4	5	6	7 Completely Agree
Once I make a decision, I don't look back.	☐	☐	☐	☐	☐	☐	☐
Whenever I make a choice, I'm curious about what would have happened if I had chosen differently.	☐	☐	☐	☐	☐	☐	☐
Whenever I make a choice, I try to get information about how the other alternatives turned out.	☐	☐	☐	☐	☐	☐	☐
If I make a choice and it turns out well, I still feel like something of a failure if I find out that another choice would have turned out better.	☐	☐	☐	☐	☐	☐	☐
When I think about how I'm doing in life, I often assess opportunities I have passed up.	☐	☐	☐	☐	☐	☐	☐

13. Do you own a car?

☐ Yes

☐ No

13.1. If, no. Why is there no car available in your household?

☐ No car needed

☐ Consciously avoided (moral responsibility)

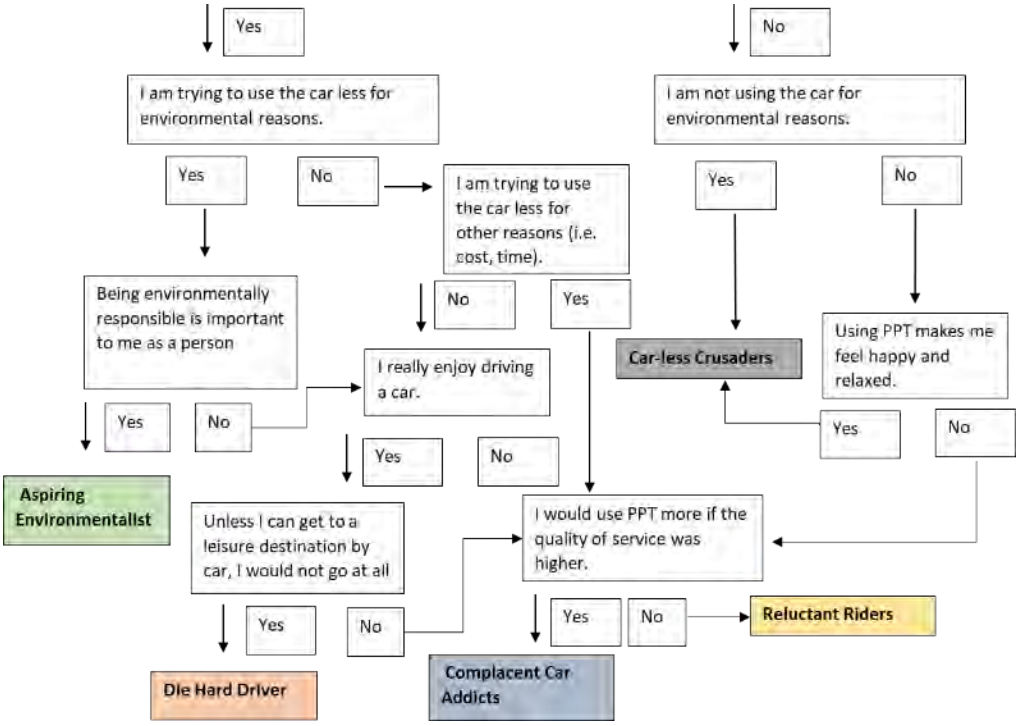
☐ Acquisition or maintenance is too expensive

☐ Health or age reasons

☐ Another reason. Please specify

……

14. Do you use a car (another person's car, or as a passenger)?



Part II: Application design requirements

15. Do you use any kind of routing applications?

☐ Yes

☐ No

If no, why? _____

If yes, which one? _____

If yes, move to the following questions. If no go to question 24.

16. When do you usually use the application? (multiple answers allowed)

☐ Before my trip, in order to know which route to follow, the proper time schedule, etc.

☐ While I am travelling, in order to see my alternatives in mode, route and time.

☐ Other, please specify. _____

17. When travelling with which mode do you use the application more often? Prioritize the following modes (1 = more often - 5 = least often).

	Private car
	Bus
	Rail (train, tram and metro)
	Bicycle
	Other. Please specify ……

18. Check **which** of the following design parameters you **like** and **which** of the following design parameters you **dislike** about the application you use.

	Likes 	**Please explain why you like these features**
☐	Background colour	
☐	Font size and type	
☐	Number of menus	
☐	Buttons (shape and size)	
☐	Warning timing	
☐	Warning sound	
☐	Other, please specify	

	Dislikes 	**Please explain why you don't like these features**
☐	Background colour	
☐	Font size and type	
☐	Number of menus	
☐	Buttons (shape and size)	
☐	Warning timing	
☐	Warning sounds	
☐	Other, please specify	

19. What excites you most in the design of an application? Indicate how exciting each of the following interface elements is.

	Not exciting	Slightly exciting	Moderately exciting	Exciting	Very exciting
Background colours	☐	☐	☐	☐	☐
Buttons' shape	☐	☐	☐	☐	☐
Buttons' colour	☐	☐	☐	☐	☐
Buttons' size	☐	☐	☐	☐	☐
Text font	☐	☐	☐	☐	☐
Text size	☐	☐	☐	☐	☐
Icons	☐	☐	☐	☐	☐
Number of menus to achieve a task	☐	☐	☐	☐	☐
Shortcuts	☐	☐	☐	☐	☐
Personalised functions	☐	☐	☐	☐	☐
Warning timing	☐	☐	☐	☐	☐
Warning sound and earcon	☐	☐	☐	☐	☐
Warning sound duration	☐	☐	☐	☐	☐
Warning text font	☐	☐	☐	☐	☐

20. The design of an application can be characterized using words like cool, trendy and so forth. What do these words mean to you in terms of you?

	What does this word mean to you in terms of your feelings? (i.e. happy, satisfied, smart, bored, anxious, etc.)	**How do words relate to application design elements?** (Please tick the box if it is directly relevant)					
		Colour	**Shape**	**Font**	**Size**	**Sound**	**Other (please specify)**
Cool		☐	☐	☐	☐	☐	☐
Trendy		☐	☐	☐	☐	☐	☐
Homely		☐	☐	☐	☐	☐	☐
Sporty		☐	☐	☐	☐	☐	☐
Fun		☐	☐	☐	☐	☐	☐

21. Look at the FIVE pictures that follow. First, prioritize them from **1= Extremely Nice, to 5= Extremely Ugly**. Second, rate the impressions you get from looking at the application design, on a scale from 1-5, where **1 = Low, 3 = Average, 5 = High.**

Picture	Rank Order	Cool	Trendy	Homely	Sporty	Fun
1						
2						
3						