AN INVESTIGATION INTO USER EXPERIENCE OF MOBILE PASSENGER SYSTEMS

A THESIS SUBMITTED TO
THE GRADUATE SCHOOL OF NATURAL AND APPLIED SCIENCES
OF
MIDDLE EAST TECHNICAL UNIVERSITY

BY

SELCEN KÖKCÜ ÇETİN

IN PARTIAL FULFILLMENT OF THE REQUIREMENTS
FOR
THE DEGREE OF MASTER OF SCIENCE
IN
INDUSTRIAL DESIGN

APRIL 2019

Approval of the thesis:

AN INVESTIGATION INTO USER EXPERIENCE OF MOBILE PASSENGER INFORMATION SYSTEM

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ABSTRACT

AN INVESTIGATION INTO USER EXPERIENCE OF MOBILE PASSENGER SYSTEMS

Kökcü Çetin, Selcen
Master of Science, Industrial Design
Supervisor: Inst. Dalsu Özgen Koçyıldırım

April 2019, 153 pages

With the developments in information and communication technologies, the use of mobile apps has increased significantly in many areas, one of which is transportation. Transportation, especially in urban environments, is a very current and prominent issue, with the ever-increasing size of the cities requiring more roads and more vehicles, while traffic congestions worsens day by day. Therefore, urban residents want to choose the most convenient and the least time-consuming way to complete their journeys. Mobile passenger information systems serve citizens for this purpose, by giving real-time information on public transports. It is important that these systems are designed with a human-centered approach in order to increase the quality of life of their users. This approach entails understanding both the experience of the passengers that use such a system and how they relate to the technology that operates the system.

In this thesis, the factors that influence user experience as well as the technology acceptance of mobile passenger information systems were investigated through field studies conducted on a

sample application dedicated to a specific urban location. The results were discussed in light of the literature review of how these systems evolved, along with their current and projected future situations, to offer insights and suggestions on how the experience and the design leading to it may be improved.

Keywords: User Experience, Mobile Passenger Information System, Technology Acceptance, Human-Centered Design, Smart City

ÖZ

MOBİL YOLCU BİLGİLENDİRME SİSTEMLERİ KULLANICI DENEYİMİ ÜZERİNE BİR ARAŞTIRMA

Kökcü Çetin, Selcen
Yüksek Lisans, Endüstri Ürünleri Tasarımı
Tez Danışmanı: Öğr. Üyesi Dalsu Özgen Koçyıldırım

Nisan 2019, 153 sayfa

Gelişen bilgi ve iletişim teknolojileri ile birlikte mobil uygulama kullanımı her alanda artmıştır. Bu alanlardan biri de ulaşımdır. Giderek artan şehirleşme ile birlikte şehirlerde ulaşım sorunu da artmıştır. Özellikle de metropol şehirlerde trafik sıkışıklığı her geçen gün artmaya devam etmektedir. Bu yüzden şehir sakinleri kendileri için en uygun, (çoğu durumda en kısa ve ücreti en az olan) ulaşım türünü seçmek istemektedirler. Mobil yolcu bilgilendirme sistemleri toplu taşıma araçlarının gerçek zaman bilgisini vererek bu amaca yönelik olarak yolculara hizmet etmektedir. Bu sistemlerin sürdürülebilir olması için kullanıcı odaklı olmaları gereklidir ve iyi bir kullanıcı deneyimi yaratmanın yanı sıra, sunulan teknolojinin de kabulü kolayca kabül edilmesi önem arz etmektedir.

Bu tez kapsamında örnek bir uygulama üzerinden mobil yolcu bilgilendirme sisteminde kullanıcı deneyiminde ve teknoloji kabulünde hangi faktörlerin etken olduğuna bakılmıştır. Araştırma sonuçları, bu sistemlerin nasıl geliştiğini, günümüzdeki

konumlarını ve geleceklerine dair öngörüleri inceleyen literatür taramasının ışığında tartışılmış, daha iyi bir kullanıcı deneyimi ve kullanıcı kabulü sağlamak için tasarımlarına yönelik çıkarım ve önerilerde bulunulmuştur.

Anahtar Kelimeler: Kullanıcı Deneyimi, Mobil Yolcu Bilgilendirme Sistemi, Teknoji Kabulü, Kullanıcı Odaklı Tasarım, Akıllı Şehir

To Atlas

ACKNOWLEDGEMENTS

I am sincerely and heartily grateful to my advisor Dalsu Özgen Koçyıldırım, for the support, guidance and appreciation she showed me throughout my studies. I am thankful for her valuable insights, inspiring advice, understanding, and effort for the completion of this thesis.

I also would like to express my sincere thanks to each of the committee members Prof. Dr. Ebru Vesile Özalır Akünal and Assoc. Prof. Dr. Gülşen Töre Yargın for their comments and feedbacks.

I would also like to thank all the participants involved in the questionnaires and interviews for allocating their valuable time for participating to the study.

I wish to give a heartfelt thanks to my friends, Gözde Benzer Koçar for being such a good friend by motivating me all the time, Çiğdem Demir for huge support, encouragement and being beside me in this journey, Cande Kurt for her help and support in this study and also her friendship, and Esra Aydoğan Koçak and Tuty for their endless supports and friendships.

I would like to express my sincerest thanks to my family; my dear parents Cevriye and Kenan, my dear brother Alper Çağrı. Their presence has always been the greatest source of my motivation.

Lastly, and most importantly, I am very grateful to my husband Haydar, without his support and encouragement this thesis would have never been completed.

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INTRODUCTION

1.1. Background and Motivation of the Study

> "They say the universe is expanding. That should help with the traffic."
> Steven Wright, American comedian (Brain Quote, 2019)

Nowadays, cities are over-crowded with population and overgrown with buildings, which results in various problems, traffic being a preeminent one: it not only damages the environment, but also decreases the quality of human life. Public transportation, an idea first implemented more than a century ago to solve the transportation problems that were newly arising at the time, does not suffice on its own in facing the level of crowdedness encountered today.

New solutions have been emerging in recent years thanks to new technologies, such as the 'smart city' concept that offers innovative solutions to urban transportation problems under its 'smart transportation' sub-set. Indeed, smart transportation is a broad area that is concerned with a variety of issues, from organizing the flow of urban traffic to communicating with passengers.

The smart mobile devices and the apps they offer have recently come to occupy a huge place in smart transportation, becoming ubiquitous in every aspect of daily life, all around the world. At the present, mobile apps act as the most effective and popular interaction tools between passengers and the transportations they use. As a result, how these apps guide the passengers' as they travel through the city, whether or not they encourage the use of a certain type of transportation vehicle or route, and whether the efficiency of public transportation is affected by these influences needs to be

investigated as a potential solution to urban traffic problems (Shaneen, Martin, Cohen, Musunuri, & Bhattacharyya, 2016).

Even though urban transportation is traditionally considered to be a topic of inquiry for urban planners, as they question how to organize the urban landscape with its roads and traffic flows, due to the above-mentioned increasing use of mobile apps for transportation related purposes, it has entered within the scope of design research as well.

Another significant contribution of design to the inquiry would be the human-centred approach that is often omitted in urban planning. Even though the importance of human-centred studies is emphasized in urban planning literature, how it should be conducted and implemented is untold. Consequently, this study investigates the use of new technologies in urban transportation, specifically focusing on the human factor.

This bridging of the fields of planning and design is especially of note since the researcher conducting this study in partial fulfilment of a graduate degree in design, has herself a background in urban planning. Indeed, the motivation behind this thesis arose from her own personal observations on the lack of human dimensions in her original field of study, such as what the passengers actually need or desire, how exactly they interact with the urban space and its public vehicles, etc.

1.2. Aim of the Study

The overall aim of the thesis is to indirectly help improve urban transportation, or at least ameliorate how its passengers cope with it, by focusing on the public transportation side of it, and more specifically, on the new technological solutions offered to its passengers.

With this aim, the following items are investigated:

- The urban transportation problems and their underlying reasons
- The proposed technological solutions to these problems: mobile Passenger Information Systems (PIS) and new mobility

- The human interaction and experience with these technologies

Through this investigation, the thesis strives to answer the following main and supportive research questions:

How can mobile Passenger Information Systems be improved to become a more human-centred tool of new mobility in urban transportation?

What is the current state of public transportation amidst the technological change in the urban scape?

- How did urban transportation develop and what problems does it face?
- What are the recent solutions proposed or services offered as answer to these issues?
- How do other environmental factors such as geography, infrastructure and governmental policies affect urban transportation, its problems and solutions?

From a passenger centred point of view, how effective are the offered solutions and how can they be improved?

- What are the factors that influence the experience of passengers?
- How do new technologies affect their experience?
- What design considerations may be followed to improve the passenger experience?

1.3. Structure of the Thesis

The thesis is comprised of three main sections and seven chapters. The sections are:

- *The presentation* (Chapter 1, Chapter 2 and Chapter 3) where the topic of inquiry is introduced, its choice is justified and the historic and theoretical knowledge required for its understanding is laid out,
- *The investigation* (Chapter 4 and Chapter 5) where the topic is examined through the specifics of an existing case,
- *The deduction* (Chapter 6 and Chapter 7) where the results of the investigation are discussed and conclusions are drawn.

Chapter 1, *Introduction,* focuses on the problem statement, aim and research questions of the thesis.

Chapter 2, *Developments in Urban Transportation,* briefly presents an overview of the past and present of urban transportation, to better understand its key issues and current standing in urban developments.

Chapter 3, *Understanding Passengers,* is a review of the design literature on user experience and technology acceptance, to help determine how passengers use urban transportation and its related technologies.

Chapter 4, *Field Studies,* offers the aim, methodology and design of the field studies, where data were collected from users and experts in search of answers to the research questions and Chapter 5, *Findings of the study,* presents their results.

Chapter 6 initiates *Discussion* on the implications of the presented findings, in relation to previous literature review.

Finally, the *Conclusion* presents a summary of the thesis by readdressing the research questions posed at the beginning and points to possible future directions for the research in light of the limitations indicated.

CHAPTER 2

DEVELOPMENTS IN URBAN TRANSPORTATION

2.1. History of Urban Transportation

Before the 18th century, only a minority of the population lived in urban environments, with the majority residing in rural areas. There were only a few cities around the world where the urban population reached approximately 100.000 (Sjoberg, 2002) made up 10% of the countries' total population; whereas today, 54% of the world's total population is urbanites. Cities were of much smaller size and could be walked from one end to the other: the distance between the city centre and the city periphery were no bigger than 4 km (Lipovac, Nenad; Jandriček, 2011). The main attraction of these cities was their marketplace where raw material and goods from abroad could be bought. These goods were carried to and from the cities by human and animals (Sjoberg, 2002).

However, starting from the 18th century, a rapidly developing phenomenon called industrial revolution causes extraordinary changes in urban landscapes, with cities becoming much bigger, more crowded and filled with various vehicles that try to respond to the transportation demand of the ever-growing urban population.

2.1.1. Industrial Revolution

Industrial revolution was a global phenomenon that took place in the 18th and 19th Centuries and that had ground breaking effects all around the world. Britain is seen as the country that led this over reaching period of change by initiating technological implementations for production. However, as Stearn (2013) states, even if industrial revolution is usually defined as originating from one country, it then spread all over the world, with other countries quickly following the developments of Britain.

Although the exact dates of the industrial revolution are debated, many historians set its beginning at about 1760 because many inventions were brought forth starting from this date onwards. While there is not a specific ending date, the peak year of industrial revolution is stated as 1850 (More, 2000), with the increasing construction of railways for the steam engines which were in use since 1830.

Before the 18th Century, agriculture was the main capital of economy and manual labour production was the widespread source of income for the majority of the population. However, the new century saw the beginning of a changeover from the craftsman or manual labourer to the machine. Thanks to new technological inventions, more prolific manufacturing processes became possible. For example, inventions in textile machinery, like the spinning jenny device developed by James Hargreaves around 1764, facilitated the handling of large quantities of harvested cotton through mechanisation and transformed the textile manufacturing industry. As a result of these developments, export from Britain to India, Southeast Asia and Africa increased by 1,500% between 1800 and 1840 (Stearn, 2013).

The discovery of the steam engine is regarded as the key invention of this period, because it brought about many other inventions and developments in different fields. In the 1780s, a great number of steam-powered factories were established in Britain. Iron was one of the many products manufactured in these new factories and its production soon became a major industry. Stearns (2013) mentions that *'Britain had produced 25,000 tons of unrefined iron in 1720; by 1796 the figure was 125,000 and by 1804 was 250,000'*.

The discovery of the steam engine also instigated a great leap forward in terms of transportation. The most important implementation of a steam engine was the steam locomotive that could carry a lot of weight very fast. Large quantities of goods as well as passengers could now be carried at once across longer distances. Following the invention of steam locomotive, numerous railways were built, with the help of well-established iron industry. (Weller & Bawden, 2005) explain that *'Between 1830 and*

1850 around 6,000 miles of railway opened in Britain, and by 1850 over £240 million had been privately invested in rail.' The first intercity railway, between Liverpool and Manchester, was opened in 1830. Raw materials and labour that were required for the rapidly growing industries could be provided by intercity railway in a short span of time. Weller et al. (2005) explains that '*In 1750 it took ten to 12 days to make the 413 miles journey to Edinburgh from London; 100 years later it took only 17.5 hours (Hobsbawm, diagram 16). Today one could make the journey in 4.5 hours. The magnitude of the speed revolution was unprecedented'.*

The abovementioned technological developments also had a significant effect on the daily lives of the common people who were farmers and crafters up to the 18th century. The investors and entrepreneurs started to invest capital in the constantly growing industries, encouraged by governmental policies implemented to support economic innovation. This fast growth offered new job opportunities for large number of people, creating a new social class of workers that in turn invigorated the economy, the production and the industrial revolution. This new social class of workers, called proletariat, was not engaged with farming anymore but were working in factories. The emergence of the proletariat brought about a change on the society. The most striking transformation was seen on the working life. Coupled with mechanization, the production quantity and speed were increased, which dramatically affected the working conditions and extended the working hours, as the work became independent of seasons, daylight hours, manual skills and personal expertise. The cultural structure was also transformed: the industrial revolution heightened the perceived importance of science and technology, which in turn started a shift from religious life to a more secular one (Stearn, 2013).

All these social and cultural changes fundamentally influenced the rapid growth of population in urban areas as the former habitants of rural areas started to settle in the cities to answer the ever-increasing demand for factory workers, which in turn became a major factor that boosted these social and cultural changes.

2.1.2. Urbanization and Suburbanization

Until the 18th century, the world population was increasing at a natural and uniform pace. However, the technological and social developments brought forth by the industrial revolution significantly changed both the population growth and its geographical concentration (O'Brien & Quinault, 1993). Thanks to the invention of new production techniques, agriculture became more productive and more food could be grown in smaller areas. As food production soared in the 1700's, both the quantity and the variety of food available to the common people increased, with potatoes being the primary yield of this productivity. The increase in production and better nourishment resulted in dramatic population growth. Stearn (2013) confirms that '*increasing adaptation of the potato supported the beginnings of rapid population growth in Europe by the 1730's'. The* population of Britain doubled between 1750 and 1800, while the population of France, Germany and Italy increased from 71 million to 93 million (More, 2000).

Proletariat represented the majority of this growth: the most significant increases were occurring in the periphery of factories located close to energy resources. Manchester is a good example of such a population growth. It was a tiny town in 1772 with a population of 25,000 but was transformed into a metropolis as it became the cotton capital of Britain, with a population of 367,232 by 1851. The population in Birmingham increased similarly between 1821 and 1831 (Stearn, 2013). The demand for labour instigated by industrialization did not only cause the population of closer rural areas to move near the cities, but also attracted people from further distances, such as other European countries and Asia.

Establishment of factories and expansion of population in the cities caused the alteration of the city form. While the most far-flung areas in cities were within walking distance before the 18th Century; with industrialization, cities expanded and absorbed the surrounding lands. As a consequence, living and working areas within the cities

started to become distant and the need for urban public transportation emerged. The first significant examples of urban public transportation were horse cars and the omnibuses (horse driven precursor to buses) (Fig. 2.1.). Later on, cable cars became common in metropolises such as Boston and San Francisco by the end of the 1880's (Lipovac, Nenad; Jandriček, 2011). These newly-emerging public transportations had a significant place in the lives of low and middle-income commuters. As the urban population continued to increase dramatically, public transportation was further implemented with the emergence of new transportation means like the electric tramway and metro. These developments, such as the construction of London Metro in 1884 and the Paris Metro in 1900, laid the foundation of the most important present-day public transportations (Mumford, 2007). The Moscow Metro for example, constructed in the 1930's, carries today a daily average of 6.6 million passengers (Richard, 2017) on 12 lines and through 182 stations (Çetindağ, 2003).

Figure 2.1. An Example of Omnibus (Thornton, 2017)

Starting from 1895 the high-income inhabitants started to move away from the city centres due to the negative consequences of urban development, such as air pollution and overcrowded living areas. This phenomenon of relocating to areas surrounding the cities became known as ‘suburbanization’. Although these new houses were located in rural areas now called ‘suburbs’, work, shopping malls and entertainment centres were still located in city centres. As a consequence, ownership of private cars increased as a means of transport to and from the city (Mumford, 2007).

In conclusion, new living conditions that emerged from developments incidental to industrialization provided a basis for urbanization, which was followed by the appearance of new types of communal transportation for the public in 18th,19th and 20th centuries. However, the latter also saw a substantial growth in private transportation, with new production techniques allowing the increase of private vehicle ownership.

2.1.3. Ford T Model and the Rise of Car Ownership

The demand for private cars to travel from the suburbs to the city centre would not have been possible and definitely could not have been met, if a major development in automobile production had not occurred previously.

Henry Ford, the famous industrialist, changed the production of automobiles into a much faster and cheaper process by introducing standardization and the use of the assembly line to his factories (Fig. 2.2). With this new approach to production, his company developed the T model, the first automobile affordable to the middle-classes (Fabrice, Steven, Timothy, 2009). The company produced half a million cars and was able to reach 50% of the American market. With the emergence of other companies, like General Motors, the following years saw an ever-increasing production and sale of automobiles of different models (Vidal, 1973).

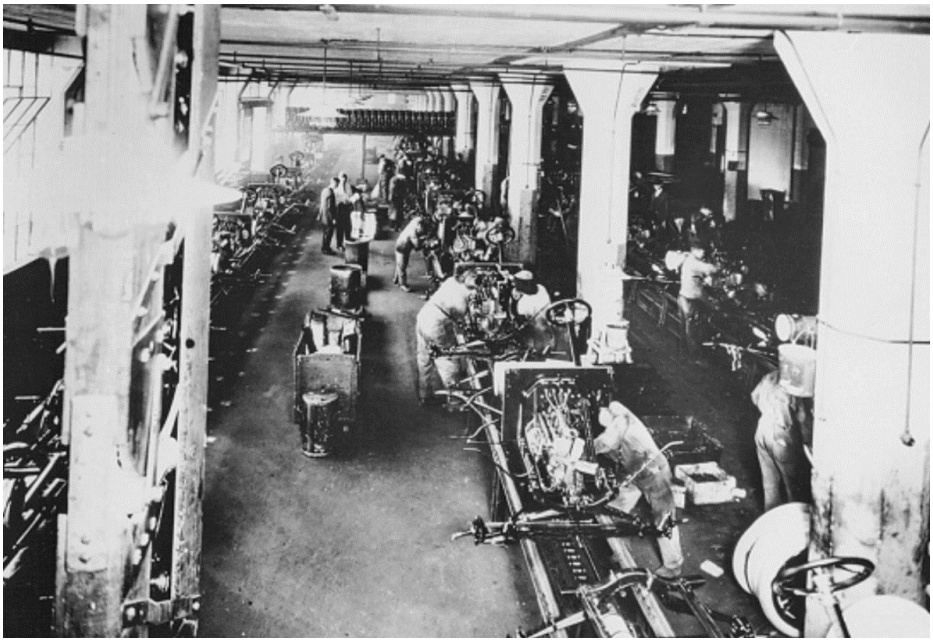

Figure 2.2. Ford T Product Line (Ford, n.d.)

This spread of private car ownership directly caused the construction of highways to gain prominence over railways in this period. As cars and roads became easily available, people started commuting more and more with their private vehicles rather than with public transportation, which in turn further increased the demand for more cars and more roads, while somewhat decreasing the importance of railways for public use (Bradley, 2012; Vidal, 1973)

2.2. Current State of Urban Transportation

Today, urban transportation has become a major problem for cities and is an issue of greater scale than it ever was up to now, as cities suffer due to the growth of their urban population as well as the lack of necessary infrastructure to accommodate their ever-increasing population. The number of cars on the road has also been growing proportionally: while there were 8,000 cars in Britain at the start of the 20th century, this number has reached 21 million by the end of the century ("Car Ownership," n.d.). This substantial increase of both population and private vehicles give rise to four major

issues in urban transportation: congestion, accidents, environmental damage and negative social impacts (Goodwin, Cullinane, Kenny, & Stokes, 2012).

2.2.1. Congestion

Traffic congestion is defined as "[...] a condition on road networks that occurs as use increases, and is characterized by slower speeds, longer trip times, and increased vehicular queueing." (Traffic congestion, n.d.).

Congestion is one of the biggest current transportation problems in cities. As the amount of privately-owned cars keep increasing, the urban infrastructures remain insufficient to support the traffic they cause even with all the attempts at improving, developing and extending the dedicated urban spaces. Especially during the rush hours, when people travel back and forth between their home and work place, traffic congestion reaches its peak, leading to waste of time and energy, decrease in productivity and increase in stress and health problems. As a result, congestion is seen as a major culprit for decreased quality of life (OECD, 1996). Furthermore, congestion increases fuel oil consumption and carbon emission of cars, therefore worsening the environmental impact that will be explained in the following title.

Congestion is not a phenomenon that only concerns private cars, but could also be caused by pedestrians, like in İstanbul's İstiklal Street, or bicycles, like in Copenhagen (Hill, 2011). However, none of these other types of congestion has as big a negative impact on the environment nor on humans as motor vehicles.

2.2.2. Environmental Damage

The current state of urban transportation causes damage to the environment on a local as well as global level. Noise and visual intrusion take the lead in the list of causes on a local scale (Goodwin et al., 2012). Noise of various levels is emitted by motor vehicle such as buses, cars and metro, either due to their working engines (or mechanisms) or as intentionally attention-grabbing caution signals like the sirens of fire trucks and ambulances or the reverse gear sounds of burden vehicles. Visual

intrusion could be anything that is disruptive to the eye and could emerge in different ways. For example, illegal parking on sidewalks (Fig 2.3) is a visual intrusion that disrupts the look of streets, besides becoming an obstacle to pedestrians (Goodwin et al., 2012). Some of the overpasses in Ankara could also be given as an example of visual intrusion, especially to the first and second floor inhabitants of the surrounding buildings (Fig. 2.4)

Figure 2.3. The Example of Illegal parking on Sidewalk (Şentürk, 2016)

Figure 2.4. The Example of an Overpass in Kızılay, Ankara (Yılmaz, 2016)

On a global level, transportation vehicles are considered as one of the main culprits of the most harmful and universal ecological problems, such as climate change. The burning of fossil fuels in cars causes substantial amounts of carbon dioxide to be released into the atmosphere. Since, carbon dioxide is a greenhouse gas that prevents heat from Earth to escape into space, its excessive emission increases the greenhouse effect which in turn causes climate change. Furthermore, the gases released when fossil fuel is burned also harms the ozone layer of the Earth's atmosphere. The depletion of the ozone layer causes serious health problems for humans such as skin cancer, harm plant life, decreases agricultural production and further enhances the greenhouse effect.

Although the local environmental damages caused by the current state of urban transportation explained above may appear to be insignificant and effective only on a personal and psychological level, the global environmental issues threaten not just human but all life on Earth. Therefore, it is crucial to decrease traffic problems and provide better solution for urban transportation.

2.2.3. Accidents

Accidents are a serious threat to human, as well as animal life. They may cause economic damage and physical injury (even death) as well as negatively influence the psychological health of humans.

At the end of the 19th century, car accidents were a new thing for the population, with the first recorded fatal accident happening in London in 1896. However, nowadays people have grown accustomed to frequent car accidents and their various consequences (Goodwin et al., 2012). In 2015, there were a total of 6.3 million traffic accidents that resulted in fatality, injury or damage in the U.S. alone (Statista, 2018a).

Terlouw (1990) states that human factors are the main reasons behind traffic accidents. Human behaviour such as disregarding the traffic rules significantly increments the number of accidents. The second biggest factor that causes an accident is vehicle

defects (like broken machinery) while the third factor is inappropriate roads such as animals on the road (Goodwin et al., 2012).

2.2.4. Social Impact

As explained above, with the emergence of industrialisation and urbanisation, socio-economic developments in cities influenced and shaped the urban transportation systems. For example, the introduction of women into business has led to an increase in the number of cars per household (Quality, 2006). As commuters have less and less time to reach numerous destinations in a single day or journey, such as the children's school, their work place or shopping mall (EEA, 2008), they may prefer to use their private car rather than public transportation to save time as well as to travel in comfort. However, this choice worsens the situation they wanted to avoid, by increasing congestion, leading to more stress, accidents, and anxiety. All these have an impact on society and the society in turn affect the structure of the urban transportation by the way it acts in traffic and the resources or services it desires and demands of its policy makers.

In conclusion, all of the above-mentioned problems related to or caused by the current state of urban transportation are intertwined: they affect and reinforce each other bidirectionally. Since private car ownership appears to be a common culprit in all these, preventing it or at least stalling its heavy increase by promoting public transportation appears to be a promising measure to decrease traffic congestion, car accidents and environmental damage, which in turn would minimize the negative effects these have on the society and the individuals. These specific problems as well as the overall issue of urban transportation need to be addressed urgently and effectively for the wellbeing of the public as well as of the planet they inhabit, and the recent decades saw the rise of two prominent concepts as intermediary to finding solutions: sustainability and smartness.

2.3. Solutions for Urban Transportation Problems: Sustainable Transportation and Smart City

Sustainable transportation has become significant as a concept in the 1990s, after the term *sustainable development* was introduced in the 1987 report of the World Commission on Environment and Development (the Brundtland Commission) (OECD, 1996). Sustainable transportation is based on two main concepts: behavioural and technological change. Behavioural change is associated with human behaviour; for example, choosing public transportation over driving a personal car. Technological change implies development of transportation related technologies that are more sustainable and efficient, such as energy-efficient cars (Steg & Gifford, 2005). Technological change is a significant force in creating more sustainable transportation solutions because it can help facilitate the change in behaviour as well, by rendering the sustainable alternatives more desirable: for example, an electrical car that performs better on the road than a fuel one could induce consumers to choose the more sustainable options. However, technology is not always sufficient on its own in initiating behavioural change: the electric car may need to be more economic (costing less retail, consumption and tax wise), convenient (with sufficient charging spots distributed around the city), visually appealing, etc. The inescapable fact is that any development or improvement related to urban transportation has to be made in consideration of human needs, expectations and values, for the public to change its behaviour. Therefore, a holistic approach, bringing together both the technological and behavioural considerations is necessary to ensure sustainable transportation, which would require multidisciplinary collaborations (Terry Moore and Julia Pulidindi, 2011). In this context, it is not only the city planner, civil engineer or product designer that have a role but the local authorities as well, who would implement the policies for sustainable transportation. In fact, the need to improve integrated transportation networks that are supported by policies is as great as the need to develop energy-efficient vehicles.

In addition to sustainable developments in transportation, the idea of using technology to support and develop cities has risen recently to provide solutions for urban problems, to make people's lives better and easier (Chourabi et al., 2012; Jin, Gubbi, Marusic, & Palaniswami, 2016; Nam & Pardo, 2011; Ojo, Curry, & Janowski, 2014). This approach, also known as "digital city" or "intelligent city", is more frequently referred by governments and the business world as the "smart city" (Kitchin, 2014).

Smart cities are envisioned as urban environments equipped with digital infrastructure that organizes how the city functions. Different studies give different definitions for Smart Cities in the literature, (Chourabi et al., 2012; Kitchin, 2014): while some focus on the technologies integrated in a Smart City, others indicate the importance of being human-centred (Nam & Pardo, 2011). However, all projects related to smart cities agree that it requires the involvement of various stakeholders (Chourabi et al., 2012). In the Smart London Plan (2016), prepared by the municipality of London to improve the lives of Londoners by using data and technology, the real meaning of smart is defined as making a better connection between different systems like the local government and market through digital technology. This idea of smartness through connectivity closely relates to the Internet of Things (IOT), and indeed, all smart cities have devices that use IOT (Jin et al., 2016). IOT is defined as:

> Interconnection of sensing and actuating devices providing the ability to share information across platforms through a unified framework, developing a common operating picture for enabling innovative applications. This is achieved by seamless ubiquitous sensing, data analytics and information representation with Cloud computing as the unifying framework. (Jin et al., 2016, p. 112).

In turn, due to their being an important component of IOT, Information Communication Technologies (ICT) are also key elements in these cities (Schierz, Schilke, & Wirtz, 2010). In fact, Nam and Pardo (2011) state that the integration of

ICT into the city infrastructure and services is the most common feature of smart cities. Analysis of the connected information that is provided by ICT can help develop better understanding of the moment to moment situations and flow of cities, as well as contribute to their efficiency and sustainability (Kitchin, 2014): the data can help in developing strategies such as energy usage for the decrease of carbon emission (Ercoskun, 2015; Neirotti, De Marco, Cagliano, Mangano, & Scorrano, 2014).

In summary, smart cities are not just urban places supported with digital infrastructure (Kitchin, 2014); they are people centric (Chourabi et al., 2012; Nam & Pardo, 2011), use smart technologies to enrich the environmental, social, cultural and economic conditions of cities (Kitchin, 2014) and provide a better connection between different urban systems (London Smart Plan). Indeed, the attributes of a smart city could be gathered under 6 domains (Fig.2.5): environment, economy, mobility (called transportation in certain studies), governance, living, and people (Giffinger, 2007).

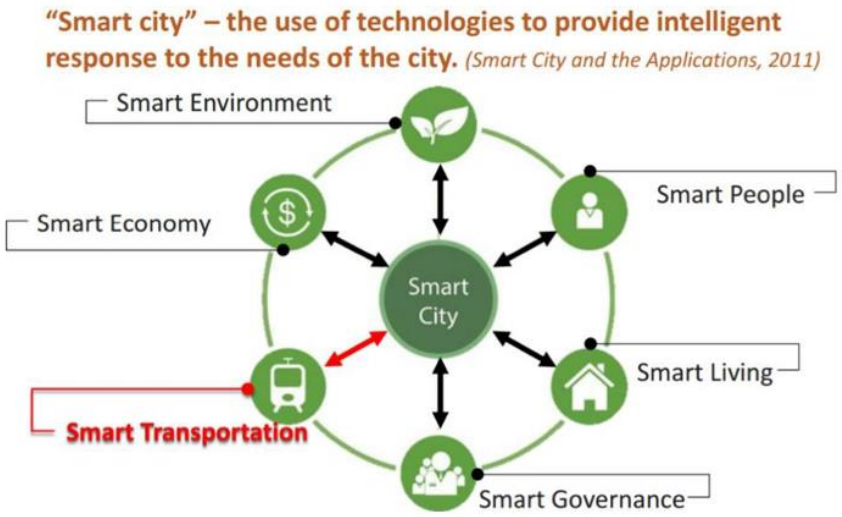

Figure 2.5. The Study Areas of Smart City (Lam; Lo, 2013)

Since the focus of this thesis is urban transportation, the mobility characteristic of smart cities, in other words smart transportation, will be further explored in the next part.

2.3.1. Smart Transportation: Intelligent Transportation Systems (ITS)

Within the concept of smart cities, Intelligent Transportation Systems have emerged as the main solution to transportation problems. An Intelligent Transportation System (ITS) is an integrated advanced communication, information and electronics technology for transport infrastructures and vehicles (Ocalir-Akunal, n.d.). The purpose of ITS is to create more intelligent roads, vehicles and passengers (Figueiredo, Machado, Jesus, & Carvalho, 2001)**.** Under the pressure of both urbanization and motorization, ITS has a vital role nowadays on the overall transport system of urban areas (Wang, Oh, Wang, & Yuan, 2013) in helping to increase the safety, reliability and speed of travel, improve traffic flows and satisfy travelers using all kind of transportation.

Besides its economic and social benefits, ITS also offers great potential for environmental improvements, by helping to reduce fuel consumption and carbon emission, which assigns it the significant role of building a sustainable world.

The major areas of application for ITS are quite numerous, as is shown in Table 1. Among these the Passenger Information System (PIS), the Traffic Management System (TMS) and the Electronic Toll Collection (ETC) are the most commonly used and known ones. PIS, is a tool actively used by passengers to access transport related information in order to plan their individual journeys. TMS is an interactive system that monitors parking and receives feedback from vehicles, controls traffic sign boards and provides information to the police and emergency management systems (Qureshi & Abdullah, 2013). The Electronic Payment allows drivers to pay and pass without stopping, but it can also weight the passing vehicles to ensure compliance with legal limits. (Qureshi & Abdullah, 2013).

Table 2.1. *Major Study Areas of ITS*

Areas of ITS	**Services**
Passenger Information System	Real time travel information, travel planning, navigation
Traffic Management System	Traffic control, incident management, transportation infrastructure maintenance
Vehicle	Prevent collision, automatic vehicle operation
Freight	Commercial vehicle operations
Public Transportation/Transit	Transit management
Emergency	Emergency vehicle management
Electronic payment	Electronic financial transactions
Personal security with highway	Increase of passengers' security
Weather and environmental conditions	Monitoring of weather and environmental conditions
Disaster response	Disaster data management, pre-disaster management
National security	Monitoring and controlling suspect vehicles

(Turkish Republic of Ministry of Transport Maritime and Communications, 2014)

The Passenger Information System, as the main ITC application to serve the passengers of public urban transportation, is a major topic that will help answer the research questions of this study and therefore, is explained further in the following section.

2.3.2. Passenger Information System (PIS)

Of the several services that are comprised in ITS, providing real time information to passengers of public transportation is one of the most important. Isa, Ismail and

Ahmad Tajedi (2013, p. 364) state that “Beside security and convenience, a good and reliable public transportation system depends on how good the passenger information system (PIS) is.”

PIS may provide a wide range of information to the passengers such as arrival and departure times of public transportation vehicles, locations of these vehicles, their routes, general information on the service area, service disruptions and delays, fares, transfers options and alternative transportation services, weather conditions, public announcements and security related information (Politis, Papaioannou, Basbas, & Dimitriadis, 2010). Its main contribution is reducing the uncertainty of transport waiting time and helping travellers plan their journey according to their needs and priorities (Monzon, Hernandez, & Cascajo, 2013).

PIS shares information with passengers both through non-interactive and interactive media. Non-interactive media (mainly static tables) has long been and still is the most common way to publish and transmit public transportation information. For example, schematic metro maps that display the range of each line and their points of intersection, or static timetables that list the bus numbers, respective routes, directions and times are among the most familiar non-interactive PIS. However, with the advance of information and communication technologies, interactive PIS media are gaining importance and reaching more and more people. Especially *electronic displays* that are also called *dynamic message signs* have become one of the most common tools of passenger information systems (Politis et al., 2010). Electronic displays provide useful information such as traffic conditions or travel time for users (Fig.2.6). Another interactive PIS approach that has recently become very popular, especially in the larger metropolises, is the use of online services, which provide passengers with up-to-date, easy to reach and customizable information. In every major city in the world, there are online platforms that provide real-time information about bus, train, flight or even ship travels. For example, in Turkey, the National Transport Portal (Ulusal Ulaştırma Portalı, n.d) provides real-time information about the departure time of buses, trains and airplanes, along with road and weather condition, and through a

travel planner, helps its users plan their journeys. Although these services used to be reachable only through the desktop of a computer, thanks to developments in mobile technologies and increased smart phone usage, the information is now available to passenger everywhere and anytime, both before and during their trips.

Figure 2.6. Examples of Electronic Display (Ohio Department of Transportation, n.d.)

2.3.3. Mobile Passenger Information Systems

With the increasing use of smart mobile devices, there has been a tremendous growth in development of mobile applications (apps) designed to function within a mobile device such as a smartphone, offering a very large variety of services. In fact, according to data of the third quarter 2018, there are 2.1 million apps for Android users and 2 million apps in Apple store (Statisca, 2019).

Mobile apps have a significant role in the increase and improvement of the interactions between passengers and transportation systems (Shaheen, Cohen, Zohd, & Kock, 2013). In fact, since the very beginning of their existence, mobile apps have been used to convey real-time public transportation information to passengers, playing an important role in the integration of the people to the city (Chourabi et al., 2012; Kitchin, 2014). As a result of this, as well as their increase in popularity, research on mobile apps have become an integrated part of smart city studies.

Shaneen et al. (2016) stated that mobile applications related to transportation are comprised of *connected vehicle apps* that are "allow remote access to a vehicle through an integrated electronic system that can be used in times of emergencies (e.g., locked out of a car, asking for help when in an accident, etc.,*"* (page 13), *smart parking app* that "provide information on parking cost, availability, and payment channels" (page 13) and *mobile passenger information systems*, or *mobile PIS*, which provide real-time information to users about various transportation services and are the most commonly used smart transportation apps.

Mobile PIS provide two main services for the passenger: giving the arrival time of public transportations and helping with travel plans. These applications cover both the intercity and urban areas, however, since the study focuses on the latter, only the urban mobile PIS examples were investigated. One such example is NXTBUS, a bus information system that provides real time information in Canberra, Australia (NXTBUS, n.d.). Apart from the mobile app, passengers can also reach this platform through a web browser, SMS or phone call, while on the bus or at the bus stop. There are others mobile PIS that bring together different modes of transportation, such as *9292*, a Dutch service defined as "a daily source of travel information for public transport for all kinds of passengers [, bringing] all information from all transport companies together in a user-friendly way" (9292, 2016). Passengers can plan their journeys easily with this platform by choosing the departure and arrival station for any public transportation such as bus, tram, train, ferry or subway, seeing the total calculated fare and checking delays and service disruptions (Fig.2.7). Moreover, the app provides the carbon footprint of planned journeys, comparing the consequence of using public transportation versus private cars.

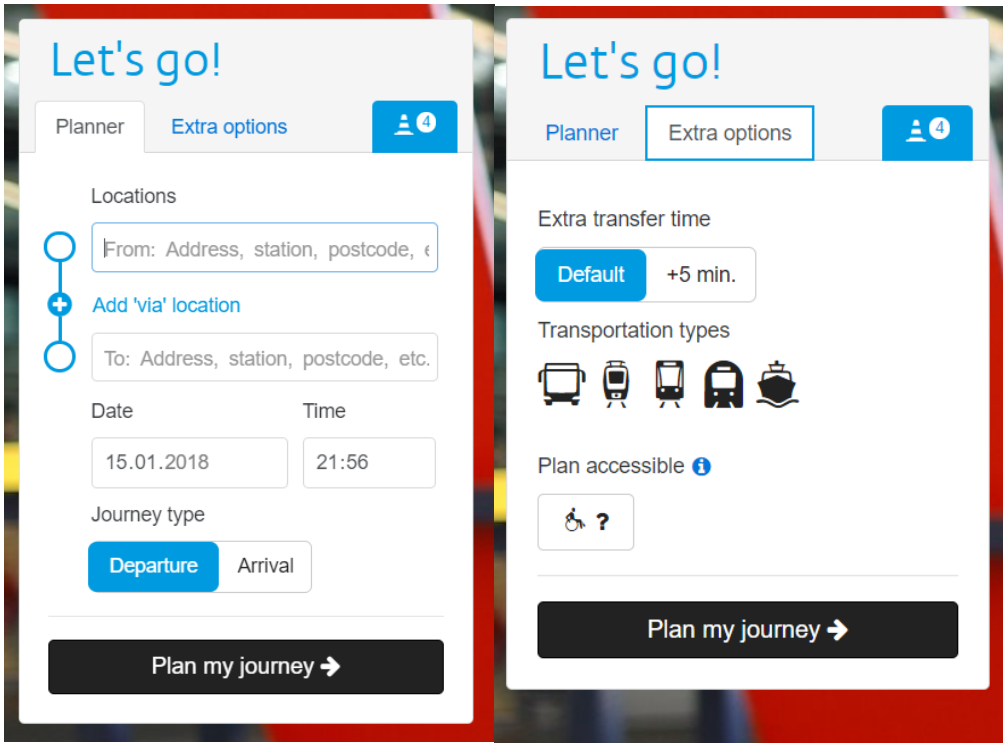

Figure 2.7. Interfaces of the Mobile App-9292 (9292, 2016)

Another example is Mobiett, developed by İstanbul Metropolitan Municipality. It provides information about the arrival time of buses to the station, help journey planning with multiple choices and transmits user complaints to the municipality.

Thanks to these mobile apps, users can reach information about different transportation options and choose the one that is most convenient for them. Furthermore, with developing technologies mobile apps dedicated to transportation have been evolving into more comprehensive services that address more of the users' needs (Shaheen et al., 2013). One example is the Citymapper app, who includes 39 cities all over the word. It offers more advance features such as combining taxi information with public transportation, providing alternative travels routes and vehicles in case of road works, sending alarms, displaying friends' travels and using gamification in its services (Citymapper, n.d.).

2.3.4. New Mobility

As concepts such as smart cities and smart technologies become more prominent as solutions to urban problems, researchers that study urban development and transportation state that we have entered the era of *new mobility* (or *smart mobility*) defined as strategies that "seek to integrate Internet and mobile communication technologies, various modes of transportation, and smart land-use planning into convenient, sustainable systems for providing people with door-to-door access to the services they need and opportunities they wish to pursue." (Dutzik, Madsen, & Baxandall, 2013, p.37).

In the New Mobility World 2017 Conference, "the place where start-ups, disruptors, decision makers and the automotive industry come together to radically rethink mobility", more than 100 speakers have expressed common thoughts when defining new mobility: it refers to intelligent, interrelating, shared and autonomous mobility (New Mobility World, n.d.). They stated that this new era is marked by attempts to better understand the concepts of *interconnectivity* and *data* as well as an onset of preference for *shared systems.*

Many governments are initiating projects dedicated to new mobility in order to develop and improve the transportation of their countries. Smart Mobility Action Plan (2016-2018) developed in Netherlands can be cited as an example of such a new mobility study. The plan emphasizes the importance of data for solving transportation problems in limited time and place, along with the added advantages of *mobile ticketing*. For example, the research and projects developed under the plan suggest that, by providing travel advice to its users, depending on their individual locations, and allowing them to pay transportation or parking fee through the app, a mobile PIS would use the data it gathers effectively, provide customized feedback, help passengers avoid transportation related problems and save time (*Smart Mobility Action Plan 2016-2018*, n.d.).

Besides governments, private companies such as Toyota or Siemens also conduct projects related to new mobility. Toyota's project, named Toyota Harmonious Mobility Network (Ha: Mo) aims to help develop local transportation by creating a connection between personal and public transportation vehicles. Toyota's smart car, named 'I Road', is part of an interconnected transportation system and its users can make their travel plan through a mobile app, check available parking and accordingly choose between using their smart car, a public transportation or a car sharing service. This multimodal approach that makes use of a network with multiple transportation modes such as bus, train (Booth, J., Sistla, P., Wolfson, O., Cruz I.,F., 2009) , provides users with comfort, in addition to helping them save time and money (Toyota, n.d.).

As the core elements of new mobility, 'shared system', 'interconnectivity' and 'data' are explained in the following titles.

2.3.4.1. Shared Systems

Social media are "forms of electronic communication (such as websites for social networking and microblogging) through which users create online communities to share information, ideas, personal messages and other content" (Social media, n.d.) that have become highly popular for content sharing and social networking in recent years (Asur, S., Huberman, B.; 2010). Usage of social media around the world amounts to 135 minutes daily as of 2017. The most commonly used social media service is Facebook, with 1.86 billion users by the end of 2016, followed by Twitter, Instagram and Tumblr (Statista, 2017). In recent years, governments have started to use social media to interact with their citizen in order to create public engagement and provide better services (Edison, n.d.). Studies on Smart Cities have shown the importance attached by local governments to the use of social media, especially in regard to transportation. The local governments announce *accurate prediction of length of delay*, *reason for delay* and *alternative routes through social media*, as research has shown these to be the information the citizens most want to attain (Edison, n.d.). Social media is helpful in building a bidirectional interaction between

passengers and the government as well, since users are able to give information and feedback back to their government through their suggestions or complaints. In Turkey, Metropolitan Municipalities of İstanbul and Ankara (the two largest cities as well as the financial and political centres of the county) both use social media to make announcement about closed roads and accidents, advertise their services and receive passenger complaints.

Mobile apps dedicated to social media have especially become increasingly popular with the widespread use of the Internet as sell as smart devices, and these mobile networking tools have led to the rise of shared systems and a sharing economy: platforms where people can share information, address their needs such as buying and selling products, as well as arrange to share rides or vehicles. Various shared systems for urban transportation have appeared in recent years and, as stated by Borgnat et.al (2011, page 416), they "…offer a new way to look into the dynamics of movements inside a city, and more generally into its activity".

The major example of a shared system in urban transportation is the *carsharing* system that is seen as a potential solution for congestion (Dutzik et al., 2013). When people prefer to share their car with their co-workers or neighbours, it helps save money and decrease overall vehicle quantity and stress in traffic. In addition, it leaves more parking space for cars in the crowded city centres. Less number of cars in the traffic also means less carbon emission, less fuel consumption and a decrease of the negative environmental effects of urban transportation. Future projections predict that sharing in transportation will be more common in the upcoming years (New Mobility World, 2017). There are three types of car sharing methods: fleet-based, peer-to-peer and ride sharing.

Fleet-based is a type of car sharing where people rent a car from a company. The most commonly used and well-known examples of fleet-based cars are ZipCar and Car2Car. These offer their services through their mobile apps and web sites: users sign up and can reserve an available car they would like to use for a specific amount of

time. To get physical access to the car parked in a pre-indicated location, the user either scans a membership card with a card reader located on the car itself or uses the mobile app. Fleet-based car could be used for a roundtrip or one way trip (Dutzik et al., 2013): in the former, users are expected to return the car to the place they collected it from, while in the latter, they can leave the car in any parking space determined by the company. Fleet-based car sharing is a growing sector: Car2Car reached 2.2 million global customers by growing at a rate of 43% in 2016 ("Car2go 2016," 2017).

Peer-to-Peer sharing services such as Turo and Get Around, function through their web sites and mobile apps, and connect those who are willing to lend their car for a fee with those who need to borrow a car. Specific features like a non-smoking car, specific number of seats or luggage space may be indicated and searched for.

Ride-Sharing services connect people who would like to share the same car. Mostly functioning through mobile apps, car-pooling services such as BlaBlaCar or Zimride help people who travel on the same route to find each other, save fuel and socialize along the way. In the case of Uber, another well-known service, passengers hail an available car using the mobile app, just like they would physically hail a taxi on the road, choosing whether to share a ride or not, and paying accordingly. But unlike a regular taxi, payment is made online, a specific type of car may be requested and both the passengers and the driver may rate each other and the quality of the trip.

In addition to carsharing, bike sharing, a practice that emerged in the 1960's, is also used in major cities. Its basic operating principle is as follows: the users can take a bike from a dedicated parking area located in the city, travel with it to a desired location and then leave the bike on another dedicated parking area nearby. Citi Bike that operates in New York City (Dutzik et al., 2013) and Nexbike that operates in over 60 German cities and 27 countries worldwide (Nextbike, 2017) are two examples of bike sharing program.

2.3.4.2. Interconnectivity

The commonly accepted understanding of interconnectivity for new mobility is the idea that the various modes of transportation in cities should be integrated (Allard & Moura, 2016)with each other.

An integrated transportation system is the most important feature that separates leading global cities from the rest (Houghton, Reiners, & Lim, 2009). In leading global cities, transportation problems are approached with a holistic view and the transportation needs of citizens are provided through an integrated system. For instance, in Stockholm the quantity and frequency of buses were increased and an integrated ticketing system was implemented at the same time a congestion tax was put into effect. As a result, usage of private cars decreased by 25% and carbon emission in traffic decreased by 14% (Houghton et al., 2009).

Allard & Moura (2016) express that interconnectivity in transportation has three main factors: connectivity, choices and collaboration. *Connectivity* means the strengthening of the link between transportation modes (Houghton et al., 2009). An important factor of connected transportation is how the issue of transfers in transportation is dealt with, when passengers change from one vehicle on a certain route to another one on a different route in order to reach their destination. Transfer points needs to be well-designed, firstly because passengers may be reluctant to change vehicles mid-journey, but more importantly, because they may have financial concerns about paying additional fares for a transfer (Allard & Moura, 2016).

Choices, means that users are provided with a selection of different modes of transportation, are able to make their own travel plans and use the interconnected system more efficiently.

Collaboration between different transportation systems is needed to achieve the interconnectivity of new mobility. The example of rail-air transportation collaboration is a well-recognised one, successfully established in many cities: passenger' access to and back from the airport is mostly supplied by railways, due to long distances and

prices. For that reason, collaboration between these two transportation modes play an important role in building a good connected transportation system.

Ticketing has a significant role in building transportation interconnectivity. If transportation ticketing is common in all transportation modes (if it is supported by a multimodal transportation system), it helps connectivity in transportation, increasing its convenience for the public by providing more choices to passengers, as can be seen in the example of Singapore's integrated ticketing system, called e-payment (Houghton et al., 2009).

The increasing use of mobile apps in transportation along with the need for tickets to become interconnected induced the emergence of **mobile ticketing**, a service that offers online tickets that can be store in mobile digital devices like smart phones or tablets. Mobile checking, event ticketing or transportation ticketing are all examples of mobile ticketing (Puhe, Edelmann, & Reichenbach, 2014).

There are two kinds of mobile ticketing systems. In the first group, called visual or flash mobile ticketing, the paper ticket is sent in a digital format to the mobile device of the passenger. The passenger shows the ticket to a driver, an inspector or staff member. The second group depends on either a barcode scanner or a Near Field Communication (NFC) system to read the ticket, such as a barcode bearing Turkish Airlines plane tickets .

Some mobile PIS applications enable the passengers to buy transportation ticket and also show real-time information of transportation like TfL Oyster App. Moreover, the passengers can pass through a ticket barrier using the QR code displayed in the app.

Mobile ticketing in transportation, with the benefit of learning the prices, reserving and buying tickets through the same service, is both convenient (Puhe et al., 2014) and satisfactory (Accurate, 2011) for passengers familiar with mobile technologies (Tavilla, 2015). Passengers do not have to queue in front of a ticket office, nor need fear losing their tickets; they make direct payment from their money accounts and save time. Furthermore, mobile ticketing contributes to sustainability because it reduces

paper tickets or plastic cards and reduces costs by eliminating the need both for ticket offices and expensive smart cards (Puhe et al., 2014).

Due to all these advantages it offers, mobile ticketing was indicated by Accenture, a global technology consulting services and outsourcing company in more than 120 countries (Accenture, 2011) as a crucial new mobility feature to be integrated into a mobile PIS application.

2.3.4.3. Data

Data are the driver for the development of new transportation systems as a part of smart cities and "will be the invisible infrastructure that lies behind all the future mobility possibilities", as explained by Steven Armstrong, president of EMEA Ford Motor Company (New Mobility World, 2017). As Nuaimi, Neyadi, Mohamed, Al-Jaroodi (2015) explained, data can help improve transportation in cities such as by "optimizing route and schedules or accommodating for varying demand*"* (page 5). By using data implementation, innovative mobility projects can be conducted in in cities, such as making traffic congestion predictions by using real-time information or helping to optimize shipping movements (Nuaimi etc., 2015).

The previously explained core elements of new mobility, shared systems and interconnectivity, both help with the collection and implementation of data about passengers (such as how frequently they use buses, which routes they prefer) as well as transportation vehicles (such as when they depart from a specific stop, how full or empty they are) through various platforms such as social media, traffic management systems and mobile ticketing. The implementation of these data contributes to solving transportation problems by helping develop strategies (Ercoskun, 2015; Neirotti, De Marco, Cagliano, Mangano, & Scorrano, 2014). First, it helps create a more efficient system by providing information to urban administrators or experts who plan urban transportation (Jin et al., 2016; Kitchin, 2014; Menon, 2017). For example, the Oyster Card that is used as a ticket in the London transportation system, collects data about user's travels such as 'where people travel', 'what mode of travel they choose', 'how

frequently they travel' and 'how reliable are their journeys', which is then analysed to improve transportation planning. Second, data help make passengers' life easier by giving real-time information about their travels and can even encourage the use of public transportation. For example, information about roadwork or the best choice for public transportation in regard to fee or time provided by mobile app makes users a part of interconnected transportation system. Through all these, data implementation also helps create a more sustainable city by reducing cost and resource consumption.

Although new mobility offers new opportunities, it also comes with its own challenges. Alongside a need to be supported by governmental policies for the creation of efficient and successful mobility systems (New Mobility World, n.d.) and requirements for technical expertise and infrastructure, some of the major issues of new mobility are user related. How a new technology is perceived, how easy or difficult it is to use, how well accepted or how pricy it is, are all factors that affect the users' choice and therefore, have an impact on new mobility. As a result, a human centred approach appears to be crucial to the development of new mobility, which will be the focus of Chapter 3.

CHAPTER 3

UNDERSTANDING PASSENGERS

As mobile devices are becoming ubiquitous, the number and variety of mobile applications offered to their users have also expanded proportionately, and a significant number of these are dedicated to transportation. As mentioned in Chapter 2.3.3, mobile PIS play an important role in transportation and are among the most commonly used mobile apps, which entails that an increasing number of passengers acquire information about and make use of public transportation by interacting with new technologies. As a result, the properties of such an interaction could directly affect how efficiently these apps are used and in turn, impacts the efficacy of the PIS itself in an urban environment. Therefore, understanding and improving the interaction between mobile PIS and their users appears to be an important factor for achieving a better urban transportation. A primary requirement for that end is to understand the users and their experiences as they interact with the mobile apps in question.

3.1. User Experience

User-product interaction has become a prominent issue since technology started to dominate the daily life. The field of *Human-Computer Interaction (HCI)* has emerged in the early 1980's to investigate the implications of this interaction and to help its development as needed. The definition of HCI given by the Curriculum Development Group of ACM SIGCHI (Association for Computing Machinery's Special Interest Group on Computer-Human Interaction) is as follows:

> Human-computer interaction is a discipline concerned with the design, evaluation and implementation of interactive computing systems for human use and with the study of major phenomena surrounding them. (page 5, 1992).

HCI was first developed within the field of computer science and then became an important research area, especially in Information Communication Technologies (ICT). In recent years, HCI related studies are being conducted in divers' fields, expanding the affluence of HCI beyond computer science or ICT, and turning it into a cross-disciplinary and multidisciplinary subject. While engineering oriented fields such as computer graphics and programming are interested in the machine part of HCI, industrial designers, social scientists and cognitive psychologists focus more on the human counterpart (ACM, 1992).

HCI focuses mainly on usability and conducts task related studies to make products or systems more useful and easy to use. These studies have generally aimed to maximize the efficiency of systems, rather than to increase human satisfaction from using the system (Rex Hartson, 1998). However, understanding the user - what motivates and satisfies him or her - is critical in understanding how he or she interacts with the product and therefore in achieving optimum efficiency. As a result, studies that focus on 'the user' along with the usability of the system started to gain importance in the late 1980s. This approach, whose main goal is to investigate the user's needs, is called User-Centred System Design. Gulliksen et al., (2003) have defined UCSD as: "A process focusing on usability throughout the entire development process and further throughout the system life cycle" (page 401, 2003).

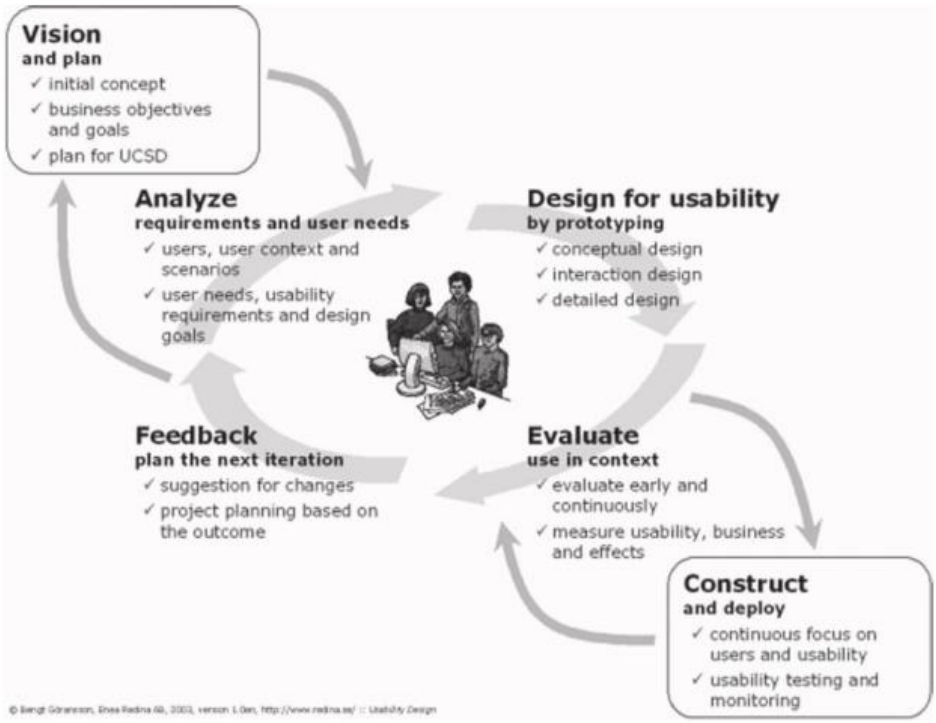

Figure 3.1. User Centred System Design (UCSD) (Gulliksen et al., 2003)

The main components of a UCSD process are a *focus on the user*, an *active user involvement and prototyping*. Designers focus on understanding the user's needs and what is fundamental for this understanding is the involvement of the user in the process through user studies and behaviour observations. Prototyping is treated as a successive and iterative process, where each iteration is tested in context and user's behaviours, reactions and opinions are evaluated to develop the next iteration. The design ideas are developed through these continuous user evaluations and usability testing (Gulliksen et al., 2003).

In the 1990's, the growth of the Internet has brought a new understanding to user-system interactions. When the diversity of the services offered through the World Wide Web and the complex interactions that happen in online environments were considered, studies that focused on product usability or user needs and requirements

started to appear inadequate. A new approach called *User Experience (UX)* emerged, aiming to investigate the interaction between humans and products or services in a more holistic manner (Rosenzweig, 2015).

Although HCI, UCSD and UX are all research areas that investigate human interaction with designed products, UX is the one that brings together the user, the product and the experience born out of their interaction.

The term *User Experience* was put forward by Don Norman for the first time at SIGCHI conference in 1995, when he needed a new term to:

> "... cover all aspects of the person's experience with the system including industrial design, graphics, the interface, the physical interaction, and the manual."

There are various models that define how UX is to be understood in the context of design. However, their common point is that UX investigates what experience the system or product incites for the user (Kuru, 2013). Furthermore, this experience can be influenced by an external factor such as a social, cultural or organizational pattern (Arhippainen & Tähti, 2003; Forlizzi & Ford, 2000).

Overall, it can be said that user experience is the result of three main factors (the user, the product and the context) as well as the interaction between these three.

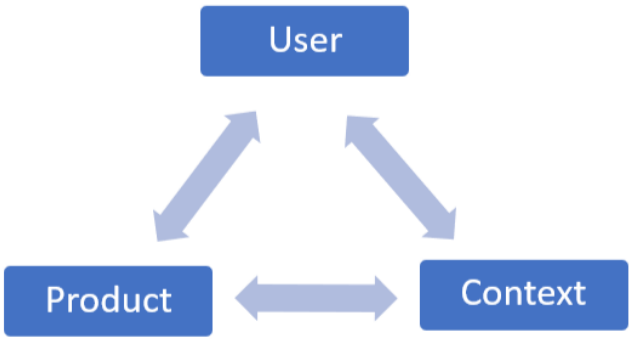

Figure 3.2. The Relationship between the main factors UX

3.1.1. The User

> "Humans should be seen as the most important element of information systems and should be designed in." (Ritter, Baxter, & Churchill, 2014; page 43).

Understanding the user has a great importance in designing a successful product (Forlizzi & Ford, 2000) and to understand a user, one has to consider his/her characteristics, all the personal factors that affect who he/she is and how he/she acts, which "includes all the users' emotions, beliefs, preferences, perceptions, physical and psychological responses, behaviours and accomplishments that occur before, during and after use." (ISO, 2010).

In the overall UX literature, even if the particular importance attributed to each differ from one study to another, the factors that influence and determine the user component are given as:

- Perception
- Expectation
- Motivation
- Behaviour
- Emotion

Perception

Whether or not users will actually use a product, as well as how they will use it, can be affected by their *perception* of that product (Rogers, 1995). Perception has an important impact on the user component of UX because how a product is perceived directly affects what is expected of it (Hiltunen et. al 2002, Roto, 2006), while at the same time, causing an emotional reaction (Thüring & Mahlke, 2007)**,** therefore affecting both the second and final factors listed above

Expectation

Users often judge their experience with a product in comparison to their initial *expectations* from it (Hiltunen et al 2002, Hassenzahl & Tractinsky 2006, Arhippainen &Tähti 2003). But expectation not only serves as a ground for judgment but also influences how the product was perceived to begin with (Roto, 2006; Hiltunen et al, 2002) affecting whether or not it will be used or how it will be interacted with.

Expectation is influenced by the user's previous experience (Kankainen, 2003) and is said to mostly affects user's motivation (Vroom, 1964). For example, users might be unmotivated to use a product if they expect it to be hard to use or could be motivated to maintain it properly if they expect its use to be of long-standing.

Motivation

When people are motivated to use a product, or to use it in a certain way, for a certain purpose, they mostly do it. *Motivation* is a significant factor in determining the user experience (Mäkelä&Fulton Suri, 2001, Hassenzahl & Tractinsky 2006, Arhippainen &Tähti 2003), as it influences behaviour (Ajzen, 1991) by affecting the attitude-behaviour process (Fazio & Olson, 2014). Furthermore, motivation is a significant factor in instigating behaviour change (Kuru, 2013).

Behaviour

People's experiences affect their decisions and behaviours. In return, these *behaviours* have an influence on their future experience. For example, a user who had a past experience with a quickly responding interface, may click and move too fast when using a slower interface, resulting with a negative user experience as well as negative emotions such as frustration. Indeed, behaviours can be influential in shaping emotions (Shpancer, 2010).

Behaviours are generated by intentions that are created prominently by attitudes and these attitudes in turn are shaped by underlying beliefs (Ajzen,1985). However, human behaviour is believed to be influenced not just by personal factors such as intention and attitude, but also by environmental ones (Bandura, 1989). One would behave differently in dark street than in a brightly lit room, but he or she would behave equally different depending on the social environment.

Emotion

As Hassenzahl and Tractinsky (2006) clarified, UX is human-centred and since emotion and its affects are innate and fundamental aspects of being human, *emotion* is a crucial factor to consider in UX studies (ISO; Arhippainen & Tähti, 2003). It could even be said to embody or materialize the experience itself (Forlizzi & Ford, 2000). While past studies focused on negative emotion to inform design, nowadays the importance of positive emotion is widely discoursed in UX research.

There is an interactive relationship between emotion and behaviour. One's behaviours as a consequence engenders emotions, as explained in the previous title, but one may also acquire knowledge about someone's emotions just by observing their behaviours (Bem, 1972). Furthermore, emotions influence the judgements, decisions and resulting actions of the user by affecting the attitude-behaviour process (Forlizzi & Battarbee, 2004; Hassenzahl & Tractinsky, 2006; Roto, 2006; Thüring & Mahlke, 2007).

Apart from its relationship with behaviour, emotion can also affect both the perception (Roto, 2006) and the motivation factors of the user component (Kankainen, 2003).

As can be concluded from the descriptions given above, these five factors that influence the user component of UX affect each other bi-directionally and help shape the user's experience through their interaction (Figure 3.3).

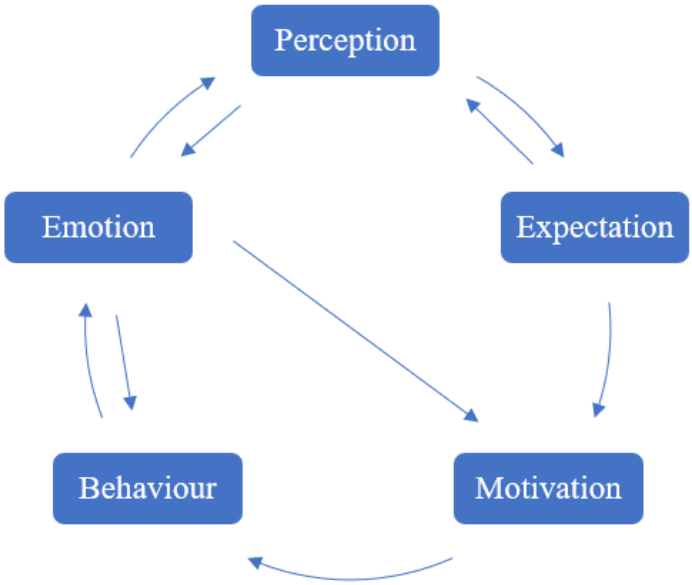

Figure 3.3. The Relationship of the User Components of UX

3.1.2. The Product

Product, whether it is a physical object, a service or a system, is the second main component in the creation of the experience. The inherent qualities that define the product are usually categorized into two groups: *the instrumental qualities* related to functionality and usability, and *the non-instrumental qualities* related to appeal or visual appearance (Thüring & Mahlke, 2007).

Instrumental Qualities

The instrumental qualities of a product that influences the user's experience are also called *pragmatic qualities*, as they are not related to intellectual or aesthetic matters but are relevant to *behavioural goal*: they support *do-goals* such as 'making a telephone call' (Hassenzahl, 2003). These qualities are closely related to the functionality of a product or system, or in other words, to its *usability* (Thüring & and Mahlke, 2007). As one of the most important subjects in UX (Roto, 2006) as well as in HCI (Rusu, Rusu, Roncagliolo, & González, n.d.) usability has been defined in various ways, with its best known definition being:

> *"*The extent to which a system, product or service can be used by specified users to achieve specified goals with effectiveness, efficiency and satisfaction in a specified context of use. (ISO 9241-11, 1998)."

In the ISO Model, there are three prominent factors that influence usability:

- *Effectiveness* is related to the user's ability to finish a task with *accuracy* and *completeness.* For example, if a person can get weather information for a specific day and city via a mobile app, it can be said that the mobile app is a effective weather forecast tool.
- *Efficiency* depends on how effectively the product provides, whatever it is meant to provide, to the user. Efficiency was formerly defined by ISO as *productivity.* For example, if a forgetful person is reminded of his daily tasks via a mobile app designed specifically for this purpose, it can be said that the mobile app is an efficient daily assistant.
- *Satisfaction* refers to the positive attitude, comfort and pleasure of the user, and is directly proportional to the user's needs. (Rusu et al., n.d.) (Harrison, Flood, & Duce, 2013). For example, if a person who wants to develop her performance as a runner can get detailed information about her training sessions through a mobile app, it can be said that the mobile app satisfies the user.

In addition to these, the Nielsen Model (Harrison et al., 2013), declares three other usability factors:

- *Learnability* refers to the user's ability to understand a product in order to use it. How easily a user learns to interact or use a product affects how usable the product is judged to be and as a result, how often, how long, etc. it will be used. For example, when a user interacts with a new mobile application for the first time, he or she would approximately give 5 minutes to understand and learn it (Harrison et al., 2013). If the product proves to be hard to understand, or requires more time, then it is highly probable that the user would download another application that offers the same or similar service.
- *Memorability* is related to how easy it is to remember and reutilize a product after some time has elapsed. For example, if the user cannot easily recall how to accomplish a task or reach a certain information after not having used a mobile app for some time, he/she will judge its memorability, and therefore its usability, to be low.
- *Errors* define the mistakes made by the user while using a product. For example, a written text or customized setting may be deleted by mistake or an unwanted access may be provided to a third-party application. A product's usability is considered to be low if it allows for many errors to be made. Gaining knowledge about such errors is valuable for the designers in order to develop better products.

The PACMAD (People at the Centre of Mobile Application Development) (Harrison et al., 2013) model added a final factor, intended specifically for the usability of mobile devices:

- *Cognitive load* is the total amount of mental effort being used, which is especially meaningful for mobile application since users may be performing multiple tasks at the same time. For instance, the user could be using a certain app while walking (Harrison et al., 2013), which leads to the behaviour of the user and the usage of the app affecting each other respectively.

In summary, there are seven factors that affect usability of a product: effectiveness, efficiency, satisfaction, learnability, memorability, errors and cognitive load.

Non-Instrumental Qualities

Even though usability is an undeniable factor in UX as stated in the previous section (Forlizzi & Batterbee, 2004) more recent studies show the need to go beyond preventing problems of usability if one desires to achieve good user experiences (Hassenzahl, Tractinsky, 2006). With the advance of new technologies, products are expected to not just be usable but to be desirable as well. Thüring & Mahlke (2007) called these product features associated with appeal and attractiveness *non-instrumental qualities*, while Hassenzahl (2003) named them *hedonic attributes*, in contrast with pragmatic qualities, as they are associated with psychological well-being features like pleasure. Non-instrumental product qualities support *be-goals* such as ‘enjoying making a telephone call’, as opposed to *do-goals.* These features focus on the question of why does someone own and use a particular product.

The *aesthetic characteristic*, a non-instrumental product feature, is especially significant in shaping the user experience (Alben, 1996) as it can influence the user component by affecting how the product is perceived and what emotions it incites, as well as the product component by inducing satisfaction (Arhippainen & Tähti, 2003).

3.1.3. The Context

Although the user and the product, with their respective inherent features, appear as the primary components of the interaction that make up the user experience, the environmental (physical, social or cultural) factor, called the *context* acts as the third component that influences this interaction. Dey and Abowd (1999) defined context as "any information that can be used to characterize the situation of an entity."

The context of use, as the component surrounding the other two, has a significant role in user's experience (Arhippainen & Tähti, 2003; Forlizzi & Ford, 2000; Roto, 2006; Thüring & Mahlke, 2007). Even when the user and the product stay the same, if the context changes, the resulting experience may also change. Therefore, time, place and environmental factors should be considered in user-product interaction.

Context of use can be gathered under four titles as follows (Roto, Law, Vermeeren, & Hoonhout, 2010).

Physical context

Also called the *place* (Arhippainen & Tähti, 2003) *or geographical location* (Roto, 2006), this is the physical space where the user interacts with a product and has an experience. Among the different context types, the physical environment has the most impact on a user's experience. For example, using a product when sitting on a table would be a very different experience then using it while traveling on a bus (Roto et al., 2010). Physical aspects specific to the bus, such as crowded space, noise levels or the motions of a moving vehicle, would influence the passenger's experience as he or she interacts with a mobile application.

Social context

All humans apart from the user that are somehow related to the experience (either physically, like sharing the same space, or psychologically, like having emotional attachment), constitute the social environment. Forlizzi & Battarbee (2004) indicate that social context has an influence on the user's experience. Roto (2006, page 55)

explains social context as “the expectations other people have for the user in the current context, or the willingness of the user to participate in a social situation, such as sharing browsing results with a friend.”

Temporal context

Roto (2006) defines temporal context as “the time period that the user is able to dedicate for the system given the context restrictions, e.g. finding out which bus to take before missing it.” She specifies that in case of multitasking, the time allocated to a product is divided into many parts. For example, the activity of browsing the web on a mobile device would be split into three, beginning as one waits for the bus, continuing while sitting or standing in the bus, and finishing later at home (page 55). ”

All time related factors that influence the user-product interaction, such as date, duration or the limited time allowed for the performance of a task, constitute the temporal context of the experience.

Technical and information context

Relevant specifically for mobile apps, the technical and information context defines the situations where technical features of digital products and the information transferred from network to digital products effect a user’s experience (Roto et al., 2010). For example, the speed of the internet connectivity can affect the user’s experience of certain mobile apps.

As indicated by the arrows of Figure 2.3, there is a two-way relationship between all three components of UX explained above, the user, the product and context, and the user experience is shaped through this interaction. For example, the aesthetic quality of a product could trigger a positive emotion in the user as well as have a positive impact on his social context, which in turn may make him feel more satisfied with the product as well as more motivated to use it in that specific context.

User experience studies investigate the user, the product and how they interact with each other in a certain context, providing valuable information to designers for the development of more user-friendly products. However, UX studies alone may not always be sufficient in ensuring the efficiency of a design, especially when a new technology is offered to the user. Whether users accept to use this new technology to begin with or not, and whether they continue to use it after their first interaction are significant issues in the creation of user-friendly products and why studies related to technology acceptance has gained significance.

3.2. Technology Acceptance

Lai and Mahapatra (1997) define the term information technology (IT) in a broad sense as "technologies dedicated to information storage, processing and communication." Information technology has become an important part of people's lives, and its significance is ever increasing: as computers and smart devices are becoming ubiquitous, humans interact more and more with products that promise to fulfil their needs through IT.

The growing use and influence of IT has made it crucial to consider its relationship with users, such as how they adapt to it or how they maintain it (Shaikh & Karjaluoto, 2015; Taiwo & Downe, 2013). Since information technologies are mostly used in new products, their intended users may not accept to use the technology in question, may find it too complicated or incompatibility with their needs, values or beliefs, even if the product has an innovative design and offers a valuable service. For that reason, investigating and determining which criteria affect technology acceptance is important in developing more efficient products for the user.

Many theories have been proposed to define the factors that affect user's decision on continued use of a technological product (Abu-Dalbouh, 2013). Technology Acceptance Model (TAM) (Davis, 1985) based on the Theory of Reasoned Action (TRA) (Fishbein, Ajzen, 1975) is considered the core of research in this context, over which all ensuing studies are based. In TAM, *perceived ease of use* and *perceived*

usefulness are defined as the key factors that create behavioural intention (which in turn shapes the behaviour of either using or not using a product) and therefore determine the acceptance of technology (Gianina et al., 2014). Later on, TAM was developed into TAM2, which introduced in more detail the factors that affect perceived usefulness (Venkatesh & Davis, 2000) and further on into TAM3, which examined the factors that have impact on perceived ease of use (Venkatesh, 2000). Later on, Venkatesh, Morris, Davis and Davis (2003a) provided the Unified Theory of Acceptance and Use of Technology (UTAUT) to explain the determinants for intention and usage.

There are additional theories and models of human behaviour and psychology that provide valuable information about user acceptance. For example, Model of PC Utilization (MPCU) (Thompson, Higgins, & Howell, 1991) explains the concept of *complexity*, Innovation Diffusion Theory (IDT) (Rogers, 1995) offers information about *compatibility* and Social Cognitive Theory (SCT) (Bandura, 1989) informs about *self-efficacy*.

Overall, the various theories and studies in the literature appear to define the same technology acceptance factors even though they name them differently. For example, the factors that affect the performance of the product called *perceived usefulness* in TAM, is named as *job-fit* in MPCU, and *performance expectancy* in UTAUT, or the social environment factors that influence user behaviour called *subjective norms* in TAM 2 is mentioned as *social influence* in UTAUT.

However, even though the defined factors are the same, different studies classify them under different categories. For example, UTAUT collects the factors of technology acceptance under four groups, omitting the user related ones:

- performance expectancy,
- effort expectancy,
- social factor,
- facilitating conditions.

On the other hand, Ittersum et al. (2006) gather the factors under two main titles, including the social factors under the user related ones:

- user's characteristics
- technology's characteristics.

Another approach that defines social factors as a main category of technology acceptance belongs to (Özer, Töre, & Erbuğ, 2009). They, like Ittersum et al., give separated titles for user and technology related factors (placing performance expectancy and effort expectancy under the latter) but, like UTAUT, keep social factors as a separate group, alongside a fourth title:

- technological factors
- individual factors
- social factors
- contextual factors.

Özer et al., (2009) define the facilitating conditions of UTAUT as belonging to contextual factors, under which they also expansively explain two other factors never mentioned by UTAUT: compatibility and voluntariness.

The user acceptance factors stated in the above-mentioned studies are explained in the next section under three main groups, following the classification given in the previous chapter for the User Experience factors in order to better underline their similarities and differences: the user, the technology (taking the place of the product) and the context. The social factors treated as a separate group both by UTAUT (Venkatesh, Morris, Davis, & Davis, 2003) and Özer et al. (2009), are treated as part of the contextual factors since they are associated with the social environment of users, in other words, their social context.

3.2.1. The User

Two main features are crucial to the users' acceptance of technology: their demographic and personal traits (Ittersum et al., 2006; Venkatesh et al., 2003). The demographic features can be defined as the quantifiable characteristics, such as the age, the gender, the height or the monthly income of a user. These features may have impact on technology acceptance, as in the case of an older user finding the use of Information Technology more difficult than a young one (Venkatesh, Thong, & Xu, 2012a) or an illiterate young user having problem adapting to a technology dependent on written information.

Personal traits of the user, as described by different studies from the literature, are: attitude, self-efficacy, emotion, motivation, trust and privacy concerns, .

Attitude

The theory of planned behaviour (TPB) suggests that behaviours are generated by intentions that are created prominently by attitudes (Ajzen,1985).

Ajzen (2005) defined attitude as "a disposition to respond favourably or unfavourably to an object, person, institution or event" (page 3). Whether or not a certain behaviour is performed or adopted depends on the user's attitude towards that behaviour: if the attitude is positive then the user's intention will be towards behaving as such, whereas if the attitude is negative, the user' intention will be to stop behaving that way. Therefore, if users' attitudes are favourable towards new technologies, they are more likely to try them out and keep using them.

An additional factor related to attitude is *Volunteriness of use,* defined by Moore & Benbasat (1991, page 195) as "the degree to which use of the innovation is perceived as being voluntary, or of free will". *Volunteriness of use* is a factor that creates The voluntary use of a technology increases its acceptance by positively affecting user's intention, which in turn influences attitude (Venkatesh & Davis, 2000).

Self-efficacy

Self-efficacy is defined as "the belief in one's own ability to successfully accomplish something" (DeVellis,1983, p. 15) and may lead the user to display certain behaviour (Bandura, 1989). If the users are not self-efficient with a certain technology, that is, if they do not believe they will be component on their own with it, they may decide it is too difficult to use or not want to try it out at all (Venkatesh, 2000).

Emotion

Emotion is one of the most prominent factors of technology acceptance and is mostly mentioned in the literature in the context of *anxiety* or *computer anxiety* (Venkatesh, 2000). Anxiety has a negative influence on acceptance since it makes it more difficult to use a new technology, as it may cause the user to fail while performing a task. It also has a negative effect on self-efficacy (DeVellis, 1983; Nijman, 2014; Venkatesh et al., 2003a).

Motivation

Motivation, as a user characteristic, is comprised of two parts: intrinsic and extrinsic motivation (Vroom, 1964). Intrinsic motivation is related to the willing use of technology, without any outside force and is mostly associated with *perceived fun* and *enjoyment.* For example, *computer playfulness* is a motivator that effects how users interact with a computer. As for extrinsic motivation, it is generally related to job performance, that is how well as certain task is performed using the technology. Incentives that help improve job performance such as pay or promotion are extrinsic motivators that encourage users to continue their performance (e.g. using a certain information technology) (Venkatesh, 2000).

Trust and Privacy Concerns

Trust and Privacy Concerns of the user have a considerable influence on whether he or she will risk using the technology or not. Indeed, *risk* and *insecurity* are the prominent issues in this context (Ittersum et al., 2006). Online money transactions are

a good example to illustrate how trust and privacy concerns can influence the technology acceptance of users who are asked to provide personal information such as their credit card number through a website or mobile app.

3.2.2. The Technology

When the user's acceptance of a certain technology is considered, how well this technology performs while doing a task and how easy it is to use are directly related to how the user perceives these two (Davis, 1985; Venkatesh et al., 2003). Therefore, the technological factor of acceptance was defined by Davis (1985) as *perceived usefulness* and *perceived ease of use*. Besides these two, perceived compatibility was also indicated as having an effect on technology acceptance (Ittersum et al 2006).

Perceived Usefulness

Perceived usefulness is defined as "the user's subjective probability that using a specific application system will increase his or her job performance within an organizational context" (Davis, 1989, page 320). This subjective judgement of usefulness is influenced by two factors of its own:

- *Job relevance* stands for how well the goal of an individual matches with the results of using a technology (Venkatesh, Viswanath; Davis, 2000).
  Output quality, directly proportional to *job relevance*, indicate how satisfactory the results of using the technology is (Venkatesh, Viswanath; Davis, 2000) (page 199).

Perceived Ease of Use

Davis (1989) defined "perceived ease of use' as "the degree to which the user expects the target system to be free of effort." (page 320). According to Venkatesh (2000), the perceived ease of use of technology is influenced by user characteristics explained in 3.2.1. For example, if an individual has self-efficacy, her or she finds the technology much easier to use (Ittersum et al., 2006). On the other hand, if someone is anxious

about using a certain technology, there is a higher probability of finding it hard to use (Venkatesh, 2000). Finally, if user motivation is higher, for example if there is an element of fun or enjoyment in using the technology, it will again be perceived as easier to use (Venkatesh, 2000).

Complexity, defined as a factor of technology acceptance (Thompson et. all., 1991), is related to difficulty of using a system. Rogers and Shoemaker (1971) defined complexity that "the degree to which an innovation is perceived as relatively difficult to understand and use" (p. 154).

3.2.3. The Context

Besides the user and technology, context has an impact on technology acceptance in terms of both physical context, such as facilitating conditions, and social context, such as subjective norm or image.

Facilitating conditions are relevant to the technical infrastructure that supports the technology (Thompson et al., 1991) and, from a user's perspective, means having the resources or knowledge to properly use the technology. For example, getting satisfactory support and advice from a technical team when needed, such as when a smart device with valuable information crushes in the middle of a task, would count as a facilitating condition of the technological context and would increase the acceptance of the technology in question. Existence of such facilitating conditions would also positively affect the *ease of use* factor for the acceptance of the technology (Venkatesh et al., 2003).

Subjective norm (Venkatesh & Davis, 2000), or *social influence* (Thompson et al., 1991; Venkatesh, Thong, & Xu, 2012) refers to "person's perception that most people who are important to him think he should or should not perform the behaviour in question*"* (Fishbein and Ajzen 1975, p. 302). For example, a friend's or revered acquaintance's positive thoughts and experiences about a certain technology will also increase the perceived usefulness of the technology for a prospective user (Ittersum et al., 2006).

Image refers to the idea that users decide on displaying a behaviour depending on the importance they attach to their social environment and how their behaviour will affect it (or will be perceived by others in it) (Venkatesh & Davis, 2000; Ittersum et al 2006). The concept of *image* is related to the social standing of users: the technology that users have and use contributes to their social status positively (or negatively) in their social environment (Rogers, 1995). Therefore, image may easily affect the acceptance of a certain technology depending on how conscious and attentive an individual is to his or her image in society. For example, a person uses a certain system in work and this system can affect the person's status positively (Venkatesh & Davis, 2000). *Subjective norms* (or *social influence*) and *image* affect technology acceptance not only as factors of social context (Ittersum et al., 2006; Venkatesh, 2000; Venkatesh et al., 2012a), but as factors of perceived usefulness as well.

Perceived compatibility is defined as "the degree to which an innovation is perceived as being consistent with the existing values, needs, and past experiences of potential adopters" (Moore & Benbasat, 1991, page 195). It affects the technology acceptance of a product, since the user is more likely to reject it if it does not meet his/her needs.

Perceived compatibility acts as a contextual factor, because, in addition to the user's need, the technology needs to be compatible with the user's cultural values as well. In some cases, cultural values are ignored in the process of developing an innovative product, which causes the adaptation rate of the innovation to be much lower than what it could have been. Rogers (1995) gives the following example for incompatibility: "..the use of contraception in countries where religious beliefs discourage use of birth-control techniques.."

CHAPTER 4

THE CASE STUDY: ASSESSMENT OF MOBILE PIS FOR ANKARA

This chapter introduces local approach to urban transportation and the field studies conducted within the scope of this thesis, aiming to understand the success criteria of mobile PIS in order to achieve improved designs in the future.

4.1. Local Approach to Urban Transportation: Case of Ankara

To solve urban transportation problems, strategies and planning need to be developed with a local approach, taking into account the citizen's needs specific to the city they live in (State of Green, 2016; Terry Moore and Julia Pulidindi, 2011). Therefore, any investigation on urban transportation and possible solutions to its problems needs to focus sooner or later on the distinctive traits and attributes of a given place, which, within the scope of this thesis, happens to be Turkey and more specifically its capital city Ankara.

In Turkey, as stated in the Strategy and Action Plan for Information Society 2015-2018 (Turkish Republic Ministry of Development, 2014), the government has recently started to indorse 'smart transportation' through various policies on development plans or urban plans in order to provide solutions for transportation problems. The following items of the 10th Development Plan of Turkey 2014-2018 (Turkish Republic Ministry of Development, 2013) indicate the governmental aim to improve urban transportation by implementing intelligent transportation systems:

- Strengthening the integration of and consistency between different transportation systems
- Linking intercity and inner-city transportations in an efficient way

- Developing urban transportation infrastructures that would predominately support public transportation and pedestrians
- Building bicycle roads

Beside the government, private telecommunication firms, who have an important role in providing infrastructure, data and innovative business models that shape the future of smart cities, have also been conducting studies related to urban transportation in Turkey. For example, Vodafone began to shape the smart cities roadmap that determines the methods to follow and the factors to consider on the way to establishing a smart city and inform municipalities about citizen's needs and expectations (Kızıldağ, 2017). Another study, conducted by Turk Telekom, measured the traffic density of a pilot city (Karaman). The results revealed the problem of data standardization in the city management and underlined the importance of big data to implement a smart city ("Türk Telekom," n.d.).

Informatics Foundation of Turkey (Türkiye Bilişim Vakfı) also prepared a *Smart City Roadmap,* the most extensive report to date on rendering cities in Turkey more intelligent, with the participation of 25 metropolitan municipalities (Türkiye Bilişim Vakfı, 2016). Pertaining to transportation, energy and water, the report exhibits the current situation of Turkish cities in order to act as a pathfinder in developing strategies and creating smart cites. The main findings of the study about the current situation are as follows:

- Up to now, smart city implementations were made mostly in the area of transportation.
- The first aim of municipalities that conduct smart city implementations is "to make citizens' life easier".
- Mobile applications and social media are the technological tools most frequently used by municipalities in smart city implementations.
- There is a directly proportional and strong relationship between Geographic Information System (GIS) and the success of smart city projects.

- %90 of municipalities think it would be beneficial to use data collected in the city.
- The most visible intelligent implementations for transportation are the traffic monitoring system (that screens urban traffic flows with cameras), electronic ticketing system (that reads the tickets from a card or passenger's smartphones), and smart stops (that display on an electronic screen when a public transportation will arrive at the stop).

The most common difficulties that emerge in smart city applications are:

- Financing problems
- Difficulties in cooperating with different institutions
- Insufficient GIS infrastructure
- Lack of expertise in information and communication technologies
- Citizen's degree of involvement in the process

In order to establish an efficient smart transportation system, these difficulties determined by the Informatics Foundation of Turkey needs to be overcome, and the most crucial one that needs to be addressed is the final one: the citizens should be involved in smart city projects because they are not only the users of smart cities, which are developed precisely to make their lives easier as stated above, but also the data providers that drive the smart cities (Türkiye Bilişim Vakfı, 2016). To create successful smart cities, smart transportation projects should be user-centred, as stated both in the report of Turkey Foundation for Science and the 10th Development Plan of Turkey, which will be addressed in more detail in Chapter 3.

There are also non-governmental organizations (NGO) that conduct studies related to smart cities. One of them is the Public Technology Platform established in 2013 whose general purpose is to help promote the integration of technology and public enterprises. One of its main fields of activity is contributing to smart city studies by sharing with the public the reports and other contents related to smart cities (Kamu

Teknolojileri, 2016). In 2016, Public Technology Platform started a smart city project, using Ankara as its pilot city since the capital has recently seen the highest population increase in Turkey, according to the Turkish Statistical Institute (TUIK), reaching 5.503.985 people in 2018 and is expected to reach even larger population numbers in the near future, facing chaotic situations that would equal İstanbul, the largest and most crowded city in Turkey. The president of the Public Technology Platform states that, although municipalities are making some changes in the city, these appear inadequate for the problems ahead. The city needs to take precautions right now, which this new smart city project may be useful for (Coşkun & Parlak, 2016). Due to this significant situation of the city, as well as the fact that the researcher resides there, Ankara was chosen as the local place within Turkey this thesis focuses on.

4.1.1. An Overview of Ankara Public Transportation System

The public transportation system of Ankara consists of bus and minibus systems, two metro-rail lines and a suburban rail line. As database May 2016 by Ego The bus system has 200 privately operated buses and 1709 buses operated by the municipality, called the EGO buses (EGO, 2018) Minibuses, called *dolmuş* that have been functioning for over 30 years (Yetişkul & Yetişkul, 2012), carry the biggest percentage of passengers among all other public transports: over 1 million passengers daily (Table 2.2). The Ankara Rail system has 2 major rail lines: Ankaray that has just one route (between Kızılay and Aşti – the intercity bus station) and Metro that operates on three lines (M1 between Kızılay and Batıkent, M2 between Kızılay and Çayyolu, M3 between Batıkent, Sincan and Törekent). In addition, a 3.257-meter-long telpher line, with 4 stations and 106 cabins, operates between Yenimahalle and Şentepe.

Even though Ankara stands as the city with the second largest population in Turkey, it is leading in terms of private car ownership, with 315 cars per thousand citizens whereas in İstanbul and İzmir the numbers are 246 and 288 respectively (Ankara Development Agency, 2017). The high percentage of passengers who choose private

transportation, as can be seen in Table 2.2, may result in a dire future for the capital's transportation if the situation remains the same.

Table 4.1. *Daily-Carried Passenger Numbers of Ankara Public Transportation*

Type of Transportation	**Daily Carried Passenger Numbers**	**The percentage of Passenger Numbers**
EGO Bus	728.400	12
Ankaray	130.270	2,1
Metro	307.800	5,1
Suburb Train & Telpher	10.700	0,1
Minibüs & Dolmus	1.075.000	17,7
Service Vehicle	840.000	13,8
Private Public Bus	240.000	3,9
Private Public Transportation	74.000	1,2
County Private Public Transportation	30.000	0,5
TOTAL OF PASSENGERS FOR PUBLIC TRANSPORTATION	**3.436.170**	**56,5**
Taxi	370.000	6,1
Car	2.280.065	37,5
TOTAL OF PASSENGERS FOR PRIVATE TRANSPORTATION	**2.650.065**	**43,5**
TOTAL OF ALL PASSENGERS	**6.086.235**	**100**

4.1.2. ITS and PIS in Ankara

The main ITS applications in Ankara consist of loop detectors and signalling detectors. Loop detectors, functioning at 50 different junctions, monitors the traffic flow to determine the duration each red light, therefore preventing the unnecessary cutting of traffic. On the one hand, it helps save fuel and time, while on the other hand, it decreases long-term waiting time in traffic for passengers and drivers. The signalling

detectors at intersections control whether or not the traffic lights function properly and informs the Traffic Control Centre so that it may intervene in the event of any failure in signalling ("Akıllı Ulaşımın Başkenti," 2018).

Ankara also has different types of PIS applications that provide transportation or traffic information to passengers. There is an information system within the EGO buses that provides audio and visual information to passengers through smart screens, such as the route of the bus and its future stops. At metro stops, information on how many minutes are left until the next train is provided with screens as well (Ankara Büyükşehir Belediyesi, 2018). The *ABB Trafik*, both a web page and a mobile app, is a PIS service provided by the municipality where users can instantly monitor the flow of traffic on the capital's roads. Many information from road closures to traffic density is transferred to followers instantly (EGO, 2018).

Besides the above-mentioned passenger information systems, there are three mobile PIS apps available specifically for the public transportation of Ankara: TRAFI, MOOVIT and EGO CEP'TE.

TRAFI

TRAFI is a mobile PIS that is being used in eight different countries, and it supports four cities in Turkey: İstanbul, Ankara, İzmir and Bursa. It offers the option of making travel plans depending on travel time and fee. It also visualises travel information: through a map, users can see the nearest stops, reach information about bus and metro& Ankaray lines (for the case of Ankara), save their favourite stops or locations and indicate their work and home location. Users can report an issue through the app by choosing any of the titles on the app such as *route issue* or stop is missing. Finally, the app has an online communication platform called 'live updates' through which users may give feedback or leave comments, such as a recent car accident or road closed to traffic.

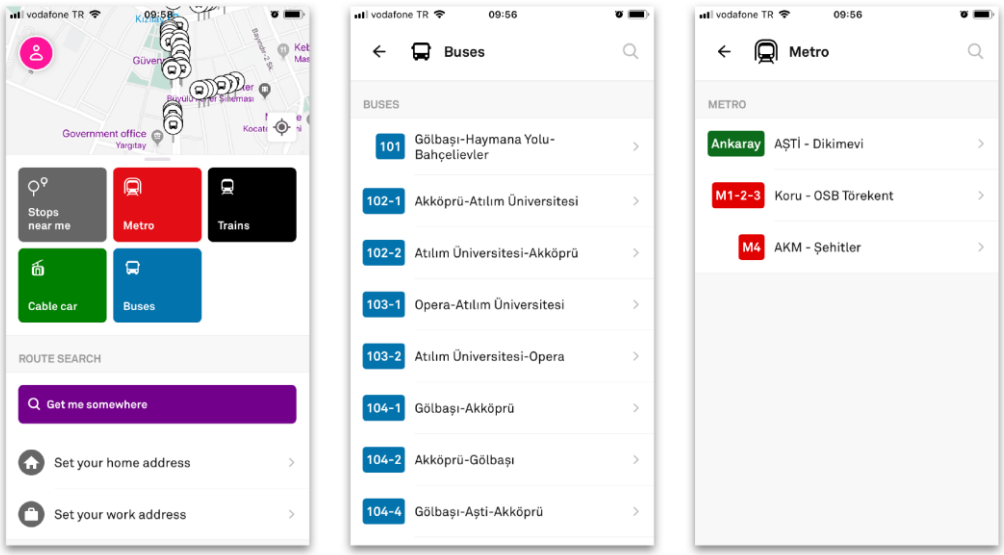

Figure 4.1. *Screenshots from Trafi Interface displaying the home page, bus and metro information*

Table 4.2. *Features explanation of TRAFI App*

FEATURES	EXPLANATIONS
Stops near me	Provides information about stops in the nearest location
Metro	Gives metro line information with a map and frequency of departure time (e.g. every 5 minutes) according to weekdays and weekends
Trains	Gives train line information with trains departure time for every line
Cable car	Gives cable car line information with a map frequency of departure time
Buses	Provides bus line information with a map and departure time according to weekdays and weekends
Get me somewhere	Provides travel plan (information of how to go somewhere)

Set your home address	Enables users to set their home address, therefore they can choose their home address without writing while making a travel plan from their homes to somewhere or somewhere to their homes.
Set your work address	Enables users to set their work address, therefore they can choose their work address without writing while making a travel plan from their works to somewhere or somewhere to their works.
Live updates	Provides information about updates such as line changes and also enables users to make comments.
My favourites	Allows users to add their favourite routes and stops, therefore they can see quickly view the next departure times
Settings	Lets users set some adjustments such as selecting country/city and language; moreover, allows users to set notifications settings for example turn on/off comments
Help	Provides report an issue

MOOVIT

The MOOVIT app that covers 2.200 cities over the world, includes 15 cities from Turkey. The app is an open source service that aims to gather transportation information from the citizen themselves. Like TRAFI, it offers information on the railway system (Metro and Ankaray) and buses for Ankara, for the users to make their travel plans. The *alert* section of the app conveys notifications provided by EGO head office. The app also gives information about transportation fees: smart card fee for single bus/metro pass, cable car fee and single-use card fee for bus/metro pass. Moreover, MOOVIT attempts to raise the awareness and interest of its user through gamification: users gather point by the app as well as by taking a public transportation.

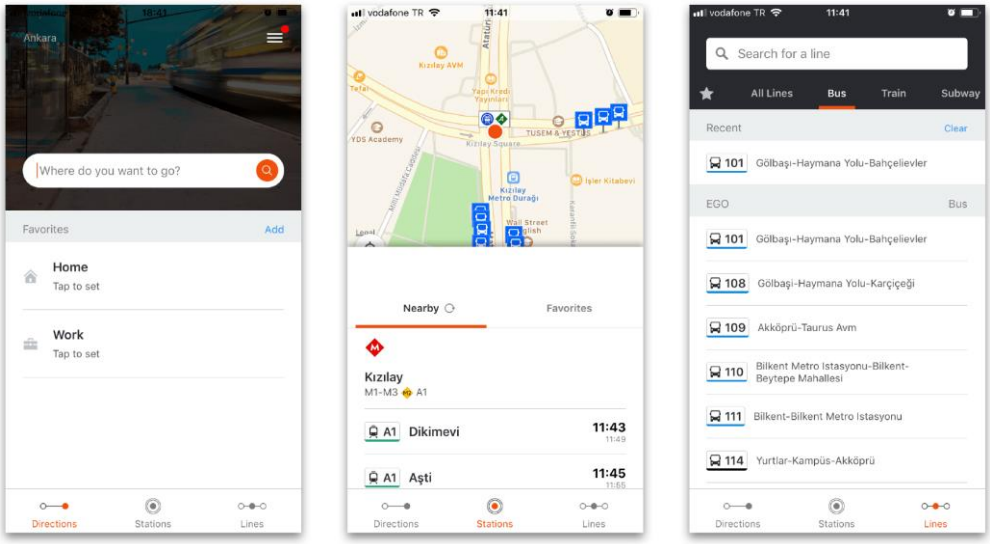

Figure 4.2. Screenshots from Moovit Interface displaying the home page, stations page and line page

Table 4.3. *Features explanation of MOOVIT App*

FEATURES	EXPLANATIONS
Where do you want to go?	Offers travel plan to users
Favorites	Enables users to set a home and work address in order to reach and see travel information quickly
Recent trips	Provides information about travel plan that the user has done before into the app
Stations	Offers bus and metro and Ankaray stations location through a map
Lines	Provides information about bus, metro, Ankaray, train and cable car lines
Notification center	Gives notifications related to Moovit app

Agency alerts	Conveys notifications provided by EGO head office
Offline maps	Offers rail and cable car line map
Settings	Allows users to change the country & city and to set route and transit types to make travel plan
Fee	Gives information about transportation fees
Help center	Enables users to submit a request

EGO CEP'TE

While TRAFI and MOOVIT service many cities worldwide, EGO CEP'TE is solely dedicated to Ankara. It was created by the Public Transit Authority of the Greater Municipality of Ankara in 2011. It was awarded "the most promising e-government award" by WeGo e-Goverments Organization in 2014 (EGO, 2015).

EGO CEP'TE has both desktop and mobile application. In its early stages, passengers could get only get information about the arrival time of a bus to a specific stop by entering the stop number. However, it has now developed to offer more extended services and includes many new features (Table 2.5).

As TRAFI and MOOVIT do, EGO CEP'TE provides information about buses, metro and Ankaray for the capital. However, unlike two other apps, EGO CEP'TE has a more local approach, providing services specific to Ankara, like the *Important Places* feature that gives information on notable places, grouped under categories such as library or hospital, or the *Ankarakart* feature, through which user may check the balance or their card and upload credit.

Moreover, EGO CEP'TE has more advanced settings than the two other apps, such as choosing how frequently data on bus locations are update.

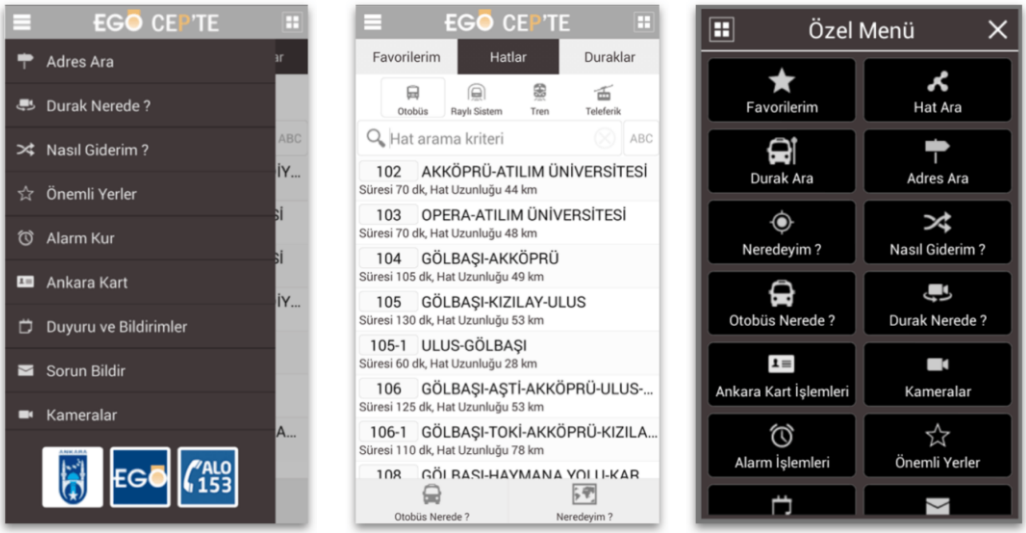

Figure 4.3. Screenshots from EgoCep'te Interface displaying home page, the lines page and special menu

(Figure 2.10 belongs to EGO CEP'TE Android interface for Android smartphone that was are used by the participants of the field studies explained in Chapter 4).

Table 4.4. *Features explanation of EGO CEP'TE App*

FEATURES	EXPLANATION
Where is the bus?	Offers information about the location of the bus at the instant of inquiry and the arrival time of the bus to the stop (by entering the number of the stop). It also includes technical information related to bus such as licence plate, brand of the bus, occupancy rate, speed, (instant) location of the bus.
Search line	Provides information about a specific bus line such as length of the line, total travel time on line from beginning to end, the buses that operate on the line, stops on the route, departure time of buses and technical information about the buses.
Search stop	Provides information about the bus line passing through a given stop (by entering the name or number of the stop).
Search address	Provides the location on a map of an entered address/neighbourhood/county/street as well as the nearby.
Where is the stop?	It locates the passenger's position with GPS and shows the nearest stops by opening camera on the phone. Provides the location (and the live view) of the nearest bus stop after checking passenger position through GPS.

How to go?	Helps plan the journey to a specific location. The travel plan can be structured according to passengers' choices: it may include a transfer or not, take into consideration walking distance or travel duration.
Favourites	Offers easy access to the frequently used information. Passengers can create favourite stops and lines with this feature.
Ankarakart	Provides information about the remaining balance on AnkaraKart, the smart card for public transportation in Ankara, servicing buses, metro and Ankaray. Moreover, the users can upload credit to their smart card.
Cameras	Provides camera feeds from different locations in the city, to check traffic flow and congestions.
Set up alarm	Customizable alarm that notifies user when a specified bus/rail/cable car nears a specified stop.
Important places	Provides a list of notable locations in Ankara, grouped under categories such as shops, restaurants, hospitals, etc.
Notifications	Provides notifications on transportation related issues such as change of any line.
Report a problem	Passengers can report a problem related to transportation or the app, with the condition of providing their user information (profile and phone number).
Settings	Provides customization of basic app setting. Users can enter their personal information (e.g. name&surname), choose map display type or update frequency of bus locations.
Transportation map	Non-interactive map of Ankara's rail systems.
Help	Provides brief explanations of some app features of the app through 10 basic steps.
Where am I?	Locates user position through GPS and shows the nearest bus stops on the map. Users can access the 'where is the bus?' feature by clicking one of the stops shown on the map and reach information about the bus line that goes through this stop.
My panel	Provides easy access to information on frequently used destinations. Different from Favourites, My Panel has both line and stop information. Users can get real-time information about destinations such as their home or work. Moreover, they can get arrival time notification if they set an alarm.

At the time the case study (2014) was being conducted, Moovit and Trafi were very new in Ankara and just beginning to collect information from their users, as their infrastructure requires. Therefore, neither had formed enough of a database to be considered as a substantial PIS for Ankara, as their substantially inferior download rate was proof of Google Store (2014).

4.1.3. New Mobility in Ankara

The available shared systems in Ankara are limited: even though there is no peer to peer car sharing system, there are some fleet-based car sharing companies such as aracla.com. The only company that offers ride-sharing is BlaBlaCar. However, people mostly use it to make intercity journeys. For example, as stated in the BlaBlaCar app, the most popular journey for Ankara citizens is between Ankara and İstanbul. Another type of ridesharing that is encountered in Ankara is hitchhiking, preferred mainly by students in university campuses (e.g. METU or Hacettepe University). Ankara has no bike-sharing system.

As a part of shared system, social media is used in limited format by the municipalities. For example, Ego Head Office use social media (Twitter and Facebook) to announce news about updates and developments for public transportation to citizens.

In terms of interconnectivity, the major service provided to Ankara's citizens is a contactless card, called Ankarakart, with which people can pay their transportation fees, by showing it to a card reading device within the public vehicle or when entering the station. Apart from that ticketing solution, Ankara's interconnectivity may be considered a bit backward: There are some bus and metro connectivity but these connections are not common in Ankara. Moreover, there is almost no collaboration for interconnectivity among the different governing bodies or institutions. For example, contrary to most capital cities, there is no rail-air transportation collaboration in the city.

4.2. Aim and Methodology of the Conducted Studies

As indicated in Chapter 3, the success of mobile PIS in urban transportation is closely related to the experiences of the passengers that interact with it. Therefore, the assessment of mobile PIS requires an investigation of the factors that affect the interactive experience, such as the expectations and emotions of the user, the efficiency and aesthetic quality of the mobile PIS, and the physical or social context of use. However, as mentioned in the literature review, the user experience alone is often not enough to ensure the success of a technological product, since user may still reject to use it. For that reason, the assessment of mobile PIS also requires the investigation of the factors that affect the acceptance of technology, such as how confident the users are in their ability to use the product by themselves, how trustworthy they find it or how useful they perceive it to be. The assessment of the user experience and technology acceptance factors of a mobile PIS will help surmise if the passengers would keep using it, reap its benefit and consequently, allow it to act as a solution to at least some urban transportation problems.

Furthermore, since mobile PIS are considered today as part of the developing new mobility concept, the evaluation of their success also needs to be made within that context, taking into consideration things like their connectivity to other urban systems and social media, or the versatility of the services they provide such as sharing and mobile ticketing.

As a result of this conjuncture, four exploratory studies were conducted to assess the EGO CEP'TE app, the chosen mobile PIS that serves Ankara's urban transportation passengers. The majority of the conducted studies were qualitative, except for the third study where a scale for technology acceptance was used to retrieve certain quantitative data.

The first study that focused mainly on the user and product related UX factors was carried on with three groups of users who were differentiated by their level of familiarity with the app. The purpose of choosing different types of users was to better

see how their expectations and perceptions differ, as well as assess the learnability and memorability of the app. Participants were first interviewed about their traveling habits and opinions on mobile PIS, and then their behaviours were observed while using the EGO CEP'TE app.

The second study, on the other hand, was conducted only with participants who are already familiar with the app and use it frequently so that their interaction with the app may be analyzed without the temporal and behavioural constraints caused by a first-time user's needs to get acquainted with the interface first. The aim of this study was to investigate more thoroughly the UX factors, including those not dwelled on in the first study. After an initial interview like in the first study, participants were expected to use the app frequently during a determined period of time, in order to gather different information such as the errors or difficulties encountered, the most and least commonly used features, and the underlying reasons for these behaviours.

The third study was conducted to assess the technology acceptance level of the EGO CEP'TE app. The same participants as in the second study were asked to fill a Likert scale questionnaire adopted for that purpose from an existing scale.

Finally, the fourth study was conducted to specifically investigate the state of the EGO CEP'TE app in terms of the new mobility concept. Both users (participants of the second and third study) and city planners with expertise in urban transportation were interviewed about the mobile PIS' standing regarding data, shared systems and interconnectivity, through discussion of issues such as mobile ticketing and use of social media for public transportation.

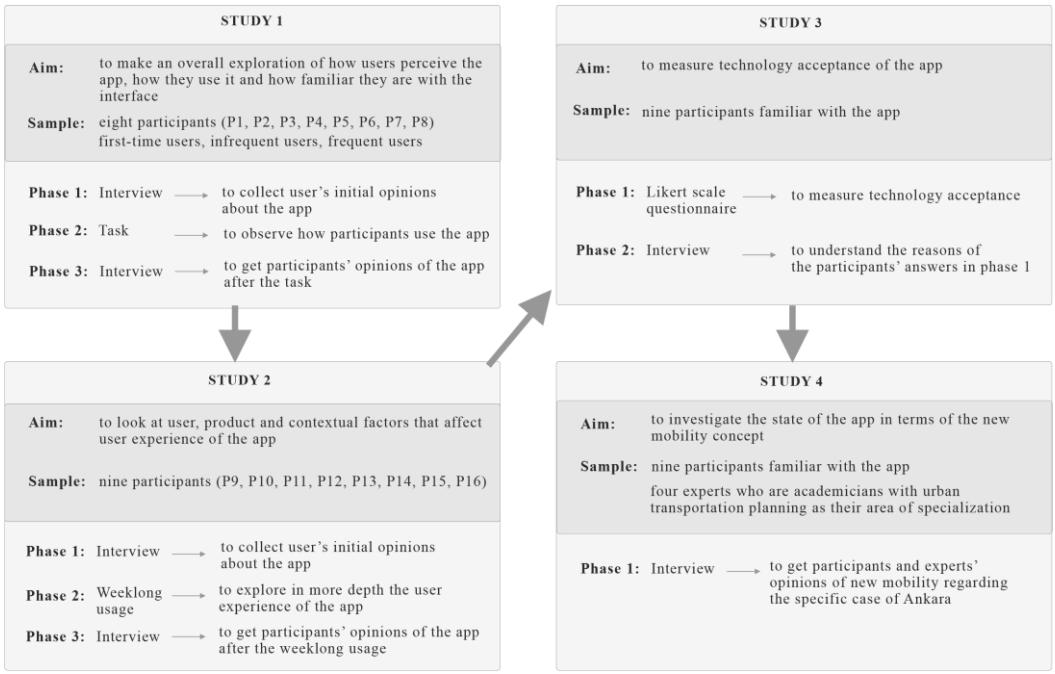

Figure 4.4. Overview of the Methodology of the Studies

4.2.1. Design of the First Study

The aim of this study was to get a first glance on how users perceive the app, how they use it, and how much familiarity with the interface and functions affects users' interaction with the app. The study was conducted with eight participants among which three were frequent users of the app, two had used the app at least once before but rarely used it in their daily lives, and three had never used the app before.

There were two main criteria for the selection of the participants: that they own and use an Android smartphone and that they use public transportation frequently. Since the aim was to investigate the user experience factors of a mobile PIS, it was imperative for the study to be conducted using the EGO CEP'TE app that can be downloaded to smartphones, even though the application can also be reached through a website. Since the latest updating of the EGO CEP'TE is available only for Android users, the participants were expected to own and use an Android smartphone to ensure

their familiarity with this technology and to eliminate as much as possible any difficulties that may arise from the use of the device rather than the app in question. Furthermore, since the study aimed to investigate an application that promises to deliver information about the public transportation of Ankara, the participants needed to be familiar with the available transportation options in the city and with the way they function. Even though two of the participants owned a car and were not using public transportation at the time of the study, they were still accepted as participants since they've been using public transportation until quite recently.

The participants' ages varied from 24 to 29 and they were mostly students. Participants were selected from this relatively younger age group because, as Ceobanu & Boncu (2014) indicate, youths and young adults adapt easily to new technologies and are very competent with smart and mobile technologies. Another reason for choosing this age group was that they rely mostly on public transportation to conduct their daily lives.

The study was composed of three phases. The first phase consisted of asking interview questions to get the demographic information of participants, their initial expectations of a mobile PIS and overall perceptions of the app. The second phase comprised the fulfilling of a task to observe how participants actually use the app and gather information on its usability, such as how effective, efficient, memorable and easy to learn it is. Third phase gathered the participants' opinions about the app after the task.

4.2.1.1. The First Phase

The initial phase of the study focused mainly on investigating the users themselves in relation to the app's UX, such as their expectations and perceptions of the app or their motivations for using it. The conducted interview started by gathering information about the participants, such as their age, job, and their daily habits in using public transportation (Appendix A). Then, participants were asked their general opinions about the public transportation in Ankara, to use as a touchstone when evaluating their perception of the app in relation to their perception of the public transportation in the city.

The participants were then asked about their familiarity with the EGO CEP'TE app. The users who knew about the app were asked to give their overall opinion on it. They were asked to list the features of the app that they can remember, indicate which of these they use the most and then to demonstrate how they use them on the app itself.

Non-users were requested to download the app on their smartphones. The participants were then asked to have a look at the app and play around with it a little. In the meantime, their behaviours were observed such as which buttons they first clicked and which features they did or did not notice.

4.2.1.2. The Second Phase

The main aim of the second phase was to observe how participants use the app, to have a better understanding of its effectiveness, efficiency, learnability and memorability in terms of user experience, as well as the encountered errors.

All participants were asked to perform a simple task: finding out how to go to a specific place in Ankara. The researcher determined beforehand a couple of possible locations with the likelihood of never being visited by the participants using public transportation. After conversing with the participants, one of these locations was chosen as the target of the task at hand. Participants' actions were observed during the task performance to see:

- Which menu did they open first on the interface?
- Which features were clicked first?
- In what order they used the features of the app?
- Which features of the app did they use throughout the task?
- How much time did they spend to complete the task?

4.2.1.3. The Third Phase

The main goal of this phase was to get the participants' opinions of the app after the task. For the first time users, the researcher mainly focused on their initial and overall impressions of the app, for the infrequent users, the emphasis was on how much they

remembered the app, and for the frequent users, opinions on specific app feature were noted. Overall, the positive and negative opinions of all participants were gathered.

4.2.2. Design of the Second Study

The aim of the second study was to explore in more depth the user experience of the EGO CEP'TE app, once again looking at user and product related factors, but investigating the contextual factors as well, such as the physical and technical context of use. The selection criteria for the participants was the same as in the first study (that they own and use an Android smartphone and that they use public transportation frequently). However, while in the first study, three different user groups were selected, in the second study all participants were familiar with and frequent users of the app. Their ages varied from 19 to 31 and they were accustomed to using digital technology. Moreover, they were required to use Whats Up, a free online messaging application, to send daily reports to the researcher. Whats Up was chosen as the communication medium since it is one of the most popular messaging tools freely available for mobile devices (Statista, 2018b).

The second study, like the first, was structured in three phases: pre-interviews, usage and post-interviews.

4.2.2.1. The First Phase (Pre-interview)

Since the participants of the second study were different from those of the first study, the first phase of the second study also consisted of gathering demographic information about participants, asking their general opinions, expectations and perceptions regarding the app, as well as their transportation related habits in Ankara.

The participants' level of familiarity with EGO CEP'TE and their frequency of use was investigated, to ensure a that they are similarly acquainted with the app.

4.2.2.2. The Second Phase (Weeklong usage)

In the second phase of the study, participants were expected to use EGO CEP'TE for seven days. Thus, data on their everyday life interactions with the app could be

collected without being in a controlled interview environment. They were sent a short questionnaire via Whats Up at the end of each day, for a week (Appendix B). The questions of the questionnaire were:

**Which features did you use today?*

**What was the level of difficulty in using these features? Please give a number between 1 to 5 (1 very easy, 5 very difficult).*

**When did you use the app? (for example: before leaving the station or at the station)*

As the study progressed, participants' attentions were called on to different feature of the app that remained unused. The aim of these prompts was to see whether the user habits were caused by unawareness or misunderstanding of app features or whether they developed due to a problem pertaining to these features or the app in general.

4.2.2.3. The Third Phase (Post interview)

The main goal of this phase was to get in-depth information from the participants about their experience with the app after the weeklong usage. The positive and negative opinions about the app as well as the various problems and difficulties faced were inquired through individual interviews. During the interview, the participants were asked to clarify and explain the answers they gave to the daily questions of the second phase. The interviewer went over every answered question to obtain more detailed information on the experience of the user throughout the week and to better understand why certain features were not used, why certain features were deemed too complex or difficult, why other features were found satisfactory or were perceived positively, etc.

4.2.3. Design of the Third Study

The aim of the third study was to measure the technology acceptance of EGO CEP'TE users that have participated in the second study. The participants were asked to fill out a Likert scale questionnaire for that purpose (Appendix C). The questionnaire, with 33 items that correspond to the ten factors of T.A.M, was adapted from the study

conducted on teachers' information technology acceptance by Ursavaş, Şahin & McIlroy (2014). They have checked the validity of the Turkish version they used through translation and back-translation procedures with four scholars who had MSc and PhD degrees from British and American universities.

To conclude the third study, participants were asked to voice the reasons behind their answers.

4.2.4. Design of the Fourth Study

The main aim of the fourth study was to investigate the state of EGO CEP'TE in terms of the new mobility concept. Since new mobility is part of urban transportation planning, experts' opinions were deemed necessary to better asses the app from a city planning perspective. On the other hand, participants' opinions were equally important, because human-centred approach has an important role in new mobility services as well. Therefore, both the participants and city planners, whose study area is urban transportation, were interviewed for the fourth study.

Nine participants who attended both the second and third study were interviewed on the topic of new mobility, such as their opinions related to mobile ticketing, their experience with Ankarakart, etc.

Four experts were interviewed to get their opinions of new mobility regarding the specific case of Ankara. All experts were academicians with urban transportation planning as their area of specialization. One of them had worked at the development of the EGO CEP'TE web site. They were asked semi-structured questions such as what can be done to develop more efficient interconnected transportation in the city, how to get public transportation-related information in the city and what are their opinions related mobile ticketing.

4.2.5. Data Collection Tools and Methods

In all four studies, the interviews were recorded with the voice recorder feature of a Samsung S4 smartphone, while the task performances of the first study were recorded with a video camera (Canon 60D). Overall, approximately 7 hours of voice and 75 minutes of video recording was obtained.

The daily questionnaires in the second phase of the second study were conducted with Survey Monkey, a free online survey interview service. The links to the questionnaires prepared in Survey Monkey were sent via Whats Up every day during the week, at 9 p.m. Moreover, a reminder text was sent every day during the week, at 10 p.m. via Whats Up to the participants in order to remember fulfilling the interviews.

CHAPTER 5

THE RESULTS AND ANALYSIS OF THE FIELD STUDIES

As articulated in detail in Chapter 4, four studies were conducted within the scope of the thesis. The respective aims of these four studies were to roughly sketch out users' experience of the app, to understand how users interacted with the app, to determine how effective the technology acceptance on the app was and finally to understand the app's standing in terms of new mobility.

5.1. Findings of the First Study

Since the main aim of the first study was to assess the user experience of the mobile PIS, participants' behaviours regarding public transportation and their interactions with the app was investigated.

5.1.1. Overview of the Analysis

For the interviews that took place in the first and third phases of the study, the analysis was made following the four stages of qualitative analysis, as proposed by Bryman (Gibbs, 2010). First, the answers of the participants were transcriped into a Microsoft Excel spreadsheet. Second, the important comments from the participants were underlined. Third, themes and sub-themes that encompass the meaning of these underlined texts were selected to categorize and simplify the results. Finally, the relationship between themes were investigated and interconnections were revealed.

Results of the second phase, which consisted of videos recorded as the participants were performing the given task, were analysed in three parts. First, the videos were observed in order to gather quantitative data such as how long it took to complete the task, which features were selected first and how many times they were clicked.

Second, the results were analysed with a quantitative approach similar the one described above: the participants' verbal comments, such as their positive or negative opinions about various app features, and emotional responses, such as when they expressed being annoyed, were transcribed and categorized under common themes and sub-themes. And finally, a map was created using both the quantitative and qualitative data, to relate the actions, expressed feelings and comments of participants during the task.

5.1.2. Results

5.1.2.1. Interview Results: User Behaviours and Perceptions

Participants were questioned about their habits concerning the use of public transportation and passenger oriented mobile applications.

The Users' Behaviours related the Public Transportation in Ankara

The daily transportation routines of participants generally consist of travelling between their schools or work places and homes. Out of eight participants, six use public transportation on a daily basis. They indicate that they use public transportation because they have no other alternatives since they do not own a car and find taxis very expensive. Only two participants own private cars but stated that they mostly use them in weekends, to travel out of the city centre. They prefer to use public transportation to travel within in the city, especially if they can reach their destination with a single transport, without any transfer.

The participants choice of vehicle when using public transportation is always made in favour of the shortest journey duration. Accordingly, most participants take the vehicle that arrives first to minimize their waiting time. Generally, the underground railway is the least preferred means of transport because its routes are very limited and require transfers with other vehicles to reach a final destination, which in turn extends the travel duration. Dolmuş is the second least preferred vehicle after railways because it stops frequently to pick up passengers, again extending the travel time. They mostly

prefer private bus to EGO bus since they are more numerous and the journey times are generally shorter. For instance, one participant indicated that she would need to make a transfer to reach a certain destination with EGO bus, while there is no need for transfer with private buses to reach the same destination, which reduces the travel time. Even though the participants have a tendency to minimize their waiting time by picking the first vehicle that comes, depending on their destination, they may also prefer to wait for another one, since on certain routes, a specific vehicle may be more advantageous duration wise. For example, the railway is chosen primarily for the route between Batıkent and Kızılay because buses take longer to travel and are more crowded in that region, while the dolmuş is preferred for traveling to and from Yenimahalle, since its journey time is shorter than all the other alternatives, just the way the bus is always the vehicle of choice when one needs to reach Kızılay from any location.

The crowdedness of a transportation vehicle is the second factor, after journey time, that influences participants when choosing public transportation. This is the reason why dolmuş is ranked as the second least favoured transportation since they find it to be more crowded than an EGO bus or private bus. Similarly, the second reason, after journey time, for preferring the railway between Batıkent and Kızılay is stated as lesser crowds than the buses in that region.

The participants were asked where they get the information they need about Ankara's transportation. Three out of eight participants, when going to a location never visited before, check it out from Google Maps, while two participants search the information directly from Google. However, all five pointed out that they confirm the accuracy of the information provided by Google or Google Maps by asking their family or friends. Two participants get the information from EGO's web site. They specifically indicated preferring the web site to EGO CEP'TE because of the difficulties in using the app, which will be further addressed under the next title.

Since transfer points are important part of urban transportation, the participants were asked questions related to transfer point in the city. Two participants never use any transfer points in their daily routines, while three participants use them rarely and only three participants use them frequently. When asked if they face any problems while making a transfer, three out of six participants that use transfer points mentioned the long waiting time for the buses: a minimum of 15 minutes wait that often extends to 30 minutes, which they find to be very long. One participant stated that making a transfer has become much easier of late, since they can now search the departure time of buses through the EGO web site.

Since there is a close relationship between emotion and behaviour, as was explained in Chapter 3.1.1, the participants were asked how they feel when traveling to a destination never gone before. Five out of eight participants indicated feeling anxious and uneasy because they do not know which bus to take and where to get off. Moreover, two female participants expressed that they feel uneasy because they do not feel safe, most particularly in evening hours. One participant stated that she prefers to use underground railway because she finds it safer rather than the bus or dolmuş.

Even though behaviour change is beyond the scope of this thesis, in order to evaluate the role of the mobile PIS in creating a more effective public transportation, as is stated in the research questions, the participants were asked whether the app encourages use of public transportation or not. All eight participants believe that mobile passenger information systems in general have the potential to promote the use of public transportation. However, only two participants responded positively to whether Ego Cep'te is successful in that regard. One of them expressed her own experience related to this topic:

> I believe that the app encourages use of public transportation. For example, this morning, my dad offered to take me to the school. However, I checked the real-time information of buses from the app and realised that the bus would be

> at the station in two minutes. After receiving this information, I preferred to take the bus.

Four participants expressed that they did find the app useful even though they did not consider it encouraging in terms of increasing the use public transport.

P2 stated that:

> People in Ankara will not use public transportation if they have an alternative mean of getting around, because it is crowded and limited. The app does not encourage usage of public transportation, it only makes the lives of passengers already using public transportation easier.

P5 stated that the mobile PIS would encourage public transportation if it helped solve existing transportation problems. She indicated that:

> Encouragement of public transportation is a difficult subject. Planning of public transportation has to be made comprehensively. Mobile application is just a small piece of this issue. First, transportation planning has to be made efficiently. However, if mobile PIS would be integrated to transport planning, it could then help encourage the use of the public transportation.

Two participants commented that the EGO CEP'TE app did not offer any incentive for people to use public transportation, and one of them stated that:

> There are deficiencies in the app: it does not make it easier to use public transportation, so it would not encourage its use either. On the contrary, it will dissuade people from using it.

The Users' Behaviours related to usage of the EGO CEP'TE app

After getting information about their public transportation behaviour in general, the participants who were familiar with the chosen mobile passenger information system were asked how, or for what purposes, they use it, to get an overall idea about their

behaviour towards the app in question, such as which features they use or when they use them.

Among these participants who were familiar with the app, the feature that is most commonly used is “Where is the bus”, followed in equal popularity by “Ankarakart”, “Search line” and “Stop number”.

When asked about when they actually use the app, two participants indicated checking the app before leaving their home, while two other participants check it at the station. One participant checks it both before leaving the home and at the station. Overall, they all check the app before leaving the home and/or at the station. They mostly do not use it on the bus, due to two main reasons. First, they do not need to check the app on the bus since their only need from it is to learn when the bus will arrive at the stop. It’s only when they will be transferring to another bus that they feel the need to check the app while on the bus. Second, they do not prefer to use the app when on a bus because buses are mostly very crowded and hence users cannot move comfortably.

As stated in the previous title, none of the participants use the app to discover how to get to an unknown location and only two use the EGO web site for this purpose.

P1 stated that:

> Searching from the web site, using the computer, is easier because I can reach the line and bus numbers, I could not reach through the app. The web site is simpler than the app.

P2 said:

> If possible, I prefer to use the web site rather than the app because checking from the app takes more time. The uploading time in the app is slower.

The Users' Perceptions of the EGO CEP'TE app

How the app is overall perceived by the participants who are familiar with it was sought out by asking their positive and negative opinions on the app. All participants stated that giving real-time information about buses is the most positive feature of the app. They indicated that reaching this real-time information of public transportation makes their life easier. A participant stated that "The app is useful to me as a person who frequently uses public transportation and also needs to be punctual."

As a negative feature of the app, the participants indicated that the app does not include information about private buses nor dolmuş, which "plays an important role in the public transportation system of Ankara", as stated by one of the participants. Furthermore, the app is said to sometimes give wrong real-time information on buses, as witnessed by one participant who expressed: "For example; although it indicated the wait time to be 15 minutes, the bus arrived at the station after only 2 minutes". And finally, the app was found to upload slowly.

Participants familiar with the app were asked to name the different services it contains/offers, without looking at the app. 'Ankarakart', and 'where is a bus?' were the prominent features remembered, followed by 'search for the line' and 'How to go' options. Finally, 'search for stop', 'favourites' and 'where am l' features were also remembered by the participants.

The users were mostly aware of the features of the app that are on the home page and seen at first glance. Some participants mistook the "my panel" feature as a new service that appeared with the new version when in fact it already existed in the old version, but was recently placed on the homepage.

The infrequent users (those who have used the app in the past) were also asked which features of the app they remember to use. Even though they indicated remembering the 'where is the bus' feature, the researcher observed they were having trouble using it because of the difficulty in accessing other information necessary to use the feature,

like the bus line and stop numbers. In their previous uses, they probably had memorized this information and hence did not need to find them through the app.

The first-time users were asked their opinion on the app after they had taken a look at the app. They clicked on firstly “where is the bus” and “how to go” and then they discovered other features on the app. They all were surprised at the number of features in the app. They expressed positive opinions for the first interaction with the app.

5.1.2.2. Task Performance Results: Observation of User-Product Interaction

The participants were given a simple task to perform (finding out ‘How to go’ to Nata Vega shopping mall) in order to observe how effective the app is in helping them reach a new location. The results of the task for each participant can be seen in Table 5.1.

Table 5.1. *The First Study's Task Analysis*

Type of Users	Participants	Task Completion Time (Minute)	The Chosen Features and the Emotion Triggered	Comments
Frequent Users	P2	0.5		
	P3	0.5		
	P4	1	→ → Frustration	Too Complex
Infrequent Users	P1	2	→ → Relief	Too Complex
	P6	2	→ → → → Frustration Relief	Too Complex
First-Time Users	P5	1	→ → → Self-doubt	Too Complex Inefficient
	P7	2.5	→ → Frustration Relief	Inefficient
	P8	3	→ → → → Self-doubt Frustration Relief	Too Complex Inefficient

: How to go, : Search stop, : Search line, : Search address, : Home page

A direct correlation has been observed between the familiarity with the app and the duration of the task performance, with the frequent users finishing in one minute or less, the infrequent ones in finishing in twice as long a time (two minutes) and the first-time users finishing mostly over two minutes. The first-time user P5, is the exception, who also finished one minute. Two frequent users completed the task in half a minute, by using a single app feature, while the third completed it in one minute, after picking the wrong option and returning to the main page to begin again.

The feature of the app that was most used during the task was 'How to go', with four out of eight participants choosing this option to reach the required information. Three out of these four began right away by using this feature, while one only clicked it after failing to find the information with 'search stop'. Through the 'How to go' feature, participants easily learned which public transportation to take in order to reach their destination. Moreover, this feature also provided them with additional information on the number of the stops they will pass through. However, participants found that information too *complex*. All participants stated that they would get station information from their familiars and drivers. For example, one participant commented: "I would use the app only to some extent. I'll learn which bus to take from the app and then ask the driver at which station to get off."

The 'search address' option was the second most used feature. Due to the app's design (with its unexplained features), participants who chose 'search address' also needed to use the 'search line' feature, which caused them to frequently return to the main page. In that process, participants verbally commented that these features are difficult to use. Compared with them, participants who chose 'How to go' almost never had to return to the main page and finished the task in a shorter time.

The first-time users were given the chance to briefly play around with the app in order to get acquainted with it before starting with the task. Their behaviours during their discovery process were deemed especially insightful to assess how the app and its

specific features are perceived and used. These participants mostly started by clicking the ‘search’ button in the main page. However, participants did not realize that it only searches through their favourites, which were empty at their first use and could not understand why they did not reach any information. The ‘lines’ and ‘stops’ buttons, located next to the search button, were their second choice.

The first-time users P7 and P8 took the longest to complete the given task because they could not understand the search criterion of the features they picked and as a result felt nervous. When they finished the task, one participant exclaimed “Oh, finally I get it!”, while an another one said “I thought I would not be able to finish the task”. Once they were finished with the task, the first-time users also checked other features on the app. They were mostly interested in the ‘Ankarakart’ feature, which they found useful, and the ‘Camera’ feature, which they found interesting.

As seen in Table 5.1, the analysis of oral comments made during the task performance indicate that the majority of participants found the app complex. When the participants found the feature was complex, they also felt frustration. Especially for the first-time users, frustration was the dominant emotion during the task performance and their comments indicated that the app did not make them fell self-efficient.

5.1.2.3. Post-Task Interview Results: User Evaluations and Comments

After completing the task, users commented on their experience and indicated what they had expected of the app during their interaction. The majority of the participants with prior knowledge of the app had expected the app to provide better guidance about the functions of its various features. In addition, they had wished for information about other types of public transportation, such as dolmuş, and one participant in particular had wanted the pages to load faster.

The participants who were familiar with the app indicated noticing for the first time the existence of some features located at the bottom of the home page. One participant even exclaimed: “I only just noticed the *set up alarm* and *My panel* features. This look good!”

The first-time users did not find the use of the app difficult but neither did they find it efficient since they could not reach the information about the stops numbers through the app. Related to that, P7 stated:

> I could not find the number on the stop located near my home. Therefore, I will have to memorise that. I do not think this is an efficient way to check real-time information of buses.

Participants made some overall suggestions for the improvement of the app, based either on their previous experiences or considering their task performance such as:

- Giving proximity notification, to warn users of bus approaching a selected station.
- Providing driver information, to keep tabs on their behaviours and prevent breaking of traffic rules.
- Enabling inter-city integration, to use the same app in different cities.

5.2. Findings of the Second Study

The second study was comprised of three phases. The first and second phases was conducted for a more in depth look at the factors that influence the user experience. In the first phase, similar to the first study, the participants were asked about their public transportation behaviours and their perception of the app, followed by the second phase, where participants were asked to use the app for a week and comment on it daily, for a more detailed understanding of their experience with the app. The third phase aimed to collect participants' thoughts and comments after the use period, through a questionnaire and post-interview.

5.2.1. Overview of the Analysis

The results of the first phase, where participants answered questions about transportation in Ankara and EGO CEP'te in general, was analysed just the way the first phase of the first study was, as explained in Section 5.1.1.

In the second phase, the information that came daily from the participants were collected in an Excel file and statistical data were extracted for each participant. The use frequency of various app features and their indicated level of difficulty were noted day by day and their weighted average was calculated at the end of the week. In light of the results, additional questions were asked at the post-interview to understand the reasons why some features were more often used or what made them difficult.

Furthermore, as the initial phases of the first two studies were identical in their aim and methodology, their results were combined here to get a better understanding of the user related factors that influence the user experience of the EGO CEP'te app, such as the behaviour of public transport passengers.

5.2.2. Results

5.2.2.1. Interview Results: User Behaviours and Perceptions

Participants were questioned about their habits concerning the use of public transportation and mobile applications for passengers, just as in the first study except with one exception: the questions related to transfers were not asked since the first study revealed it to be of small significance for the study group.

The Users' Behaviours related to the Public Transportation in Ankara

All participants use public transportation because they have no other alternatives for travel, since they do not own a car and find taxis very expensive. Just like in the first study, the participants choose what type of public transportation to take depending on journey time. Only the participants whose homes and schools are located near its stop use the railway, while all the others prefer to use the bus or dolmuş, whichever comes first.

The participants get the information about 'How to go' to an unknown place by searching through Google or asking their family or friends, none of them use the app for this purpose.

Eight participants out of nine indicated that the mobile passenger information systems in general would help encourage usage of public transportation. However, six out of these eight do not find EGO CEP'TE successful in that regard, with one participant specifically indicating the cause as the difficult usage of the app.

The Users' Behaviours related to usage of EGO CEP'TE

As is in the first study, the participants of the second study mostly use the app to retrieve real-time information on buses and the EGO CEP'TE is the only app that provides it. However, almost all participants expressed that the app sometimes misinforms and gives inaccurate data on bus departure times. One comment made on that topic was:

> Sometimes the information given by the app can be wrong. For example; although it indicated the wait time to be 15 minutes, the bus arrived at the station after only two minutes.

In addition, participants stated that the app uploads slowly.

Participants remember using mostly the Favourites, Where Is the Bus, Ankarakart and Search for Line features of the app. The combined results of the first and second studies on the most used app features are given in Figure 5.1.

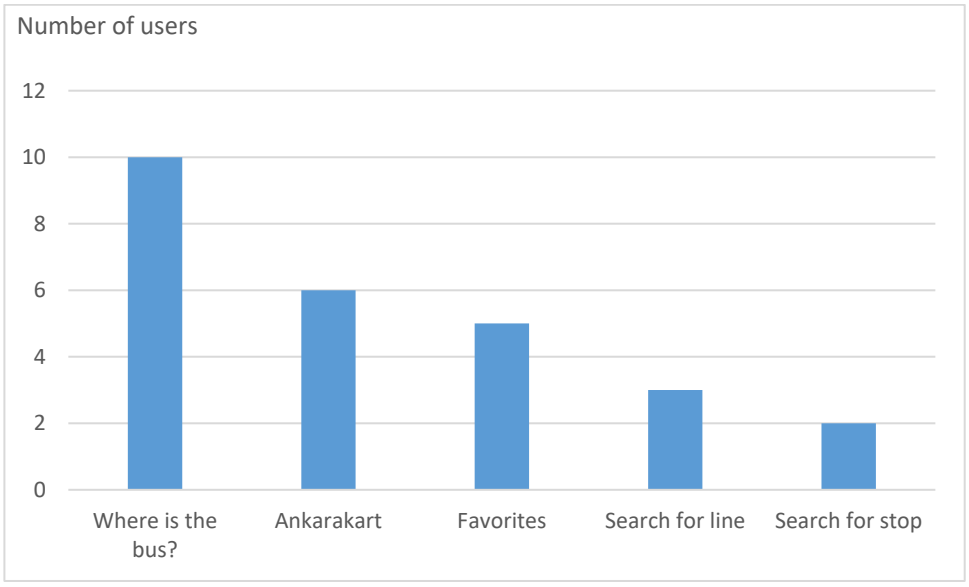

Figure 5.1. The Most Used Features of the App

When the use of the app in general is considered, without focusing on specific features, the participants indicated looking at the app both before leaving their location and when they arrive at the stop, but never on the bus. The combined results of the first and second study is given in Figure 5.2.

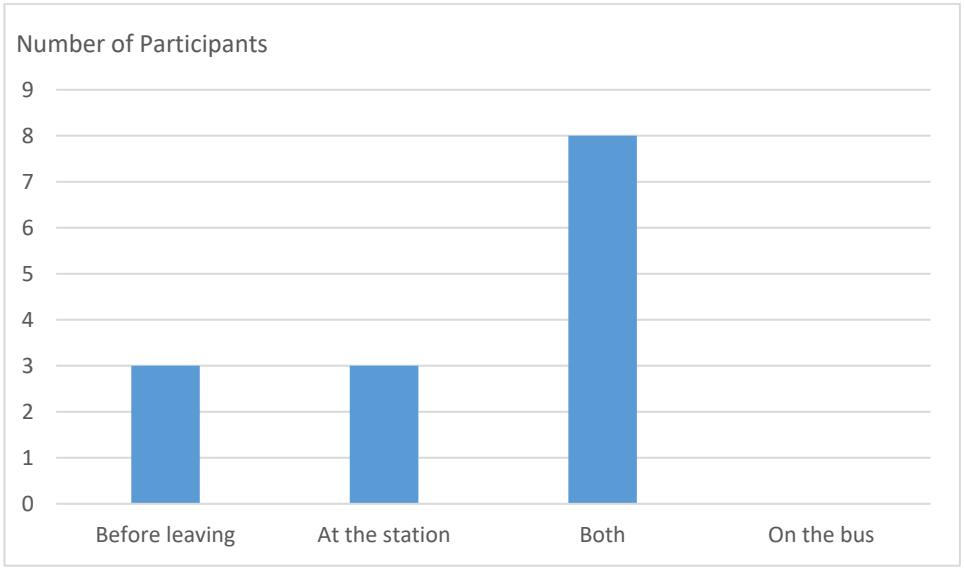

Figure 5.2. The Timing of App Use

The Users' Perceptions of EGO CEP'TE

Overall, the participants of the second study have a similar perception of the app as the participants of the first study, with a positive regard for a service that provides real-time information versus a negative one for when this information is not accurate. For example, P12 expressed that:

> It is useful that the app gives information about which bus will depart a certain station and at what time. Thus, I can learn about alternative buses and can also save time.

As an example of negative reviews, P14 indicated that

> The app sometimes gives wrong real-time information on buses. For example, it says that a bus has 'ten minutes to arrive at the stop', but the bus comes much later.

Unlike the participants of the first study, the participants in this study also expressed negative opinion about the app's interface. They indicated that the app displays too many features in its interface and that makes the app complex.

After the second phase of the study, the participants were once again asked their perception of the app in order to see how it might have changed after a weeklong usage. They were especially asked their perceptions of the features used for the first time. As in the first study, the participants were initially mostly aware of the features located on the home page and seen at first glance. They noticed the 'Set up alarm', 'Camera' and 'Emergency places' features only during the weeklong usage. Again like in the first study, some participants supposed the 'My panel' feature, recently placed on the homepage, a new addition that came with the update.

5.2.2.2. Results of The Weeklong Usage

As stated in Chapter 4, the second phase of the second study was conducted in order to better understand the experiences of those who use the app frequently, over a period of time. Through the weeklong exercise, information on which features are most used, where and when they are used, what sort of difficulties are encountered, what remains undiscovered or useless, etc. was gathered.

The Features Used

The features used by the participants during the week reveal information about participants' needs, what they require of the app as well as their habits related to usage of the app. As was in the first study, all participant in the second study needed to get departure time of buses and two distinct use tendencies were displayed as they tried to retrieve that information: using a single feature of the app ("Where is the bus" or "Favorites") or using multiple features together (using 'Search for line', 'Search for stop', and then 'Where is the bus' or 'Favorites').

Most of the participants were not aware that they could load money to their Ankarakart through the EGO CEP'TE app. Only two of them knew of this service but both choose not to use it because the transfer of money from the bank to the card takes a while, which is inconvenient when they wish to catch a transport as soon as possible.

After the weeklong usage, participants commented about their awareness of the various features of the app. They found out about the existence of certain app features thanks to the daily questionnaires given by the researcher that included a list of app features. Four participants were not aware of the 'Setup alarm' feature, two participants of the 'Camera' feature and one of the 'Emergency call' button. Two participants did not realize that the app provides departure times of the metro, alongside buses.

The Participants' Usage of the App

Through daily questionnaires, participants were asked when they use each separate feature of the app, whether before leaving their home, office, etc, at the station or on the bus (Figure 5.3).

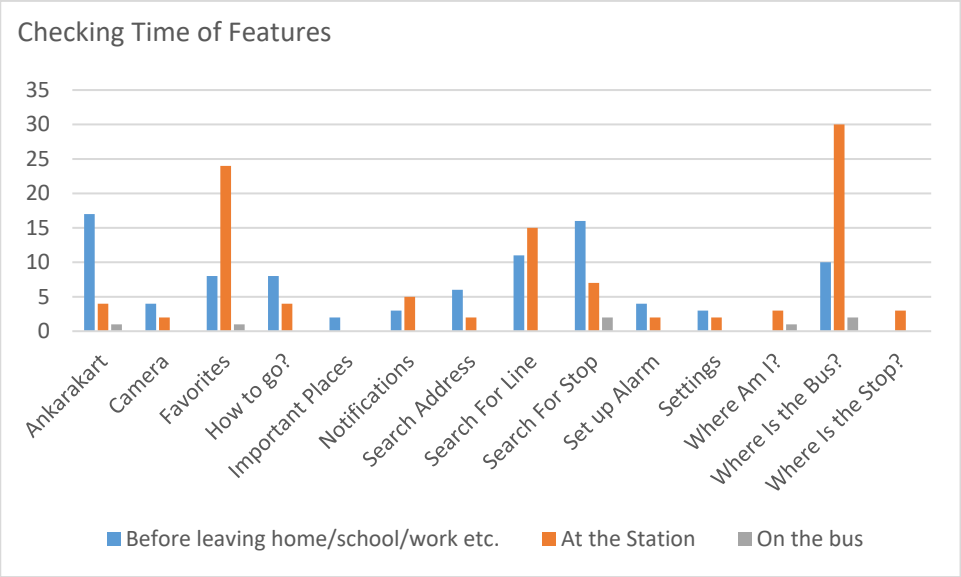

Figure 5.3. Timing of Feature Use

The features that are mostly checked at the stations are 'Favourites' and 'Where is the bus', whereas 'Search for stop', 'Ankarakart' and 'How to go' were looked at before leaving for the station and 'search for the line' was near equally clicked both before and after starting the travel. The participants rarely use the app on the bus, but do so for mainly two reasons. First, they want to confirm the stop where they will get off. Second, they want to check real-time information on the next bus they will take. One participant stated that he sometimes consults the Ankarakart feature on the bus in order to learn the exact time he got on the bus. Another participant said that she looked at the 'Where am I?' feature to check whether or not the app gives the correct information about the bus location.

The Use Frequency of EGO CEP'TE features

The results of the study show that the participants use the app with a certain routine: they tend to keep using a few familiar app features, without experimenting with alternative features. Following these settled routines, the 'Where is the bus' feature was the most used service provided by the EGO CEP'TE app followed by 'Favourites', 'Search for the line', 'Search for the stop' and 'Ankarakart'. These five most used features revealed through the weeklong usage are consistent with what the participants claimed in the interviews (Figure 5.1), with the only difference being the ranking of Ankarakart feature (claimed as the second most used, but revealed as the fifth). The least use feature was 'Important places', tried just once by a single participant and the second least used one was 'Where is the stop', by two participants as seen in Figure 5.4.

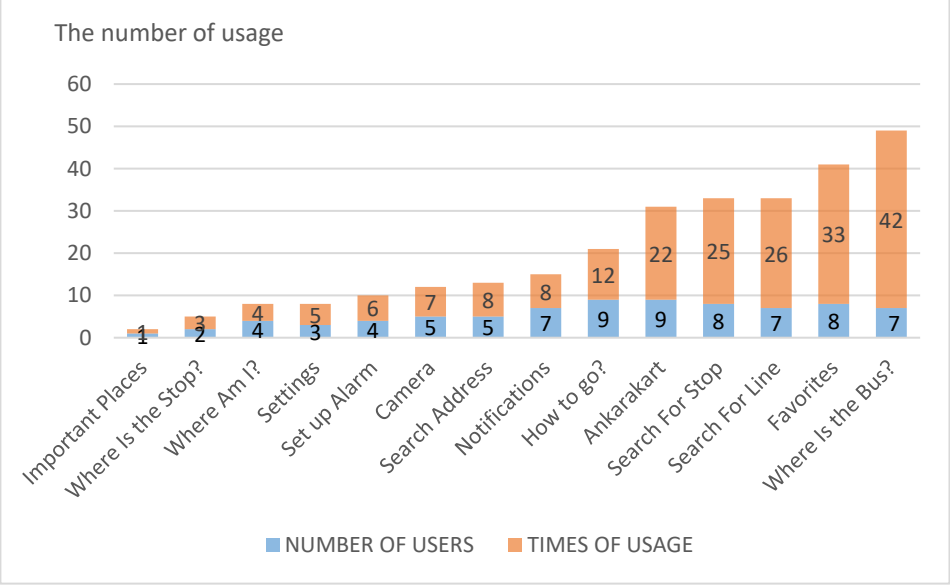

Figure 5.4. The frequency of usage of features of the EGO CEP'TE app

The Level of Difficulty of the Features of EGO CEP'TE

The participants were asked daily to rate the difficulty level of the app features they used during the weeklong exercise. The features they use as part of their daily transportation habits ('Where is the bus', 'Ankarakart', 'Favorites' and 'Search for line') were not found difficult. Moreover, the 'Ankarakart' and 'Where is the bus' features were found to be the easiest ones by all participants.

In general, the level of difficulties of the features did not differ from day to day. Only three participants reduced the 'Search for stop' feature's difficulty rating by one after their first use. 'Settings', 'Set Up Alarm' and 'Where is the Stop' were found to be the most difficult to use features and therefore, were no longer used after the first four days. Participants specifically indicated that the difficulty of using the 'Where is the stop' feature, the second least use feature of the app, is mainly due to not understanding how it is to be used and why the 'Camera' is turned on when this feature is clicked. 'Search for Address' and 'Search for Stop' were also found to be difficult because no explanation or clue is given on what should be written in the search field.

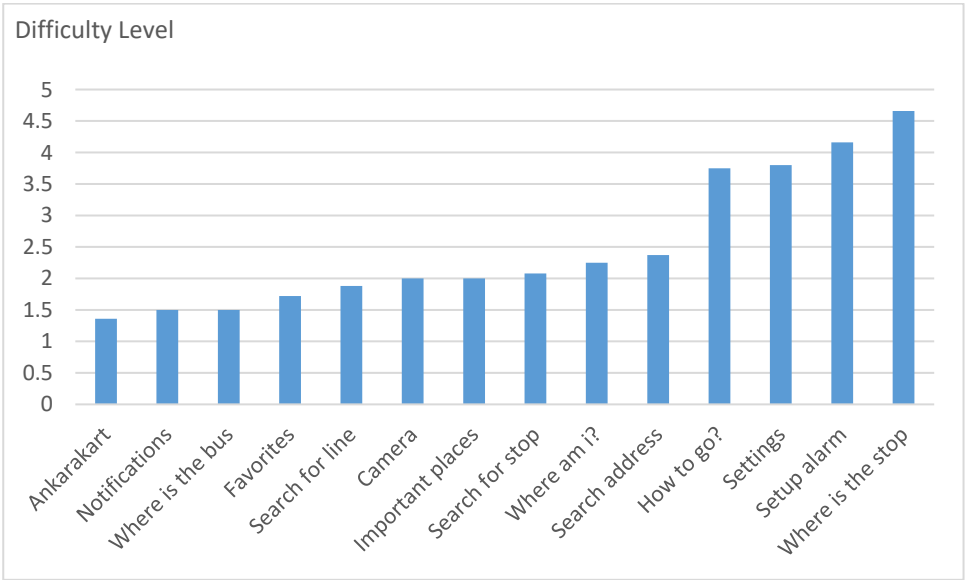

Figure 5.5. Weighted Mean of the Difficulty Levels of the App

5.2.2.3. Post-Use Interview Results: User Evaluations and Comments

Reliability was major issue was expressed by participants after the weeklong usage experience. In parallel to the results of the first phase, the participants complained about the wrong information provided by the app, even though offering real-time information on buses is its strongest suit. As a result, two participants indicated that they no longer rely on the information provided by the app. Moreover, another two participants mentioned being disturbed when asked their personal information (such as their name and phone number) when they tried to report a problem through the app. They stated that they do not trust the app with their personal information since the app belongs to the Ankara Municipality, which they do not trust.

Difficulty of certain app features was the second issue revealed in the interviews. Some participants expressed that during the weeklong usage, they were still having difficulty in using certain features, which they have used before and expected to become easier through experience. One participant (P4) expressed:

> I could not understand the 'Set Up Alarm' feature. I had tried to use it in the first version of the app but could not figure it out. I tried it again in this updated version but still could not use it. I find it too complex. I cannot understand how to set an alarm. Besides, I could not understand the 'How to go' feature either.

Another participant said:

> I used to have difficulty while using 'My Panel' on the app and supposed that it was because I used it hurriedly, but it is not so. I've spent more time with the app via this study and tried to put in more time to use this feature. However, I still could not set up a panel.

Compared to the results of the initial interview conducted at the first phase of the second study, the quantity of participant comments and insights increased

considerably after the weeklong usage experience, albeit becoming more negative (Table 5.2), with two participants even stating that the app now annoys them. The negative comments focused mainly on the four most difficult features of the app identified in Figure 5.5.

In the first phase of the second study, only one participant expressed an opinion related to visual appearance of the app. However, after the weeklong usage, three participants stated that the app looks old-fashioned: “The interface of the app is so bad. It is old-fashioned and seems like that it was made in 1998”. Moreover, participants indicated that it has too many choices on its interface, which makes it “look ugly”.

Table 5.2. *Analysis of Negative Comments on App Features*

FEATURES	**COMMENTS**	**Σ TIMES INDICATED**
Where is the stop?	Unclear	2
Setup alarm	Too complex	5
	Unclear	1
Settings	Too complex	2
How to go?	Too complex	5
	Inaccurate information	3
	Unclear	1
Search for stop	Unclear	2
	Too complex	2
	Bad integration	1
My Panel	Too complex	4

Besides their negative opinions, participants also offered positive comments about the app. Four participants mentioned that being able to customize is a positive side of the app, about which they were informed thanks to the weeklong usage of the app. They were able to customize the app for example by creating a panel where information on daily travel lines appear, or by assembling favourites that would provide real-time information of a bus frequently used. Therefore “My Panel” received both negative comments by being too complex and positive comments because it offers the chance to customize.

5.3. Findings of the Third Study

The main aim of the third study was to investigate the technology acceptance of EGO CEP’TE. For that purpose, an existing questionnaire was adopted to fit the requirements of this thesis. The results and analysis of the study are explained in the following titles.

5.3.1. Overview of the Analysis

The five-point Likert scale questionnaire was distributed to the participants as a hard copy. Once they’ve answered all the questions, they were also asked to explain their answers and these interviews were recorded.

As in the first and second study, the interviews were transcribed and then coded to determine themes and sub-themes according to the participants’ answers. Using an Excel Sheet, these themes and sub-themes were combined with the answers of each questionnaire item. Furthermore, the weighted mean of all the answers given for each item was calculated to draw an overall picture of the technology acceptance.

5.3.2. Survey Results: Technology Acceptance

The main results of the questionnaire conducted about the acceptance of technology is given in Table 5.3, with further details provided in Appendix D.

Table 5.3. Weighted Mean of Answers for Each Questionnaire Item

FACTOR	SCALE	SCALE MEAN	FACTOR MEAN
PERCEIVED USEFULNESS	Using Ego Cep'te enables me to accomplish task more quickly.	4.13	3.88
	Using Ego Cep'te improve my effectiveness.	3.67	
	I find usage Ego Cep'te useful.	3.89	
PERCEIVED EASE OF USE	I think using Ego Cep'te during the journey is easy.	3.00	3.36
	I think using Ego Cep'te at the station is easy.	3.78	
	I think using Ego Cep'te is easy.	3.22	
	I think becoming skillful at using Ego Cep'te is easy.	3.44	
ATTITUDE TOWARD TO USE	Using Ego Cep'te makes the journey more fun and interesting.	2.22	2.85
	I have fun using Ego Cep'te.	3.00	
	I enjoy travelling with using Ego Cep'te.	3.33	
BEHAVIORAL INTENTION	I think I will use Ego Cep'te frequently.	3.56	3.63
	I plan to use Ego Cep'te in the future.	4.11	
	I would like to recommend Ego Cep'te to my friends.	3.22	
FACILITATED CONDITIONS	There are people who can get help when I have difficulty using Ego Cep'te.	3.22	2.56
	When I have a problem using Ego Cep'te, I know who to get help from.	2.78	
	I get technical support when I have a problem using Ego Cep'te.	1.67	
PERCEIVED FUN	I enjoy using technology.	4.22	3.67
	Using smartphone is exciting.	4.22	
	Using mobile applications is exciting.	4.33	
	I like to use Ego Cep'te.	3.11	
	EgoCep'te is fun to use.	2.44	
SELF-EFFICACY	I have the knowledge and skills to use Ego Cep'te.	4.11	3.93
	I trust myself in use of Ego Cep'te.	3.78	
	If someone shows me how to use Ego Cep'te, I can use it.	3.89	
COMPLEXITY	I need to spend a lot of time learning how to use new technologies.	1.89	2.19
	Using new technologies has always been complicated for me.	1.89	
	It takes a lot of time to use my travel procedures on Ego Cep'te.	2.78	
COMPATIBILITY	I think I need a mobile passenger information application.	4.00	3.89
	I think I need Ego Cep'te.	3.78	
ANXIETY	I feel apprehensive about using Ego Cep'te.	2.67	2.89
	I feel forced when I use Ego Cep'te.	3.11	

The results of the Likert Scale Survey (Table 5.3) shows that EGO CEP'te's perceived compatibility is high (3.89/5) which means that the participants' needs are compatible with the service the app provides. Actually, their need is not for EGO CEP'TE specifically, but for some kind of mobile passenger information system, as they clearly

stated. Even though three participants mentioned that they required the EGO CEP'TE because it made their life easier, another three expressed that they had no alternative that they could choose.

> I need an app like EGO CEP'TE in general. EGO CEP'TE app needs to be improved, however, since it is the only available mobile app for public transportation, I need it.

In accordance with the app's perceived compatibility, its perceived usefulness is also high (3.88/5). Most of the participants perceive the app as useful because they believe it saves time and makes things easier. Except for two participants, all the others agree that using EGOCEP'TE makes their work easier. For example, one participant stated:

> I can check my money on the Ankarakart via the app. If there is not enough money on the Ankarakart, I load money before leaving home. Thus, I do not spend more time at the metro station.

And another one said:

> I find the app useful because, for example in summer, I check the information of how much time is left for the arrival of the bus. If there is a lot time left, I wait for the bus in the shade [instead of queuing under the sun].

The results of the survey show that the participants' self-efficacy is high as well (3.93/5). Eight participants believe they have adequate knowledge and skill to use EGO CEP'TE, five participants expressed feeling qualified enough but still having difficulty facing some of the problems encountered while using certain feature of the app, while one participant was hesitant about her self-efficacy. A participant stated: "I could not understand the search criteria on the 'How to go' feature. If someone showed me how to, I probably would be able to use it."

Even though eight participants agreed that if they were taught or guided on how to use certain features, they would not have any problem using the app, one participant stated

that no help or guidance would be enough, since “there is a problem originating from the app itself”.

The participants’ difficulties with the app are reflected in their emotional reactions: they feel forced when using EGO CEP’TE (3.11/5). Three of the participants stated that they feel nervous while using the app and five participants expressed feeling anxious when using specific features of the app that were difficult. A participant specifically stated that “using the app would be even more difficult for the elderly”.

The results show that technological complexity is low (2.19/5). While items related to usage of new technology is very low (1.89/5), items related to EGO CEP’TE is a bit higher (2.78/5). This difference appears to be caused by the complexity of some app features: all the participants stated having no difficulty in learning and using new technologies, but having encountered difficulties not due to their own abilities nor knowledge, but related to the complexity of the app. It was not the app in general, but specific features that were found to be too complex. One participant stated: “Generally, [the app] makes my life easier but I spend too much time while using some of its features, so it stops being convenient”, while another one mentioned that:

> Overall the app makes things easier. However, when I approach it on a feature by features basis, sometimes it does not. For example, using the ‘How to go’ feature is so difficult and takes so much time that it does not make anything easier.

Although the participants found some features of the app complex, they agreed that the general usage of the app is easy for them. As seen in Table 5.3, perceived ease of use is high (3.88/5). They said that using the application while waiting for the bus at the station is easier than using it when traveling on the bus. They mostly do not use the app during their travel on the bus because they mostly need to use the app before starting their journey and the crowded buses make its use very uncomfortable. Related to that, one participant said that:

> Using the app on the bus is difficult since I cannot travel in a comfortable way. I mostly stand among a crowded thus I cannot deal with using the app in a such uncomfortable situation.

Participants' perceived fun is above average (3.67/5). However, participants clarified that this is thanks to their liking of technology (4.22/5), smart phones (4.22/5) and mobile apps (4.33/5), not because they actually perceive EGO CEP'TE as fun. They do like EGO CEP'TE (3.11/5) since it helps them to reach real-time information of public transportation, without finding it fun (2.44/5).

The participants' needs for getting real-time information on public transportation reflect on their intention to use EGO CEP'TE. As seen in the Table 5.3, despite the fact that the weighted mean of participants' attitude towards the use of the app, meaning how much they enjoy using it, is low (2.85/5), their behavioural intention, that is how much they wish or predict they will use it, is high (3.63/5): six participants indicated that they intended to use the app frequently. As part of their intention to use the app, most of them also stated that they would recommend the app to their family or friends while some of them expressed being in a quandary about it due to some complex features.

In terms of facilitating conditions, the participants mostly believe that they can get help if they encounter a problem when using the app (3.22/5), even if they do not quite know where to get the help from (2.55/5), with three participants oblivious to the existence of technical support for the app. The disparity between their belief and their knowledge appears due to the participants reluctance in actually getting technical support when in need (1.67/5). They even stated that unless they have a long-term problem such as not being able to access their account, they do not get technical support. They indicated that for an app where the flow of information is real-time and instantaneous, technical support's answer to any inquiry would not be fast enough. One participant expressed that the main issues derive from the municipality itself, in terms of information flow, and therefore beyond a technical support's abilities.

5.3.3. Summary of Interview Results: Thematic Analysis of Participant Comments

The results of the thematic analysis that was conducted on the interviews from studies one, two and three were gathered together in Table 5.4 to showcase the qualities that were either attributed to or wanted from EGO CEP'TE. The 12 keywords that were revealed through the coding of the transcripts were *integration, accuracy, ease of use, understandability, visual orientation, simplicity, visual appeal* and *comprehensiveness*. Some of these qualities, such as accuracy, were common to all studies, while others like visual appeal were only mentioned during the weeklong study.

Table 5.4.*Qualities mentioned by the participants during the first three field studies*

KEYWORD	**TIMES MENTIONED**			
	1. STUDY	**2. STUDY**	**3. STUDY**	**TOTAL**
Integration	5	11	8	**24**
Accuracy	6	8	5	**19**
Ease of use	7	7	3	**17**
Understandability	5	4	3	**12**
Visual orientation	1	5	2	**8**
Simplicity	0	4	2	**6**
Visual appeal	0	3	2	**5**
Comprehensiveness	2	3	0	**5**
Customization	0	4	0	**4**
Safety	0	0	2	**2**

5.4. Findings of the Fourth Study

The fourth study was conducted to understand new mobility from a local perspective, that of Ankara and its public transportation. As explained in Chapter 2.3.4, new mobility plays an important role in urban transportation by providing efficient solutions for urban transportation problems with a user centred approach. For this purpose, in the fourth study, a two-way investigation was made: experts were interviewed on the topic and additional questions were directed towards the participants of the second and third study. The interviews and questions covered the core elements of new mobility: shared systems, interconnectivity and data. However, the topic of shared systems was limited to the use of social media in relation to transportation, since car or bike sharing was out of this thesis' scope as well as nearly barely existent in Ankara at the time the study was conducted, as explained in Chapter 2.4.3.

5.4.1. Overview of the Analysis

Expert opinions on shared systems (social media), interconnectivity and data related to Ankara's public transportation were gathered through semi-structured interviews. On the other hand, the participants were asked their thoughts mainly on the use of social media and interconnectivity in public transportation, as data were out of their scope of knowledge. Even though the participants had already commented on interconnectivity in the previous studies, they were still questioned on the topic to get more in-depth information, especially on issues such as mobile ticketing.

To analyse these interviews' transcriptions were coded to reveal themes and sub-themes, just like in the first phases of the first and second studies.

5.4.2. Results

5.4.2.1. The Experts' Opinions on New Mobility

As stated in Chapter 4, the mobile PIS is a significant part of new mobility and understanding the other parts of new mobility helps to integrate a mobile PIS more efficiently into the system. For that reason, the experts were asked questions such as how data is obtained and used in urban transportation or how is the interconnectivity of Ankara's urban transportation.

Experts stated that cities in Turkey lack data in transportation planning. The total number of passengers on a given bus at a given route and time is the only user related data that planners have. Surveys are made while transportation planning is being made, but information such as when or why people use a certain route, what are the busiest locations, which routes are used by which users' groups (such as students or tourists) etc. is not available. Route planning is sometimes done with foresight, sometimes according to petitions – shaped by people's complaints or requests – and is generally shaped by policies. The experts develop algorithms to plan public transportation routes and determine the location of stops for the vehicles. But these are often changed without any data or insights from citizens. Policy is the main actor for that change.

Experts indicate that smart cards could play a significant role in gathering transportation data in a city. To ensure such a collection of data, three experts stated that only one smart card should be provided for all kinds of transportation in Ankara, just like in İstanbul. Better yet, smart card and mobile passenger information systems should be integrated with each other and with the overall transportation system, in order to not only reduce passengers' travel processes, but to gather richer data from a single source as well. Furthermore, the experts also emphasised that a single smart card (or mobile application) should be used all over the country and not a different one in each city. Related to this nation-wide approach, two experts underlined the

necessity for the development of a system that would gather transportation data from around the country. One of them expressed that:

> In Turkey, different studies are conducted for each city. For that reason, the separately gathered data are not comparable or compatible. In some cities, the studies are conducted for a week while in other cities, data were gathered daily. Those studies should be based on the same structure and they should be done at the same frequency.

All experts agree on the importance of adopting a holistic view so that the urban transportation system can be designed in an integrated way, including all relevant parties, from users to governments. Indeed, three experts expressed that an integrated urban transportation system could only be sustained only with the support of policies.

The support of government through policies was also mentioned as necessary for an interconnected system, the second core element of new mobility. Discussing how an interconnected mobile PIS, could positively affect and encourage the use of public transportation, one expert suggested that:

> For example, parking for lots for private cars could be designed in certain places near the city centre and near the subway stops. A mobile PIS or digital displays could then be used to make announcements and inform car owners as follows: If you park your car here, you can reach the subway with a 5-minute walk. With the subway you can go from X to Y in 12 minutes while it would take you 30 minutes with your car because of traffic jams.

Social media was mentioned as an efficient tool that supports interconnectivity: experts indicated that, since it has an important role in user engagement and is highly used as a mobile service, its integration into the mobile PIS would be beneficial, both in terms of citizen-municipality interaction and exchange of information.

In relation to this issue of interconnectivity, one expert who had worked in the development of the EGO CEP'TE Web application spoke about the issue of

misinformation indicated by most participants of the first and second study. She expressed the underlying reason for these problems, such as giving an incorrect time for the arrival of the bus at the stop, is a failure of the interconnected system either due to a technical fault (the GPS of the bus is broken) or due to human interference (drivers who do not want to be controlled tamper with the system).

Besides all that, most experts expressed new mobility, as well as all other aspects of urban transportation, should investigated and designed with a local perspective:

> Considering the different user groups such as students or the elderly, alternative public transportation routes could be offered and this could be conveyed through mobile passenger information systems. For example, travel choices for tourists could be available in the app for touristic areas.

5.4.2.2. Users' Opinions on New Mobility

As explained above, the interviews conducted with the participants focused mainly on shared systems and interconnectivity in new mobility, because data were deemed out of their scope of interest and knowledge. Furthermore, the topic of shared systems let itself to mainly discussing the use of social media in terms of public transportation, and interconnectivity mostly involved their opinions on mobile ticketing, since they had extensively commented on other issues in previous studies.

The municipalities make use of social media for announcement related to public transportation, such as closed roads. The EGO CEP'TE app does not have an integration with social media accounts but makes use of notifications to convey these announcements to its users. However, the participants did not see any notification or announcement through the app. One participant specifically stated:

> I recently had a problem related with this issue. There was a roadwork near my station but there was no information about it on the app. On the contrary, the bus arrival time to the station was shown to be as usual. If I had not seen the roadwork, I would have waited for the bus in vain.

Participants were asked their opinions related to the interconnectivity of EGO CEP'TE with Ankara's transportation and ticketing systems, especially regarding Ankarakart. Most of them expressed that, if better interconnectivity is ensured for Ankara's transportation system, they might have more choices as they use public transportation, which is something they wish for.

All the participants agreed that overall, they have no issues with Ankarakart. Most tend to load 20 TL to their card whenever the card is empty, and they prefer to do this through a ticket-window since the automatic counters do not return any money back in change, which appears as the major complaint against the smart card. Most of the participants were not aware that they could load money to their card through the EGO CEP'TE app. Only two of them knew of this service but both choose not to use it because the transfer of money from the bank to the card takes a while, which is inconvenient when they wish to catch a transport as soon as possible: "I did not load money on the card through the app, even when I did not have any cash with me, because doing so with an ATM takes much less time" said on of the participants. They also commented on the possibility of full integration of mobile ticketing into the EGO CEP'TE app, which will allow services like paying the transportation fee directly through the app instead of Ankarakart. They all expressed their positive opinions on the topic, with comments such as these:

> "I think it would be great! Cards are old-fashioned. Nowadays, everything is made with mobile apps. Cards are unnecessary. Mobile apps can take their place.
>
> And it will solve the problem of forgetting one's card: sometimes I forget my Ankarakart at home."
>
> "It would resolve the problem of loading money on the card. I think using the mobile app for transportation is better than using a card."

CHAPTER 6

DISCUSSION

The thesis aimed to determine the factors that influence the user experience and the technology acceptance of mobile PIS in order to make suggestions that would contribute to its improvement as a new mobility tool. For this purpose, four studies were conducted and their results were given in the previous chapter. In this section, these results are evaluated within the context of factors described in the literature review.

As indicated in Chapter 3, the user experience and technology acceptance of a product may both be discussed through a three-part framework comprised of the user, the product (or the technology) and the context. Therefore, EGO CEP'TE app was evaluated under these same three titles as well, followed by the components of new mobility.

6.1. Discussion of The User Components

Demographic

The participants of the studies, whose ages vary from 19 to 31 and have – or are in the process of – completing their higher education, are accustomed to using digital technologies. They have the access, the ability and the self-confidence (as shown in the third study) to use various mobile apps. Therefore, the assessments of EGO CEP'TE that were revealed throughout the studies, such as its complexity, lack of functionality or problems of learnability, cannot be blamed on participants' incompetence with technology, unfamiliarity with mobile services, nor on their

unfamiliarity with Ankara's public transportation, as they are mostly students who choose to use it daily due to economic reasons.

Perception

As was indicated in the results, the provision of real-time information about Ankara's transportation appears as the single reason for the participants' positive perception of the app, which turns negative the moment the app provides a wrong information. Therefore, it is crucial for a mobile PIS to be accurate in order to avoid forming a negative impression.

Furthermore, as Thüring & Mahlke (2007) stated, a user's perception is created by the app's various features. During the 7-days usage experience, the participants used more of the app's features and the results showed a significant decrease in their good opinions: participants found the newly discovered or tested features too complex and difficult. This result suggests that the perception of the app is influenced by product components such as *ease of use* and *complexity*, and therefore, these need to be considered carefully in the design process for a positive user experience.

The study also revealed that not all app features are perceived equally. The users are mainly aware of the ones that appear on the home page while others remain unnoticed even with a long-term use, which should be of note when designing the interface of a mobile PIS.

Expectation

As Roto (2006) stated, the users' perceptions shape their expectations. Therefore, the factors that influence the former equally affects the latter: The participants who initially indicated their main expectation from the app as receiving *integrated* and *accurate* information – in line with the reasons behind their positive and negative impressions, specified an additional one once their perceptions changed after the 7-day usage experience: they also expect the information provided by the app to be

simple and *understandable*. How well these expectations are met, in turn, effect how motivated the participants are to use the app.

Motivation and Attitude

As mentioned in Chapter 3, satisfaction of user expectations motivates the use of a product (Vroom, 1964) and therefore, the results once again relate to the same two factors that affected expectation and perception: how reliable the information is and how easy the app features are to use. Davis (1986) underlines that perceived ease of use affects attitude toward use, as is also confirmed by the results of the third study. Accordingly, the participants indicated being motivated to use the app to check real-time information. However, they lost their motivation as soon they find its features too complicated and difficult to use, therefore not satisfactory enough compared to their expectation. However, they keep on using the app because they need the real-time information provided by the EGO CEP'TE app and they did not know any alternative mobile PIS. This ubiquity of the app over all other mobile PIS, could also be problematic in terms of the perceived voluntariness of its use, since being of free will or not is said to affect both the attitude towards it use and its social influence. Participants even stated that they have no choice but to recommend the app to their acquaintances even though they do not find it a good quality app, neither functionally nor aesthetically. These results reveal that if alternative mobile PIS enter the market, or the existing ones become more visible, they may easily be chosen over EGO CEP'TE. It appears that for passengers to be motivated to use a mobile PIS and to keep using it by choice, its design needs to make sure that it is both *easy to use* and more *appealing* than its alternatives.

As Venkatesh (2000) stated, user motivation may also be increased by ensuring that the app is perceive as *fun*. Even though the perceived fun in using smart phones and mobile apps is usually high, the participants rated EGO CEP'TE as being unsuccessful in that regard (Table 5.3). To improve it, some innovations (such as gamification) may be added to the app: for example, user travel details and statistics (e.g. the routes they

use or the number of kilometres they travel with public transportation) may be shared to compete with friends, complete missions and earn badges. Since motivation influences user behaviour by affecting their behaviour process (Ajzen, 1991, Fazio & Olson, 2014) and is a specifically significant factor for creating behaviour change (Kuru, 2013), a mobile PIS app may aim to enhance its user experience and even endorse the use of public transportation through such motivating features.

Behaviour

The studies looked both at passenger behaviours towards EGO CEP'TE and how EGO CEP'TE influences their behaviour concerning public transportation.

During the studies, participants used the app only to assist their daily routine transportation. Although this result may be due to the participant sample, since users' behaviours are determined by their demographic characteristics (Ajzen, 1985), it still suggests that the design of a mobile PIS should primarily focus on improving the app features related to the daily habits of passengers. Indeed, they liked the "My panel" feature that provides *customization* for their travel habits. On the other hand, EGO CEP'TE is fully ignored when travelling to an unfamiliar place. Since the self-efficacy of participants is quite high (Table 5.3), their reluctance to use EGO CEP'TE for this purpose appears to be due to their lack of trust for the accuracy or comprehensibility of the information provided by the app. Indeed, passengers prefer to check online maps, since they feel more comfortable seeing the layout and look of streets or buildings they will need to recognise, and then check this information obtained via technology by consulting trusted real persons, such as friends or bus drivers. In order for an app to function as a more versatile mobile PIS, beyond a simple assistant for familiar routes, its interface would need to be more *visual oriented*, rather than depend solely on textual information – and establish a trustful reputation by providing *accurate* information. The studies also showed that EGO CEP'TE in general does not influence passengers' attitudes towards the use of public transportation. Half of participants stated that such a behaviour change could only be achieved if larger

problems beyond the app's scope, like congestion, are solved first. But they also indicated that app specific problems such as the *complexity* of its use also hinders any possibility that the app might motivate its user to change their behaviour. It appears that for mobile PIS to achieve such a goal, it might need to have other characteristics, such as being *fun* through gamification like in the example City Mapper, or being more *comprehensive* like in the example of 9292, as explained in Chapter 2.3.3.

Emotion

Thüring & Mahlke (2007) state that the users' perception of a product induces an emotional reaction towards it. As a result, when participants perceived the app positively thanks to the real-time information it provides, they also had positive emotions towards it. On the other hand, when the app gave wrong information, the participants' perceptions became negative along with their emotional reactions: such a situation risks inducing anxiety in the passengers (as mentioned in the result of first, second and third studies) who cannot rely on the app and feel uncertain about their journeys. Moreover, apart from feeling nervous and anxious, the participants were also annoyed that specific features of the app are not easy to use and hinder retrieval of needed information. Due to such negative emotions, a user may easily give up any intention of using the app ever again (Forlizzi & Battarbee, 2004).

However, the emotional reactions also appear to be correlated with how familiar the participants were with the app. As the results of the first study show, participants who were not familiar with the app were more stressed-out when trying to accomplish a task, than those who were familiar with it, even though both groups encountered similar difficulties.

It can be concluded that the design of the app should aim to prevent these negative emotions from forming, first of all by focusing on the initial experience one has when first using the app, and then by ensuring that the provided information is *correct* and *easily* retrievable.

Trust & Privacy

Kaasinen (2005) indicated that trust affects the user experience since it directly affects the intention to use, as was confirmed by the results of third study where participants indicated such concerns as the reason why they quit using the app. It was revealed that loss of trust was mainly due to the mistakes encountered in the real-time information provided by the app. It appears that to resolve such trust issues, a mobile PIS's foremost concern needs to be the transmission of *accurate* information.

When users are asked to enter their personal data into an app, especially one they do not trust, they become concerned for the safety of their privacy. Therefore, it appears best for a mobile PIS to not request any such personal information, or if necessary, to assure its users that the information provided will be *not be shared* with third parties nor will it be used for other purposes.

6.2. Discussion of Product Components

Usefulness

Users of a mobile PIS do not want to put any extra effort to find any information if they cannot reach or understand it right away and with ease. This situation was apparent in the task performance observed in the first study, where many participants either failed the task at their first attempt, finished it in unnecessarily long time or could not grasp the meaning of the five-digit numbers provided by the "How to go" feature. These results suggest that to offer a better experience with a mobile PIS, its design should ensure that the specific features incorporated in the app are *effective* and *efficient*, providing the required information either in as *fast*, *easy* and *simple* way as possible, or, if the information cannot avoid being complicated, in such a way that its meaning can be deciphered readily and directly.

Ease of use

As the second study revealed, participants' interaction with the app is quickly established into a routine, where certain features are frequently used (Figure 5.4). These most frequently used features are also evaluated as the least difficult ones to use (Figure 5.5). On the other hand, the features found not easy to use, were among the least used ones. These results are not caused by any lack of skill or knowledge on the part of the participants, since they are familiar with similar technologies and are found to be self-efficient, which should positively influence their perceived ease of use of the app (Venkatesh, 2000). In fact, the results of the first three studies revealed that the participants have difficulties with the app when the information it provides (or the way it provides) is too complex or unclear. Figure 5.5 and Table 5.2 clearly show that the most difficult to use app features were defined as being *too complex* first of all, followed by *unclear* (or hard to understand). As indicated by Venkatesh and Davis (2000), negative emotions, such as anxiety, felt by users in those situations, may negatively influence the perceived ease of use of the app. Accordingly, it can be said that the self-efficacy of a user does not guarantee the ease of use of a mobile PIS, which should be designed to make its interface, functions and content as clear and simple as possible, or as a worst-case scenario, provide an explanation or a guide to assist the users.

Satisfaction

The user's expectation is a factor that affects how satisfactory the use of product is: if a product meets its user's expectation from it, then it will be deemed satisfactory (Hassenzahl, 2003). Accordingly, whether the app was found to be satisfactory or not was found to be related to the same factors that also affected user expectation: the *accuracy* of the information how *integrated* it is and the *simplicity* with which it is provided.

Because the participants mostly use the app in order to get real-time information on public transportation, as the result of first and second studies showed, they expect it

to provide whole and accurate real-time information, and were satisfied with the app as long as it was successful in that regard. On the other hand, as mentioned in Section 5.1.4.3, many of the app features were evaluated as to complicated and difficult, which negatively influenced how satisfactory the app was judged to be. The fact that the app did not include dolmuş information was another negative point against it as a satisfactory mobile PIS. Even though the participants generally do not prefer to use dolmuş (except for some specific routes such as Kızılay-Balgat) the fact that the app does not offer this option is still a point against it, as it limits participants transportation choices. If dolmus, and other possible transports such as taxis are integrated into the app, the participants would be better informed on whether or not to take a vehicle depending on their journey time, the most significant factor as mentioned in Chapter 5.1.2.1. A more *integrated approach* to the type of information provided would help improve the user's experience with and acceptance of the app, and should be considered as an important point in the design of future mobile PIS.

The first and second studies also revealed two additional user needs, which the participants did not cite as expectations from a mobile PIS: they want to browse a map freely to check their destination as well as consult others in person and not just rely on the digital technology at hand. In order to become more compatible to user need and therefore more satisfactory, a mobile PIS may strive to meet these needs. It may integrate its own browsable map and chat platform, or choose to offer access to existing ones on other sites or networks through the app.

Learnability

Study results indicate that in general the learnability of the app is not good. During the task performance of the first study, as well as during the seven-days usage experience of the second study, the participants had difficulty using certain features of the app. Even when they made an effort to understand how to use these features, which is something they rather not do as explained above, they could not figure it out. For example, one participant who checked the user-manual provided inside the app was

still unable to understand how to use the feature in question and could not achieve her intention. This issue of learnability appeared consistent, whether the participant was familiar or unfamiliar with the app, as long as they were trying a new, previously unused feature of the app.

Improved learnability in a mobile PIS could be achieved by *simpler* app features, making them *self-explanatory*, or at least by integrating feature specific in situ explanations to assist first time users without the need to check the user-manual.

Memorability

The first and second studies demonstrated that participants remember well the features they use the most (Figure 5.1 and Figure 5.5), since the use of these easily become part of their daily habits, as explained above. However, the results of the first study showed that, even with these most used features, participants did not actually remember how to use them very well. It was revealed that in their previous uses of the app, they had improvised short-cuts to overcome the difficulties encountered in various features, such as memorizing certain bus lines and stop numbers. However, after a period of non-use, they had forgotten these short-cuts and therefore, had once again difficulty in using the app and were frustrated with it.

For a good user experience, the memorability of mobile PIS need to be better than what was observed with EGO CEP'TE and the results of the first and second study suggest that the first step in achieving this is by making the app features *easier* and *simpler*, or by avoiding complexity.

Errors

The errors that were observed during the studies, as explained in the previous chapter, are mainly due to the app's interface design and fall under two categories: misuses caused by obscure attributes of the interface, such as unexplained search criteria, and accidents caused by tactile interaction with the interface, such as selecting unwanted items when scrolling on a touch screen.

The interface of a mobile PIS needs to able to visually convey how it is to be used in order to minimize errors caused by misuse, which will also be improving its learnability. Moreover, its design should also consider the requirements of the interaction in question – in the case analysed here, between a human finger and a small touch screen. Since providing a lot of choices on the interface increases the error rate, especially due to the physical requirements of haptic interactions such as scrolling, excess information should be avoided or careful attention should be paid to the placement of components on the interface

Cognitive Load

The result of first study showed that the participants are reluctant to use the app while performing other tasks such as while texting or traveling on a bus. For a better experience, a mobile PIS needs to provide solutions for such instances of multitasking. For example, as a participant in the first study suggested, audio or haptic signals may be used to notify passengers when needed: the app may vibrate to indicate a certain stop is approaching when traveling on the bus.

Aesthetic Characteristic

Even though EGO CEP'TE is the most downloaded mobile PIS app in Ankara, as mentioned in Chapter 4, as well as the only one most study participant knew about, it was found to have an old-fashioned look and become second choice as soon as participants became aware of a more contemporary looking option. Considering that the aesthetic quality of an app is significant in making it stand out among its alternatives, the design of a mobile PIS needs to take its *visual appeal* into account and ensure that it fits the stylistic expectations of its time. Furthermore, making a mobile PIS more popular, desirable, etc. through aesthetic qualities, could also improve its image, social influence or perceived compatibility to cultural values, which may even increase its perceived usefulness, as explained in the literature.

6.3. Discussion of Contextual Components

Physical and Temporal

The results revealed that the physical and temporal context of use of EGO CEP'TE is limited to stable environments, like the homes of its users or the stations at which they wait, before a travel is undertaken. There appears to be two main reasons why the app is not used while traveling. First, the type of information passengers more often retrieves from the app, such as when the bus will arrive at the stop, is inherently needed before a journey begins. Second, the cognitive load problem mentioned above makes it harder for passengers to use the app when in transit. Therefore, in order to extend the physical and temporal use context of a mobile PIS, its design should consider how and for what purpose it will be used by passengers on a public vehicle, during a journey. For example, besides the audio and haptic signals suggested above, the app could be designed to require as little input as possible to accomplish a task, so that it would be easier to use with one hand, on a moving crowded bus.

Social

From the studies conducted with EGO CEP'TE, there was no indication that the social context has any influence on the user experience of a mobile PIS. This result may be due to the fact that it has very few rivals that might socially be more popular, more approved, more appropriate, etc. Most participants were not even aware of other applications that offer services similar to EGOCEP'TE. This may be due to the fact that EGECEP'TE is more visible because it belongs to the municipality, which advertises it by posting on the stops and in local newspapers. It remains to be seen whether the choice or the experience of using EGO CEP'TE is affected if its alternatives are numerous, more varied and accessible to the public.

Technical and informational

The findings of studies showed that the EGO CEP'TE app has problems both in terms of the information it provides and its technical infrastructure. The information is

occasionally inaccurate or misleading, as mentioned in previous sections. However, whether or not the root of this problem lays in the app itself - the way it receives and processes data from the EGO network - or in the network, is unknown within the scope of this thesis. Since the accuracy of real-time information appears to have a crucial role in the user experience of a mobile PIS by affecting various factors at the same time, the underlying reason of any issue in that regard needs to be figured as a priority.

The technical problems range from loading too slowly, not being well adapted to the different platforms or screen sizes among smart devices and proneness to cause use errors, as mentioned above. The first study revealed that participants rather visit the EGO website on their Desktop when they want information about an unfamiliar location, so as not to risk any mistake due to these technical issues. These results indicate that, the design of a mobile PIS shouldn't just be concerned with the visual look of its interface, but make best use of the technologies available to construct a better functioning infrastructure, which would in turn shape and support the interface.

6.4. Discussion of New Mobility Components

Shared System

Since there is not any car or bike sharing systems in Ankara, social media platforms stand as the only means through which passengers may communicate, share transport related information and arrange to share a ride.

Social media apps are the most used mobile applications both by passengers as well as by municipalities who want to make announcement related to transportation. Therefore, social media appears to be the most convenient way through which transportation related communication may be established between passengers and institutions, and as results, its integration into a mobile PIS's structure should be considered in its design. Furthermore, the interviewed experts concurred that such an integration may have a positive influence on the users' experience.

Interconnectivity

Interconnectivity is one of the most important parts of new mobility (Allard & Moura, 2016). It helps passengers in having cheaper and more comfortable journeys by providing the option of combined travel and changing between different kinds of transportation. Moreover, it contributes to decreasing the carbon foot print of urban transportation by promoting the use of public transportation (Houghton et al., 2009).

For a truly interconnected transportation system, passengers should have the option to choose among various transportation modes and vehicles (Allard & Moura, 2016), which requires the integration of different transportation systems (Ministry of Development, 2013). However, as the results of all studies show, Ankara lacks such an integrated approach to its transportation system. The passengers expect mobile PIS apps to compensate for this situation at least by integrating all the available types of transportation, so that they may make their travel choices accordingly. Such an integration may even include private cars and any information that may be relevant to their drivers. As an expert suggested, this integration may occasionally induce private car owners to take public transportation instead of their car.

Mobile ticketing, one of the most visible tools for smart transportation according to the report of Informatics Foundation of Turkey (2016), has an important role in rendering transportation more interconnected, by providing passengers with different choices of transportation and therefore, making public transportation more convenient (Houghton et al., 2009). However, there is not a comprehensive integration between mobile ticketing and mobile passenger information system in Ankara. The importance of this integration was proven by the study results: even though the existing service of EGO CEP'TE concerning Ankarakart was found to be very limited and inconvenient in the second and fourth studies, participants still claimed it as one of the most used features (Fig. 5.1 and Fig. 5.4). A better and more comprehensive mobile ticketing integration into the app may facilitate the process of both physical and digital money loading, save time for passengers and improve the user experience of the mobile PIS

in question, as well as offer a more sustainable solution without paper ticket or physical smart cards.

Data

The acquisition, processions and distribution of transportation related information is a crucial issue in term of new mobility, both in terms of the data received by passengers – used for journey planning – and the data gathered from the passengers – used for the urban planning of transportation (Jin et al., 2016; Kitchin, 2014; Menon, 2017).

As the results and their discussions above revealed, the main contribution of a mobile PIS is the provision of *accurate and relevant data* to passengers, in order to reduce the uncertainty of transportation waiting time and help travellers plan their journey according to their needs and priorities (Monzon, Hernandez, & Cascajo, 2012), a task at which the EGO CEP'TE app has occasionally failed.

The data provided by mobile PIS, besides being accurate as a main requirement, could also be more versatile, through integration with other PIS tools. For example, the traffic monitoring system that screens urban traffic flows with cameras, as explained in Chapter 2.4, could be integrated to help passengers with their journey planning by showing live broadcast of traffic flows. In fact, the EGO CEP'TE app does provide a camera view to its users, but it only broadcasts live from a single point in the city. By further integration of other tools, the mobile PIS could also display a traffic volume map, which in turn may be used to offer statistical information and projections to the passengers, such as the expected traffic volume for a certain route during an indicated time period. Moreover, as a participant in the first study pointed out, the users frequently suffer from delays of public transportation and congestion because of car accidents and roadwork. A well-integrated mobile PIS would be able to inform its users of such unexpected situations and could even suggest an alternative travel plan.

From the urban planning point of view, data parsed from passengers, such as which stops are used, which routes are taken at what time, is very valuable. Using these

information, the transportation system of the city can be better regulated, for example, by assigning more vehicles to routes that need it or by rerouting as needed. The data sent back to passengers, such as how long a certain route will take or how crowded a vehicle is, would be improved as well. However, in Ankara, such data are not collected and transferred to appropriate information processing centres in a systematic way. An effective mobile PIS could facilitate this transfer of information and indirectly help improve the transportation system of the urban area it is used in. Furthermore, a well-designed mobile PIS, by providing efficient data flow between passengers and data centres, could also help overcome the problems caused by the insufficient GIS infrastructure in Turkey, as indicated in Chapter 2.4.

6.5. Summary of Discussion**s**

According to the result of field studies, 12 qualities needs to be considered in the design of mobile PIS for an improved user experience as well as increased technology acceptance, and these could be split into three levels of importance (Figure 6.1) determined by the number of times they were mentioned in the studies.

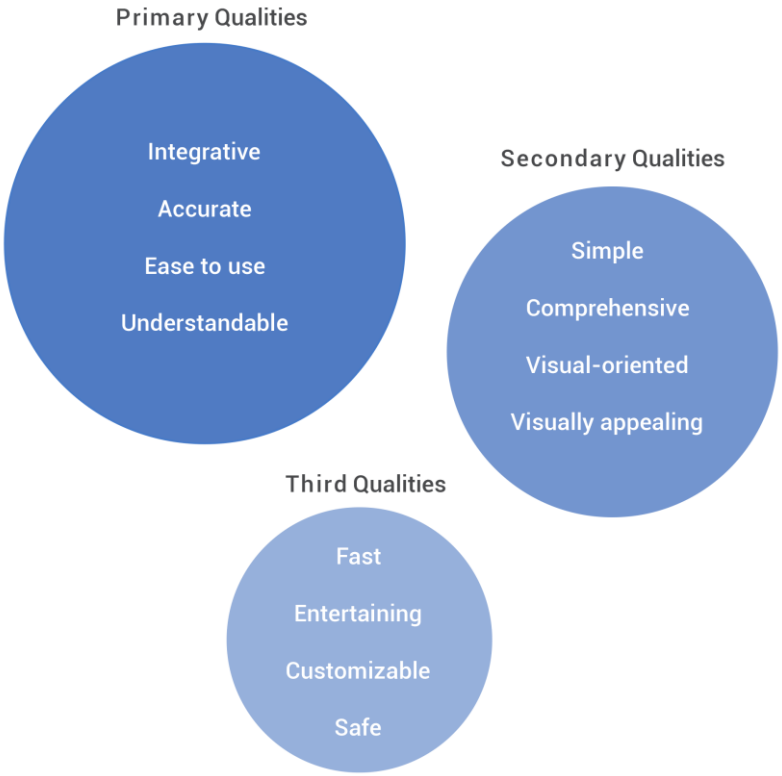

Figure 6.1. Order of Importance for qualities that affect UX of mobile PIS

The field work revealed that the mobile PIS should first of all be **integrative, accurate, easy to use** and **understandable**.

Being integrative is one of the most wanted qualities for the mobile PIS because the users expect the mobile PIS to be integrative in order that they can make travel choice more efficiently. Moreover, since the primary goal of any mobile PIS is to provide real-time information about public transportation (Monzon, Hernandez, & Cascajo, 2013), it is no wonder that accuracy was found to be among the most influential qualities. However, the studies also revealed that users of mobile PIS give as much importance to how **easily** they access the accurate information. Moreover, users expect the features of the mobile PIS to be **clear**, easy to understand. The field studies showed that being understandable increases perceived usefulness by helping boost learnability. One way of achieving this is by providing additional explanations.

However, the complexity and quantity of the explanations, as well as how they are accessed is another point of consideration that bears the risk of further hindering the clarity of the mobile PIS.

These four primary qualities were revealed to be at the core of users' expectations from mobile PIS. Since all the user related components of UX (expectation, motivation, behaviour, emotion and perception) are interrelated (Figure 3.3) and expectations directly determine the satisfaction users get from a technology (Rusu et al., n.d.; Harrison, Flood, & Duce, 2013), which in turn affect how useful the mobile PIS is perceived to be, these primary qualities have an major role in shaping the overall user experience and in whether or not it will easily accepted.

Qualities of secondary importance are being **simple, comprehensive, visual-oriented** and **visually appealing**. Simplicity is a key element to improve user experience by making the mobile PIS easier to use. Comprehensiveness helps meet up users' expectations and as a result influence other UX components. On the other hand, simplicity and comprehensiveness stand as two qualities that risk creating a contradiction: trying to be comprehensive may easily render a mobile application to complicated, while aiming for simplicity may result in omissions – or at least in loss of visibility – of necessary information. At this point, **being visual-oriented** plays an important role in the easy access of information through the interface. The field studies revealed successful visual communication in mobile PIS help users in operating the app much faster, increases understandability and simplicity. Attention to visual qualities has also the potential of improving the **visual appeal** of a mobile PIS, which plays a role in the user experience (Alben, 1996). The results of studies showed that appeal, as a visual quality, positively affects users' emotions, motivates them in using and accepting the mobile PIS. Since perception of visual style and language is subject to change over time, it is important that the app be visually updated occasionally, in order to prevent negative criticism as was encountered during the conducted studies. Some visual revision (such as redesign or rebranding) can be done periodically to improve the user experience. However, since visual appeal was categorized as a

quality of secondary importance, one could infer that such revisions may only improve the experience as long as they are executed without hindering the primary qualities or any UX components that might have precedence.

Finally, **being fast**, **entertaining**, **customizable** and **safe** are to be considered as third level qualities. As a part of the informational-technical context, operating speed is an element that affects the user experience of mobile PIS and the field studies clearly showed that slowness prevents a mobile PIS from being perceived as useful. Therefore, regardless of the infrastructure providing the information to the app or the different operating systems (e.g. iOS or Android), the mobile PIS needs to be designed in order to provide the same quality of service at all times and to compensate if necessary, for any external technical handicap. When it comes to the topic of entertainment, even though the literature indicated its effectiveness in increasing motivation and acceptance, the field studies did not deliver much on this issue except for the users' enjoyment of the app for practical reasons. Similar to the point made about visual appeal, implementation to increase the entertainment value of a mobile PIS, such as gamification, should be executed with care, so as not to miss its main purpose and primary required qualities.

Another third level quality is being customizable which is one of the coveted qualities for mobile PIS as the results of field studies showed. Offering customization options should be considered in the design of a mobile PIS because it helps create a better experience by providing the users with choices in regard to their needs.

Finally, being safe in term of privacy issues has been revealed to be of influence particularly for the technology acceptance of mobile PIS. by affecting intention to use. The results of field studies exposed that concern for privacy annihilates any intention a user may have of interacting with the app. Therefore, the design of a mobile PIS needs to ensure that users feel safe and protected.

CHAPTER 7

CONCLUSIONS

This study's overarching aim was to see how a human-centred approach, a concept lacking in urban planning, could help improve building better urban transportation, specifically through the design of smart mobile solutions.

For this purpose, an initial literature review was conducted on urban transportation to identify its current issues in light of its historic development, followed by the review of literature on UX and technology acceptance in order to better understand how mobile Passenger Information Systems function as a new technology, how passengers interact with them, and to help identify the factors that affect these.

Based on the knowledge acquired from the literature, four successive field studies were conducted to gain human-centred insights from the users of an existing mobile PIS servicing a specific location (Ankara). The first two studies both looked at the UX factors that affect the use of the mobile PIS. While the first one focused more on issues like first use and impressions, memorability, learnability, effectiveness and efficiency, the second one's main aim was a more in-depth analysis of the app's usability and user's opinions, expectations and perceptions on the app through a more longitudinal investigation. The third and fourth studies aimed for opposing directions, both in terms of investigative methods and the scope of the inquiry. While the former's purpose was to go more in depth with a Likert scale questionnaire, by looking specifically at how the technologic aspect of the app affects the user experience, the latter explored the mobile PIS in a much broader sense within the context of new mobility, through interviews with both users and urban transportation experts.

This chapter presents the prominent insights revealed by the fieldworks, in light of the literature review, in an attempt to answer the research questions posed in Chapter 1.

7.1. Revisiting the Research Question

The main research question of this thesis was *"How can mobile Passenger Information Systems be improved to become a more human-centred tool of new mobility in urban transportation?".* The research question is comprised of two main parts: the first part is related to user experience and technology acceptance of mobile PIS while the second one investigates mobile PIS as a part of new mobility.

7.1.1. How Can Mobile Passenger Information System Be Improved in Terms of User Experience and Technology Acceptance?

As stated in findings and discussion in this thesis, there are some qualities related to the user, the product and the context that affect UX and technology acceptance of a mobile PIS. Moreover, there is an interactive relationship between these three factors. According to the results of this study, Figure 7.1 shows this relationship with the qualities that play a significant role in user experience and technology acceptance of a mobile PIS.

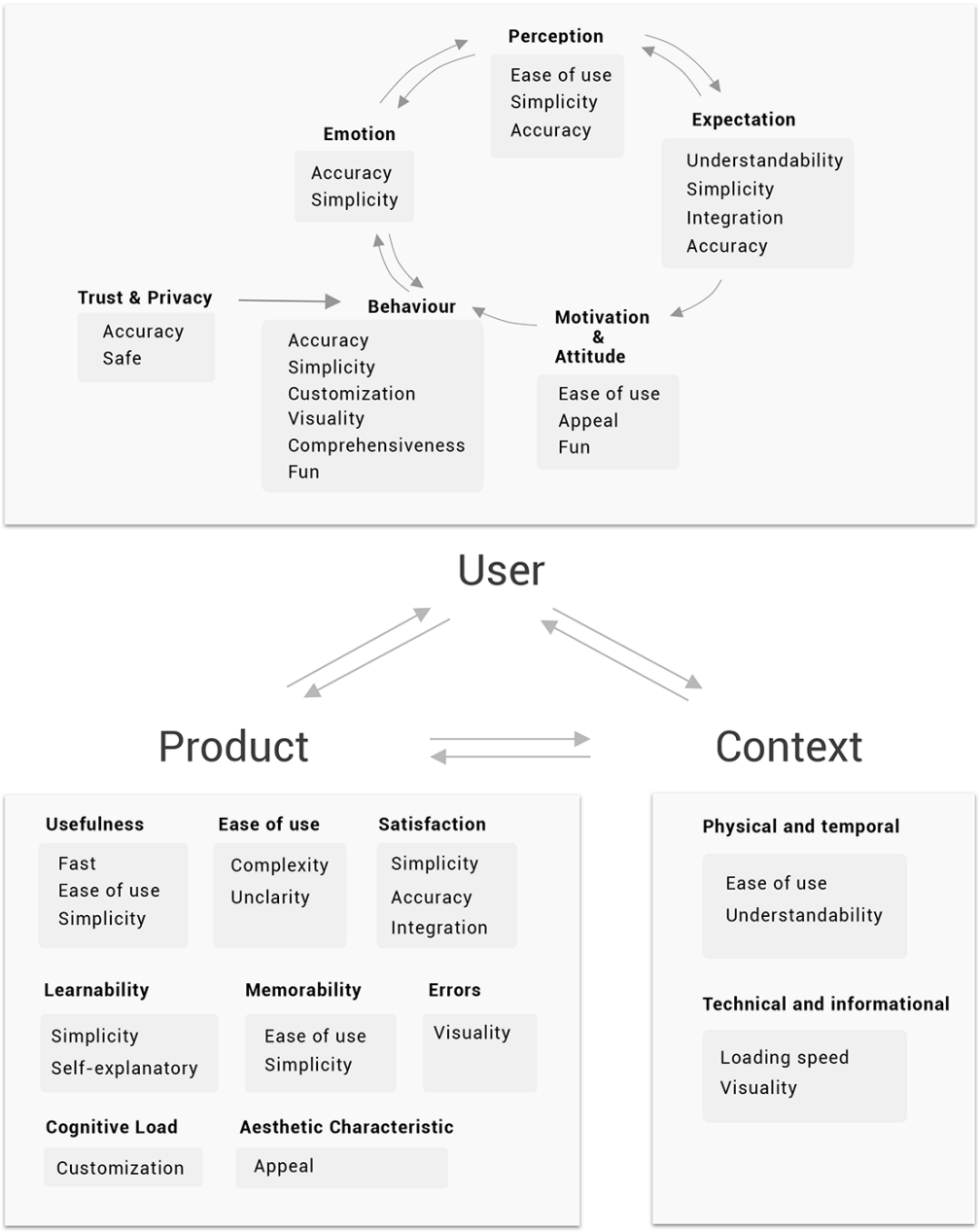

Figure 7.1. The relationship between the main three factors of UX and technology acceptance of the mobile PIS

User-Product Relationship: Technology related factors, such as ease of use, influence whether users' expectations are met, how they perceive the product, what

they feel about it, how they act toward it, or whether they are motivated to use it. All these emotions, attitudes, etc, in turn may affect how effective, efficient, satisfying or even appealing a product is judged to be. According to the results of the study, Figure 7.1 reveals which product quality affects which user component in regard to user experience, as well as the relationship between the various components.

Product-Context Relationship: The same aspects of a product may create different experiences for the user when the physical or temporal context changes, which may influence whether the technology is accepted or not. For example, a product may be more easily misused and give errors when interacted by an inattentive user in a rush or a feature deemed easy to use when sitting may become difficult when the user is walking. On the other hand, the product related factors, may have an effect on the context related ones, only through the user related factors. For example, the effectiveness, perceived fun or aesthetic appeal of a product may influence the context, by manipulating how time is perceived, whether or not users are aware of their surroundings or believe their product to be influential in their social environment.

User- Context Relationship: The context of use affects the user related factors in various ways. For example, the social context may dictate behaviours and expectations: one may be reluctant to use an app in a crowded environment or may expect specific features of it because of it. Using the app at night time, may have emotional repercussion, since the user may feel less secure, or the product may be perceived differently due to its lighted screen in the dark. User related factors, although not capable of actually changing the physical realty of the context of use, are able to shift and manipulate its influence on other factors. For example, emotions can alter the perception of time, or a change in perception or behaviour may affect the image of a product and the social influence it has.

To improve user experience and technology acceptance, the design of mobile PIS should considerate of the relationships between the user, the product and the context. Instead of developing an app focusing on one of the factors, such as the product or one

of its components such as the usefulness of the product, the design should be made in a fully human centred way, regarding all the factors and components of the experience.

7.1.2. How Can Mobile PIS Become a More Enhanced Tool of New Mobility in Urban Transportation?

With the increasing use and significance of mobile technologies, the concept of new mobility appears as the future of smart city systems. Mobile PIS takes on an important role within this scope, as a potential connecting link between the city and its citizens. Therefore, it is meaningful to investigate mobile PIS, in regard to the three core elements of new mobility: **interconnectivity, data** and **shared system.**

Further than providing information to the users, mobile PIS can help build better urban transportation by gathering valuable information from and about the citizens, and then transferring it to authorized agents or bodies that can use it to improve the urban infrastructure or plan the urban transportation anew. As the experts and participants stated in the field studies, mobile ticketing (as a part of interconnectivity) and social media (as a part of shared systems) can play an important role in building this data flow, by facilitating the gathering and transmission of information. Therefore, it is necessary to implement interconnectivity and shared systems in mobile PIS design, in order to enhance its effectiveness as a new mobility tool. Paying attention to the integration of mobile ticketing and offering ways to connect and interact with various social media platforms, appear as the first steps in achieving that goal.

Nonetheless, as the experts expressed, these improvements and contributions of mobile PIS would still need to be supported by governmental policies to be truly effective.

7.2. Limitations and Suggestions for Future Studies

The thesis explored ways of enhancing user experience of mobile passenger information systems and increasing their technology acceptance. Because of limitations, as explained in Chapter 4, the field studies in the thesis were conducted

only with the EGO CEP'TE app. Moreover, the field studies were focused on Ankara because the literature indicated the importance of having a local approach. Since the other two mobile PIS (Trafi and Moovit) received important updates since the field studies were conducted, follow up studies that would be conducted with these two apps can provide more significant results by giving new and additional information. The study could further be expanded by conducting similar studies with different local cases, and possibly enriching the results. In addition, future studies still focusing solely on EGO CEP'TE may provide new insights due to new updates made to the app since the time of the field studies.

All the case studies that were conducted within this thesis's scope were of an exploratory nature. Further studies that would go more in depth both in terms of qualitative and quantitative research may provide useful and different perspectives for the improvement of mobile PIS. Moreover, the fields studies were conducted with a small group of participants who were mostly from similar demographic backgrounds. Further studies with larger and more varied groups of participants, with different transportation habits and needs, may provide more significant results for improving mobile PIS.

As showcased by the result of field studies, the factors that affect user experience of a mobile PIS and its technology acceptance are numerous. Future research could zoom into specific factors for more in depth and detailed results. Moreover, since the thesis sole focus was not technology acceptance, only one study (the third case study) was conducted to investigate technology acceptance as a supportive study to user experience. Further studies can be done in order to get more deeply insights about technology acceptance of mobile PIS by involving more participants and asking more questions. Another note for the third case study is that the Likert scale questionnaire adapted from the study conducted on teachers' information technology acceptance by Ursavaş, Şahin & McIlroy (2014) was used in this study without a preliminary test on the success and appropriateness of its adaptation from the field of education to that of

design. This may have affected the results of how well EGO CEP'TE's technology is accepted by its users.

The case studies revealed that users found the app unreliable in terms of the real-time information it provides. The underlying reason of this issue was not investigated in this thesis. An investigation could be conducted to understand the reason for it, whether it is technical glitch or a user problem.

As indicated before, this study's greater purpose is to help build better experience with urban transportation for passengers by improving mobile PIS, which may even potentially increase use of public transportation. However, how users are to be encouraged into such an attitude or how their behaviours could be changed, is a separate topic of inquiry that may be addressed in another study. Overall, the greater purpose is to achieve what Enrique Penalosa (Colombian Politician) described as the desired, developed urban environment: "An advanced city is not a place where the poor move about in cars, rather it's where even the rich use public transportation" (Goodreads, 2019).

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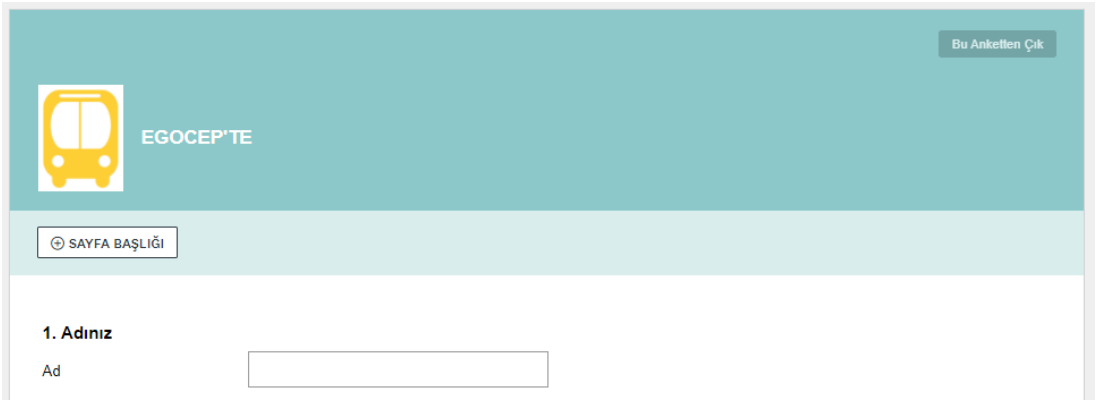
APPENDICES

A. First and Second Study Interview Questions

PROFİL	1) Cinsiyet	Kadın	Erkek
	2) Yaş		
ULAŞIM – TOPLU TAŞIM KULLANIMI	3) Aracınız var mı?		
	4) Toplu taşım araçlarını kullanıyor musunuz?		
	5) Hangi vasıtaları, ne sıklıkla kullanıyorsunuz?		
	6) Bu araçları tercih etme nedenleriniz nelerdir?		
	7) Genellikle hangi güzergahları kullanıyorsunuz?		
	8) Bilmediğiniz, daha önce gitmediğiniz bir yere giderken; nasıl gideceğiniz öğrenmek için nerden bilgi alırsınız? Neden?		
MOBİL UYGULAMA KULLANIMI	9) Akıllı telefon kullanıyor musunuz?		
	10) Telefonunuzda mobil uygulamalar kullanıyor musunuz?		
	11) En çok hangi tür uygulamaları kullanıyorsunuz? Neden?		
	12) Uygulamaları nereden duyuyorsunuz? İndireceğiniz uygulamayı nasıl seçiyorsunuz, nasıl karar veriyorsunuz?		
YOLCU BİLGİLENDİRME MOBİL UYGULAMA – EGOCEP'TE	13) Egocep'te uygulamasını biliyor musunuz?		
	14) Bu uygulamayı kullanıyor musunuz?		
	15) Uygulama hakkındaki olumlu düşünceleriniz var mı? Varsa neler?		
	16) Uygulama hakkındaki olumsuz düşünceleriniz var mı?Varsa neler?		
	17) Yolcu bilgilendirme ile ilgili başka bir uygulama biliyor musunuz?		
	18) Bunların arasından sizin kullandığınız bir uygulama var mı?Varsa; uygulamanın adı nedir?		
	19) Bu uygulamayı tercih etme nedeniniz nedir?		
	20) Bu uygulama hakkında olumlu düşünceleriniz neler?		
	21) Bu uygulama hakkında olumsuz düşünceleriniz neler?		
	22) (Eğer kullanıcı ego cep'te ya da herhangi iki veya daha fazla uygulama kullnıyorsa) Kullandığınız uygulamalar için karşılaşma yapabilir misiniz? Sizce hangi uygulama hangi özellikleri bakımdan daha iyi?		
	23) Birinden olan ama ötekinde olmayan sizin önemli bulduğunuz özellik var mı?		
	24) Her ikisinde de bulunmayan ama bulunması gerekli olduğunu düşündüğünüz özellik var mı?		

B. Second Study Weeklong Interview Questions



2. Aşağıdaki özelliklerden hangilerini kullandınız?

- [ ] Hat ara
- [ ] Adres ara
- [ ] Durak ara
- [ ] Neredeyim
- [ ] Nasıl giderim
- [ ] Otobüs nerede
- [ ] Durak nerede
- [ ] Ankara kart işlemleri
- [ ] Kameralar
- [ ] Alarm işlemleri
- [ ] Önemli yerlerim
- [ ] Favorilerim
- [ ] Duyuru ve bildirimler
- [ ] Sorun bildir
- [ ] Ayarlar

3. Uygulamadaki özellikleri kullanım açısından zorluk derecesine göre numaralandırınız (1: kolay, 5: zor)

	1	2	3	4	5
Hat ara	◯	◯	◯	◯	◯
Durak ara	◯	◯	◯	◯	◯
Adres ara	◯	◯	◯	◯	◯
Neredeyim	◯	◯	◯	◯	◯
Nasıl giderim	◯	◯	◯	◯	◯
Otobüs nerede	◯	◯	◯	◯	◯
Durak nerede	◯	◯	◯	◯	◯
Ankara kart işlemleri	◯	◯	◯	◯	◯
Kameralar	◯	◯	◯	◯	◯
Alarm işlemleri	◯	◯	◯	◯	◯
Önemli yerlerim	◯	◯	◯	◯	◯
Favorilerim	◯	◯	◯	◯	◯
Duyuru ve bildirimler	◯	◯	◯	◯	◯
Sorun bildir	◯	◯	◯	◯	◯
Ayarlar	◯	◯	◯	◯	◯

4. Uygulamadaki her bir özellik için, uygulamaya ne zaman bakıyorsunuz?

	Evden/işten/okuldan çıkmadan önce	Durakta	Otobüste
Hat ara	◯	◯	◯
Durak ara	◯	◯	◯
Adres ara	◯	◯	◯
Neredeyim	◯	◯	◯
Nasıl giderim	◯	◯	◯
Otobüs nerede	◯	◯	◯
Durak nerede	◯	◯	◯
Ankara kart işlemleri	◯	◯	◯
Kameralar	◯	◯	◯
Alarm işlemleri	◯	◯	◯
Önemli yerlerim	◯	◯	◯
Favorilerim	◯	◯	◯
Duyuru ve bildirimler	◯	◯	◯
Sorun bildir	◯	◯	◯
Ayarlar	◯	◯	◯

C. Likert Scale Questionnaires

	Kesinlikle katılmıyorum 1	**Katılmıyorum 2**	**Kararsızım 3**	**Katılıyorum 4**	**Kesinlikle katılıyorum 5**
1. EgoCep'te kullanmak performansımı artırır.					
2. EgoCep'te kullanmak işlerimi kolaylaştırır.					
3. EgoCep'te kullanmak verimliliğimi artırır.					
4. EgoCep'te kullanmayı yararlı buluyorum.					
5. Yolculuk esnasında EgoCep'te kullanmak benim için kolaydır.					
6. Durakta beklerken EgoCep'te kullanmak benim için kolaydır.					
7. EgoCep'te kullanımı benim için kolaydır.					
8. EgoCep'te kullanabilecek beceriye sahip olmak benim için kolaydır.					

	Kesinlikle katılmıyorum 1	**Katılmıyorum 2**	**Kararsızım 3**	**Katılıyorum 4**	**Kesinlikle katılıyorum 5**
9. EgoCep'te kullanmak, yolculuğu daha eğlenceli ve ilginç yapıyor.					
10. EgoCep'te kullanmak beni mutlu ediyor.					
12. EgoCep'te kullanarak yolculuk yapmak hoşuma gidiyor.					
13. EgoCep'teyi sıklıkla kullanacağımı düşünüyorum.					
14. Gelecekte EgoCep'te kullanmayı planlıyorum.					
15. EgoCep'teyi tanıdıklarıma, arkadaşlarıma tavsiye edeceğim.					
16. EgoCep'te kullanırken zorlandığımda yardım alabileceğim kişiler vardır.					

	Kesinlikle katılmıyorum 1	**Katılmıyorum 2**	**Kararsızım 3**	**Katılıyorum 4**	**Kesinlikle katılıyorum 5**
17. EgoCep'te kullanırken bir sorunla karşılaştığımda kimden yardım alacağımı bilirim.					
18. EgoCep'te kullanırken bir sorunla karşılaştığımda teknik destek alırım.					
19. Teknolojiyi kullanmaktan zevk alıyorum.					
20. Akıllı telefon kullanmak heyecan vericidir.					
21. Mobil uygulamaları kullanmak heyecan vericidir.					
22. EgoCep'te kullanmayı seviyorum.					
23. EgoCep'te kullanmak eğlencelidir.					
24. EgoCep'teyi kullanacak bilgi ve beceriye sahibim.					

	Kesinlikle katılmıyorum 1	**Katılmıyorum 2**	**Kararsızım 3**	**Katılıyorum 4**	**Kesinlikle katılıyorum 5**
25. EgoCep'teyi kullanımı konusunda kendime güveniyorum.					
26. Bir kişi bana uygulamayı nasıl kullancağımı gösterse uygulamayı kullanabilirim.					
27. Yeni teknolojilerin kullanımını öğrenmeye çok zaman harcamam gerekir.					
28. Yeni teknolojileri kullanmak benim için hep karmaşık olmuştur.					
29. Yolculukla ilgili işlemlerimi EgoCep'te kullanarak bakma çok zaman alır.					
30. Yolcu bilgilendirme ile ilgili mobil ugulamaya ihtiyacım olduğunu düşünüyorum.					

	Kesinlikle katılmıyorum 1	**Katılmıyorum 2**	**Kararsızım 3**	**Katılıyorum 4**	**Kesinlikle katılıyorum 5**
32. EgoCep’teye ihtiyacım olduğunu düşünüyorum.					
33. EgoCep’tenin toplu taşım teşviki için önemli olduğunu düşünüyorum.					
34. EgoCep'teyi kullanırken gergin oluyorum.					
45. EgoCep'teyi kullanırken kendimi zorlanmış hissederim.					

D. Survey Results of the Third Study

FACTOR	SCALE	SCALE MEAN	SCALE SD	FACTOR MEAN	FACTOR SD
PERCEIVED USEFULNESS	Using Ego Cep'te enables me to accomplish task more quickly.	4.13	2.54	3.88	2.13
	Using Ego Cep'te improve my effectiveness.	3.67	2.01		
	I find usage Ego Cep'te useful.	3.89	2.14		
PERCEIVED EASE OF USE	I think using Ego Cep'te during the journey is easy.	3.00	1.73	3.36	2.14
	I think using Ego Cep'te at the station is easy.	3.78	2.92		
	I think using Ego Cep'te is easy.	3.22	2.09		
	I think becoming skillful at using Ego Cep'te is easy.	3.44	2.01		
ATTITUDE TOWARD TO USE	Using Ego Cep'te makes the journey more fun and interesting.	2.22	1.10	2.85	1.33
	I have fun using Ego Cep'te.	3.00	1.22		
	I enjoy travelling with using Ego Cep'te.	3.33	1.82		
BEHAVIORAL INTENTION	I think I will use Ego Cep'te frequently.	3.56	1.67	3.63	1.99
	I plan to use Ego Cep'te in the future.	4.11	2.39		
	I would like to recommend Ego Cep'te to my friends.	3.22	2.09		
FACILITATED CONDITIONS	There are people who can get help when I have difficulty using Ego Cep'te.	3.22	2.09	2.56	1.72
	When I have a problem using Ego Cep'te, I know who to get help from.	2.78	1.30		
	I get technical support when I have a problem using Ego Cep'te.	1.67	1.90		
PERCEIVED FUN	I enjoy using technology.	4.22	2.29	3.67	1.79
	Using smartphone is exciting.	4.22	2.29		
	Using mobile applications is exciting.	4.33	2.47		
	I like to use Ego Cep'te.	3.11	1.56		
	EgoCep'te is fun to use.	2.44	0.78		
SELF-EFFICACY	I have the knowledge and skills to use Ego Cep'te.	4.11	2.54	3.93	2.24
	I trust myself in use of Ego Cep'te.	3.78	2.19		
	If someone shows me how to use Ego Cep'te, I can use it.	3.89	2.66		
COMPLEXITY	I need to spend a lot of time learning how to use new technologies.	1.89	1.53	2.19	1.15
	Using new technologies has always been complicated for me.	1.89	1.27		
	It takes a lot of time to use my travel procedures on Ego Cep'te.	2.78	1.20		
COMPATIBILITY	I think I need a mobile passenger information application.	4.00	2.72	3.89	2.57
	I think I need Ego Cep'te.	3.78	2.92		
ANXIETY	I feel apprehensive about using Ego Cep'te.	2.67	1.52	2.89	1.40
	I feel forced when I use Ego Cep'te.	3.11	1.56		
	MAX	4.33	2.92	3.93	2.57
	MIN	1.67	0.78	2.19	1.15

E. Interview Questions Content Form

Gönüllü Katılım Formu

Bu çalışma, ODTÜ Endüstri Ürünleri Tasarımı Yüksek Lisans Programı öğrencisi olan Selcen Kökcü Çetin tarafından Doç. Dr. Gülşen TÖRE YARGIN danışmanlığında 'Methods of User Research' dersi kapsamında mobil yolcu bilgilendirme uygulamalarının kullanıcı kabulü açısından değerlendirilmesi amacıyla bir çalışma yürütülmektedir.

Çalışmaya katılım tamamıyla gönülllük temelinde olmalıdır. Sizden kimlik belirleyeci hiçbir bilgi istenmemektedir. Cevaplarınız tamamıyla gizli tutulacak ve sadece araştırmacı tarafından değerlendirilecektir. Elde edilecek bilgiler bilimsel amaçlarla kullanılacaktır.

Görüşmede size, genel olarak kişisel rahatsızlık verecek sorular yöneltilmeyecektir. Ancak, katılım sırasında sorulardan ya da herhangi başka bir nedenden ötürü kendinizi rahatsız hissederseniz cevaplama işini yarıda bırakıp çıkmakta serbestsiniz. Görüşme sonunda, bu çalışmayla ilgili sorularınız cevaplandırılacaktır. Bu çalışmaya katıldığınız için şimdiden teşekkür ederiz. Çalışma hakkında daha fazla bilgi almak için Selcen Kökcü Çetin (Tel: 0555 697 57 01; E-posta: selcenkokcu@gmail.com) ile iletişim kurabilirsiniz.

Bu çalışmaya tamamen gönüllü olarak katılıyorum ve istediğim zaman yarıda kesip çıkabileceğimi biliyorum. Verdiğim bilgilerin bilimsel amaçlı yayımlarda kullanılmasını kabul ediyorum. (Formu doldurup imzaladıktan sonra uygulayıcıya geri veriniz).

İsim Soyad Tarih