DEI College

REdBull 2018

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Introduction

Dear Reader,

DEI College is a private educational institution with over 30 years' commitment to developing high academic standards and providing top-quality education suited to the interests and needs of people from a wide range of backgrounds. It is a partner institution of the *University of Northampton* and a registered teaching institution of the *University of London*.

It currently offers degrees on Law (LLB/LLM), Computing (BSc/MSc), Psychology (BSc), Business (BSc/BA/MBA), Economics (BSc), Tourism (BA/MA), English (BSc/BA), Social Innovation (MA), Sports (BSc), Accounting (BSc), Banking (BSc), Politics and International Relations (BSc).

Our **REdBull** offers information about new programmes to be run by DEI College in the coming academic year, projects developed by DEI staff, and research conducted by DEI's staff and students; it brings together academic news and research interests of colleagues and students; it informs current staff, students, and alumni of educational and research news as well as encourages professionals and laymen to take advantage of programmes run and research conducted by DEI College.

Enjoy our **REdBull** and remember

"Give a man a fish and you feed him for a day; teach a man to fish and you feed him for a lifetime"[1]

and

"Research is to see what everybody else has seen, and to think what nobody else has thought"[2]

UNIVERSITY OF LONDON RECOGNISED TEACHING CENTRE

University of Northampton
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[1] Maimonides or Moses ben Maimon, Sephardic Jewish philosopher, astronomer, and physician
[2] Albert Szent-Gyorgyi, Nobel Prize winner in Physiology

1. Educational News: New BSc/MA degrees running in the DEI College

DEI College has demonstrated academic excellence and rigorous support to students since 1996 as a top-quality academic institution. Periodic evaluation by internationally recognized UK Higher Education institutions guarantees the high quality of studies. In the forthcoming academic year, DEI College is ready to run a set of new programmes in partnership with the University of Northampton.

1a. BSc (Hons) Sport & Exercise Science

This multidisciplinary, undergraduate course focuses on sport, physical exercise and fitness training covering all the ongoing demands of the ever-expanding sports industry. It is practice-based and research-informed. It stimulates students to acquire knowledge and develop practical skills relating to sports equipment, software, fitness training programmes, and athletic performance.

This 3-year course is designed to provide a sound understanding of a wide range of topic areas relating to the sports industry, such as physiology, psychology, anatomy and biomechanics, nutrition, fitness training, and health. More specifically, this course examines:

- the main **physiological** systems of the human body (e.g. respiratory, cardiovascular, endocrine, muscular, metabolic, immune and kinesiology), physiological factors which influence physical performance, and use of illegal ergogenics (e.g. anabolic androgenic steroids, blood doping);

- important sport **psychological** factors (e.g. anxiety, self-confidence, motivation, peer pressure, audience effects, home advantage, aggression, coaching, group/team dynamics, emotional and behavioural responses of athletes, positive and negative mental health, and the relationship between physical activity and psychological well-being);

- **biomechanics** of the human body (e.g. osteology, arthrology, myology) as well as biomechanical factors that influence movement, performance and injury risk;

- human **nutrition** (e.g. nutrients, dietary insufficiencies, specialised diets, dietary techniques) as well as health themes (e.g. nutritional anaemia, maternal and infant nutrition, weight management and obesity, diabetes, cardiovascular disease, cancer).

- **fitness**-relating themes (e.g. the impact of fitness on health, training methods including special populations such as youths, elderly and pregnancy, and relationship between fitness and sport performance); and

- **rehabilitation and injury** risk (e.g. etiological, behavioural and environmental factors to injury, preventative techniques, treatment procedures).

Upon completion of this course, graduates could be employed in a wide range of sports and health industry sectors, such as sport science, personal training, coaching, performance enhancement, rehabilitation centres, gyms, and the fitness industry.

1b. MA International Tourism Development

This post-graduate course is designed to provide you with a substantial theoretical and practical understanding of the role and contribution of the tourism industry to contemporary urban economic development. It is practice-based and customer-focused. It focuses on sustainable tourism businesses management, strategic destination management and marketing.

This one-year MA will guarantee a sound understanding of key issues relating to tourism industry, such as sustainable tourism development, destinations management, event tourism. This course explores the global scope of tourism by drawing upon a variety of international case studies. More specifically, it examines:

- issues relating to **tourism development** (e.g. the multi-disciplinary facets of the field of international tourism futures; international case-studies that shed light on sustainable tourism development; social, cultural, economic and environmental impacts of tourism development on global destinations; cross-cultural tourism management and working in a non-native environment);

- strategic **destination** management (e.g. challenges of destination management and marketing; adverse impacts of natural and man-made disasters and catastrophes; risk and crisis management; post-conflict management)

- the role of **events** in tourism (e.g. use of events as vehicles for urban regeneration and revitalisation; the contribution of events in the cultural and economic development of cities)

This MA opens the road for a career in the vast industry of tourism sector in Greece and abroad. Graduates could be employed in tourism enterprises, tourism organisations, NGOs, aid organisations, and a variety of charities.

1c. MSc Computing (Internet Technology & Security)

This post-graduate course focuses on computing, computer technology and internet security, meeting the current high demands of the information technology industry. It is technical-based and business-oriented. It helps students to acquire expertise and hone practical and professional skills on internet/cyber security products and services.

This one-year MSc degree pays emphasis on interactions between systems, humans and the environment as well as on the challenges stemming from information technologies and web applications. More specifically, it explores the synchronisation of the software with the environment; innovative means of human communication with machines;

security issues in the so-called 'Internet of Things'; analysis and collection of data as regards the interactions between systems, humans and the environment; and the design of 'smart' interactive technologies. This course will enable students to analyse and modify different forms of internet security; design projects relating to internet technologies; evaluate techniques to develop their projects; and work independently. A brief list of subjects covering throughout this course is as following:

- data modelling techniques and deployment of databases;

- functional modules of computers;

- object based solutions to software problems;

- programming of client and server software as well as web applications;

- management and implementation of secure computer applications in an internet environment; and

- mobile device software development

Upon completion of this course, significant opportunities open for a career in the broad and ever-expanding information technology and computing industry, as information technology manager, information officer or architect, information security officer or analyst, information security risk officer or consultant, project manager, web developer or designer, cyber security manager, source code auditor, and IT security Operations specialist.

2. Projects

Being committed to developing high pedagogical standards and interested in providing essential social input, DEI College currently runs two projects.

2a. Model Digital Course Books for distance-learning LLB studies

Within the framework of this project, two core aspects of the syllabus covered by LA1020 'Public Law' (*Constitutional Sources* and *EU institutions*) and one core aspect of the syllabus covered by LA1040 'Contract Law' (*Offer and Acceptance*) of the University of London (UoL) LLB are currently being developed. The targeted group are non-native English-speaking students who find it difficult to navigate the transition to distance learning studies because of cultural, social or economic factors. This project is being developed by Mr Alkiviadis Agapidis (tutor in Contract Law), Mr Nikolaos Papalampros (programme leader and tutor in EU Law) and Dr Yannis Sygkelos (tutor in Public Law), who draw on academic research about directed-independent and blended-learning methods.

The goals of our project is to effectively direct UoL LLB students into becoming independent learners through a wide range of elements and activities, such as enquiry-based, self-assessment, think-consider-evaluate, and writing skills ones supported by the provision of guidance and generic feedback where applicable; to allow tutors of institutions teaching LLB modules to re-sequence their contents according to their class-specific needs; and to increase the perceived value of the Undergraduate Laws Programme to students and tutors. These goals will be attained by the digital and customazible format of the set course books as well as by their high degree of modularity.

After our model digital course books be reviewed by UoL content experts and become available to students, we intend to evaluate them using a sequential-explanatory method. We will collect quantitative data from students and then conduct qualitative research to assess whether our course books are effective in helping students of diverse backgrounds to engage as independent learners with the knowledge base covered therein.

We anticipate our project having significant impact upon the academic community as, first and foremost, it will develop an innovative approach to enhance the capacities of non-native English-speaking independent learners; it will increase collaboration between teaching institutions; it will constitute an instigator of a wider network of teaching institutions and tutors engaged with material supportive of directed-independent learning; it will contribute to the UoL Toolkits of Tutors. This project is funded by the ***University of London*** under the ***Development Grant Funding*** for institutions announced by the Undergraduate Laws Programme in the academic year 2017-18.

2b. Street law/psychology

Under this project, DEI College has adapted the so-called 'clinical legal education' (widespread in the USA and the UK) to a hands-on approach to study, so as students of Law and Psychology gain the opportunity to learn legal/psychological principles outside the classroom and apply them in real problems. This is a 'learning-by-doing' activity and experiential learning, which intends to make students reflect on up-to-date social issues; deepen their knowledge; make their learning experience more attractive and tangible; develop their professional skills; and enhance their self-confidence.

More specifically, at the first stage of this project, students hone skills such as conduct of legal research by discovering primary and secondary literature; team-working by dividing their work-load into groups and communicating the results of their work across the groups; and time management. At the second stage of this project, students hone skills such as drafting a brief, easy-reading, and audience-friendly analysis of the subject assigned to them; problem-solving in real circumstances; making a presentation and communicating the outcome of their work to the targeted community group.

The topic of our action is school bullying, very sensitive and controversial but rife among pupils. In their research, students were monitored and supervised by early-career lawyers and academic staff; as a result, students receive feedback on their research and familiarise themselves with the ethical and professional framework relevant to the practise of their discipline. Its ultimate goal is to make an informative presentation of human rights issues raised by bullying, of criminal liabilities applicable under the Greek legislation, and of psychological effects in the life of both bully and bullied. The targeted group will be students of secondary education. Therefore, our project will eventually forge the links between education and real life as well as between the college and the wider community. All in all, not only does this 'street law/psychology action' encourage DEI students' learning experience, but also has a significant input in Thessaloniki's society.

People involved in this project are Yannis Sygkelos (project co-ordinator), Melissa Theocharidou (lecturer in psychology), Thepi Tolidou and Antonis Zachariadis (lawyers and DEI alumni), Paraskevi Teperidou, Iliana Andria, Prodromos Laskaridis, Elenica Kuka, and Sofia Bili (DEI students).

3. Research

In this chapter, the research conducted by DEI's staff and students is presented. The first part contains abstracts of manuscripts and articles published in academic journals as well as conference presentations and ongoing research indicative of the research interests of DEI's staff. The second part contains students' dissertations of a distinguished quality as well as abstracts of those of highly commendable quality.

3a. Academic Staff: publications

- Balatsoukas Panos, Rousidis Dimitris, Garoufallou Emmanouel. "A Method for Examining Metadata Quality in Open Research Datasets Using the OAI-PMH and SQL Queries: the Case of the Dublin Core 'Subject' Element and Suggestions for User-Centred Metadata Annotation Design", *International Journal of Metadata, Semantics and Ontologies*, (2018).

The study is focused on analysing data retrieved with a novel methodology from the Dryad open access research repository and identifying data quality issues. "An open-access repository or open archive is a digital platform that holds research output and provides free, immediate and permanent access to research results for anyone to use, download and distribute". The Dryad Digital Repository is "a curated resource that makes the data underlying scientific publications discoverable, freely reusable, and citable". Dryad provides a general-purpose home for a wide diversity of datatypes.

The growth of data, and simultaneously of metadata, which are stored in research repositories is exponential. However, there are several obstacles, like human (non-automated) manipulation, management and use of the data, the huge volume of data and at the same time the lack of financial resources that are affecting the quality of data. Poor quality metadata can have negative impact on the way research datasets are retrieved, shared and used by scientists, but also on the way research data repositories are managed and audited.

The aim of the study was to conduct a descriptive analysis of the Dublin Core's Subject metadata element and identify its quality problems, if any, in the context of the Dryad research data repository. "The Dublin Core Schema is a small set of vocabulary terms that can be used to describe digital resources (video, images, web pages, etc.), as well as physical resources such as books or CDs, and objects". The Dublin Core Subject metadata element is the topic of the resource and it can be represented using keywords, key phrases, or classification codes.

A mechanism for downloading the metadata elements from the Dryad repository and transforming them to the appropriate processing format was introduced. In total 4557 metadata packages and 13,638 metadata data files were analysed following a novel data preprocessing method using SQL queries.

The qualitative and quantitative analysis found trends about the subject coverage of the repository like for instance clusters regarding the authors and the subject that they are focusing their research, which subjects are the most popular ones and more. Finally, quality problems related to the lack of controlled vocabulary and standardisation were identified.

- Bozhkov Stanislav, Lee Habin, Sivarajah Uthayasankar, Despoudi Stella, Nandy Monomita. "Idiosyncratic Risk and the Cross-Section of Stock Returns: the Role of Mean-Reverting Idiosyncratic Volatility", *Annals of Operation Research* (2018) – doi: https://doi.org/10.1007/S10479-018-2846-7

A key prediction of the Capital Asset Pricing Model (CAPM) is that idiosyncratic risk is not priced by investors because in the absence of frictions it can be fully diversified away. In the presence of constraints on diversification, refinements of the CAPM conclude that the part of idiosyncratic risk that is not diversified should be priced. Recent empirical studies yielded mixed evidence with some studies finding positive correlation between idiosyncratic risk and stock returns, while other studies reported none or even negative correlation. We examine whether idiosyncratic risk is priced by the stock market and what are the probable causes for the mixed evidence produced by other studies, using monthly data for the US market covering the period from 1980 until 2013. We find that one-period volatility forecasts are not significantly correlated with stock returns. The mean-reverting unconditional volatility, however, is a robust predictor of returns. Consistent with economic theory, the size of the premium depends on the degree of 'knowledge' of the security among market participants. In particular, the premium for Nasdaq-traded stocks is higher than that for NYSE and Amex stocks. We also find stronger correlation between idiosyncratic risk and returns during recessions, which may suggest interaction of risk premium with decreased risk tolerance or other investment considerations like flight to safety or liquidity requirements. We identify the difference between the correlations of the idiosyncratic volatility estimators used by other studies and the true risk metric the mean-reverting volatility as the likely cause for the mixed evidence produced by other studies. Our results are robust with respect to liquidity, momentum, return reversals, unadjusted price, liquidity, credit quality, omitted factors, and hold at daily frequency.

- Despoudi Stella, Papaioannou Grammatoula, Saridakis George, Dani Samir. "Does collaboration pay in agricultural supply chain? An empirical approach", *International Journal of Production* (2018)- doi: 10.1080/00207543.2018.1440654

This paper examines the effect of different types of collaboration on the level of Postharvest Food Losses (PHFL) and the proportion of low-quality peaches produced using a unique data-set of Greek peach producers. Quantile regression techniques are adopted to estimate the effects at different points of the conditional distribution of our variables of interest. The findings of this study suggest that high levels of collaboration between producers and cooperatives are associated with both low levels of PHFL and a low proportion of low-quality peaches. We also find that specific types of collaboration, such as 'goal congruence', can play a significant role in reducing PHFL and improving the quality of peach production at the extremes of the distribution. Important policy implications regarding collaborative practices and systems that can be implemented to reduce PHFL and boost a producer's performance together with sustainability credentials are drawn from this study.

- Rigas Emmanouil, Ramchurn Sarvapali, Bassiliades Nick. "Algorithms for Electric Vehicle Scheduling in Large-Scale Mobility-on-Demand Schemes", *Artificial Intelligence* (2018), 262, pp.248-278 - doi: https://doi.org/10.1016/j.artint.2018.06.006

In a world where over 60% of the total population will be living in, or around, cities the current personal transportation model is not sustainable as it is based almost entirely on privately owned internal combustion engine vehicles. These vehicles cause high pollution and face low utilization rates. Electric Vehicles (EVs) can be an efficient alternative to those using internal combustion engines when it comes to running cost, environmental impact, and quality of driving. However, these advantages come with a trade-off, as EVs have short ranges and long charging times. To address such issues, cities typically resort to building many charging stations with fast chargers, or battery swapping capabilities. Now, such facilities are only worth building if there are enough EVs to use them. However, drivers will not buy EVs if charging stations are not first available, leading to a catch-22 situation.

To increase vehicle utilization, Mobility-on-Demand (MoD) schemes have been advocated. MoD involves vehicles that are used by either individuals, or small groups of commuters, thus providing them with an alternative from using their privately-owned vehicles. Such systems have the potential to reduce traffic congestion in urban areas, as well as the need for large numbers of parking spots. By doing so, MoD also aims to achieve considerably higher vehicle utilization rates compared to individually owned ones, as few vehicles will cover the transportation needs of many commuters.

In this paper, we study a setting where Electric Vehicles can be hired to drive from pick-up to drop-off points in a Mobility-on-Demand scheme. The goal of the system is, either to maximize the number of customers that are serviced, or the total EV utilization. To do so, we characterise the optimisation problem as a max-flow problem to determine the set of feasible trips given the available EVs at each location. We then model and solve the EV-to-trip scheduling problem offline and optimally using Mixed Integer Programming (MIP) techniques and show that the solution scales up to medium sized problems. Given this, we develop two non-optimal algorithms, namely an incremental-MIP algorithm for medium to large problems and a greedy heuristic algorithm for very large problems. Moreover, we develop a tabu search-based local search technique to further improve upon and compare against the solution of the non-optimal algorithms. We study the performance of these algorithms in settings where either battery swap or battery charge at each station is used to cope with the EVs' limited driving range. Moreover, in settings where EVs need to be scheduled *online*, we propose a novel algorithm that accounts for the uncertainty in future trip requests. All algorithms are empirically evaluated using real-world data of locations of shared vehicle pick-up and drop-off stations. In our experiments, we observe that when all EVs carry the same battery which is large enough for the longest trips, the greedy algorithm with battery swap with the max-flow solution as a pre-processing step, provides the optimal solution. At the same time, the greedy algorithm with battery charge is close to the optimal (97% on average) and is further improved when local search is used. When some EVs do not have a large enough battery

to execute some of the longest trips, the incremental-MIP generates solutions slightly better than the greedy, while the optimal algorithm is the best but scales up to medium sized problems only. Moreover, the online algorithm is shown to be on average at least 90% of the optimal. Finally, the greedy algorithm scales to 10-times more tasks than the incremental-MIP and 1000-times more than the static MIP in reasonable time.

- Rigas Emmanouil, Karapostolakis Sotiris, Bassiliades Nick, Ramchurn Sarvapali. "EVLibSim: A Tool for the Simulation of Electric Vehicles' Charging Stations Using the EVLib Library", *Simulation Model-ling Practice and Theory*, 87, pp.99-119 (2018) - doi: https://doi.org/10.1016/j.simpat.2018.06.007

Electric Vehicles (EVs) are considered an efficient alternative to internal combustion engined ones, aiming to reduce global CO_2 emissions. In the last years, EVs are entering the market in an increasing pace. In contrast to conventional cars, EVs have a more complicated recharging procedure, as they demand special chargers and large volumes of electric energy, preferably coming from renewable sources. To date, several techniques and algorithms have been developed for the management of the charging of EVs. However, interoperability between various technologies and techniques is missing, and it is vital for successful large scale EV deployments. Thus, there is a need EV technologies to be able to work seamlessly and efficiently together. Different types of chargers should be able to work with all EV models, and data exchanged between entities (EVs, charging points, network operators) should have an understandable by all format and meaning.

For this reason, the development of tools for the efficient simulation of the charging of large numbers of EVs is critical. In this vein, EVLibSim is a tool for the simulation of EV activities at a charging station level. EVLibSim unifies EVLib's primary functions such as the charging and dis-charging of batteries, battery swapping, as well as parking/inductive charging. EVLib is a Java library that provides a simple, yet efficient framework for the management of several Electric Vehicle (EV) activities, at a charging station level, within a Smart Grid. EVLibSim provides a great variety of configuration options such as the types and number of chargers, the available energy, the waiting queues, etc. Furthermore, through plots and overview dashboards each user can supervise the operation of the tool in real time. Both EVLib's and EVLibSim's efficiency and scalability have been tested in realistic scenarios, while the correctness and safety of the code have been verified using state of the art tools. Finally, the user experience of the EVLibSim has been evaluated and improved through a detailed user evaluation.

- Stefanidou Anastasia. "Resistance and Diaspora in the Immigrant America of Theano Papazoglou Margaris", *proceedings of the 1st Thessaloniki International Greek-Diaspora Symposium "Greek Diaspora: Tangible, Intangible Material and Identities," Diaspora Research and Immigration Initiative (DRIMMI)* (2018), forthcoming.

Highly acclaimed by the Greek community in the USA and awarded with a prize from the Academy of Athens, Theano Papazoglou Margaris (1906-1991) does not hesitate to turn her critical and often ironic gaze against her own people's faults in their negotiation of their diasporic existence, revealing thus her extreme love towards them. In her stories, written exclusively in Greek, Margaris exposes the pain of losing one's home for ever as well as the everyday life routines, struggles, and occasional joys of the underprivileged Greek immigrants in the first half of the 20th century in America. Combining chronicle, fiction, memoir, history, and ethnography, Margaris's fierce voice, feminist spirit, and idiomatic language cannot but be loudly heard. On the other hand, her narrative silences are not to be ignored as they invite a further dwelling into the tumultuous and complex world of the Greek immigrants as they struggle to belong to two irreconcilable sociocultural contexts. In her work, Margaris shows that the endless bleakness and the psychological turmoil of immigrant life may empower the individual, and particularly women, and encourage, in surprising ways, the appearance of a new internal strength in people, which can resist even the raw exploitation by those who share the same ethnic identity, that is the other Greeks in America, and have managed to rise to a higher social class. The female characters in her stories demonstrate a more effective and dynamic attitude compared to men, demanding a share in American life and culture, and preparing the ground for a drastically new and more bearable order of things, contrary to all sorts of dichotomization, categorization, and marginalization. For Margaris, diaspora means resisting gender, ethnic, and class divisions, as well as creating a space for personal fulfilment and happiness, which has the potential to transform *xenitia* into personal re-examination and cultural renewal, transcending and enriching old traditional values and embracing a multi-faceted and self-fulfilling subjectivity in diaspora.

- Sygkelos Yannis. "Phobic Discourses of the Far-Right: the case of Volen Siderov", *East European Politics and Societies: and Cultures* (2018), 32(3), pp.586-605 – doi: *https://doi.org/10.1177/0888325417736810*

This article focuses on one of the factors that is conducive to the rise of the far right in current European societies: the articulation of phobic discourses. Far-right leadership has engaged in a systematic manipulation of phobias that lie in fears, anxieties, misdirection, prejudices, and identity politics emerging from a set of factors such as unemployment, poverty, acute social inequality, the retreat of the welfare state, discomfort towards the unfamiliar, globalisation, religious fundamentalism, membership of supra-national institutions, and fading of old traditions and values.

This article investigates a set of phobic discourses articulated by the leader of the far-right Bulgarian political party ATAKA, Volen Siderov, but not uncommon to other far-right leaders both in Western and Eastern Europe (e.g. Nigel Farage, UKIP; Heinz-

Christian Strache, Freedom Party of Austria; Geert Vilders, Party for Freedom; Gábor Vona, Jobbik). ATAKA enjoyed electoral success mostly in the second post-communist decade; it also gained success in the last general elections of 2017, but this time as a member of the electoral alliance of the United Patriots (Обединени Патриоти), which became the minor partner of the incumbent coalition government under Boyko Borisov.

The analysis relies on the qualitative methods of critical discourse analysis and discourse-history approach; it explores the articulation of Siderov's phobic discourses in his books, in his texts and speeches published in the newspaper ATAKA, and in ATAKA's manifestos. Phobic discourses are divided into two broad flip-sided categories: phobias concerning a 'collective self', which might be classified as 'ethnophobia', and phobias concerning a 'collective other', either migrant or indigenous, which might be classified as 'xenophobia' or 'alterophobia'. The analysis focuses on particular topoi of broader strategies of phobias; a *topos* is understood as a discursive scheme or formula of argumentation.

More specifically, ethnophobia, implying that the nation is withering away and that the country is being transformed into a mere colony, is explored by focusing on the topoi of "treachery and disaster" and "threatened identity." Then Islamophobia, encapsulating a fear of Islam and a fear of a threat from within, that is, the Muslim minority, is examined. Within this framework, the topoi of "perpetual cultural confrontation with Islam" and "religious terrorism" are analysed. Last, Romaphobia, denoting fear towards the marginalised group of Roma, is analysed; within this framework, the topoi of the "demographic explosion of Roma" and the "bad human capital" are discussed.

Such phobic discourses are emphasised by the far right for electoral benefit; however, far-right leaders avail themselves of phobias to which European societies have been exposed and are susceptible. The incremental far-right electoral success makes phobic discourses attractive to mainstream parties as well, and hence phobias are turned into incontestable 'regimes of truth'. For these reasons, far-right strategies and genres by which they are unfolded need to be interpreted and analysed, as the deconstruction of phobic discourses would make European societies more tolerant of diversity and more rationalist in mind.

3b. Academic Staff: conference presentations

- Stefanidou Anastasia. Fragments and Ruin in Greek American Home Returns, Hellenic Association for American Studies (HELAAS): "The Politics of Space and the Humanities", 15-17 December 2017, School of English, Aristotle University, Thessaloniki.

Whether private or public, and despite its endless dimensions and connotations, the concept of home is foregrounded on seemingly paradoxical assumptions of inclusion and exclusion, of fixity and movement, of dwelling and travelling in time and space. Unavoidably, leaving home as well as returning home entails the rethinking and reconceiving of identity in situations of transit, transformation, difference, and hybridity. It is at this viable, diverse, and contested space where identity is constituted, consolidated, represented, and questioned intermittently. In other words, home is where identity happens. As the notion of home today has been radically reoriented in terms of its geophysical, material, and psychological connotations and representations, homecoming, as a physical act and/or an imaginary return, problematizes the politics of identity and location, especially for the ones who are displaced or not placed at "home." Considering the different narrativizations of placement and displacement and the critical discourses they produce, I examine the novel *The Priest Fainted* (1998) by Catherine Themma Davidson, which builds on a mythologized home imaginary depicting a young American woman's return to Greece to reconstruct her hidden family history, and the collection of essays in *Ruin: Essays in Exilic Living* (2014) by Adrianne Kalfopoulou, which, on the contrary, enters a present moment with pictures of a ruined Greece, a ruined economy, and a fragmented identity. While *The Priest Fainted* constructs a highly nostalgic home return, *Ruin* negotiates the narrator's challenges in creating a new discourse of possibilities and spaces where the self can be positioned within a non-idealized present of transnational cultural connections and hybridity. Contrary to Davidson who abandons ruins despite her proclaimed archaeological expedition to an excised past, Kalfopoulou positions herself within a ruined and fragmented space where the achievement of completeness makes no sense because the fragments of the past, the present, and the future write the culture's history.

- Sygkelos, Yannis. Far-Right Phobic Discourses, 1st University of Northampton Research Conference, 20-21 June 2018, Northampton, United Kingdom.

Since the 1990s, Europe has witnessed the emergence and rise of many far-right parties in several countries. The sources and predominant themes of discourses articulated by far-right political leaders are addressed with emphasis on their investment in phobic discourses which have been proved conducive to their electoral success. It is argued that far-right leadership has engaged in a systematic manipulation of phobias that lie in socially entrenched fears, anxieties, prejudices, misdirection and identity politics in order to gain popularity and considerably increase their vote share. It is, also, argued that consistent social exposition to phobias makes them attractive to mainstream parties as well, which turns phobias into incontestable 'regimes of truth'.

Phobic discourses are divided into two broad flip-sided categories: phobias concerning a 'collective self', which might be classified as 'ethnophobia', and phobias concerning a 'collective other', either migrant or indigenous, which might be classified as 'xenophobia'. The methodological approach is critical discourse analysis apt to investigate rhetorical strategies that cultivate and spread phobias with a focus on a set of particular topoi, that is, argumentative schemes, of perceived threats, imminent disasters, and allegedly irreconcilable confrontations.

In the first stage of this research, the phobic discourses of the opportunist far-right leader of the Bulgarian political party ATAKA, **Volen Siderov**, were examined. In the next stages, the phobic discourses of the opportunist far-right leader of the Greek political party Independent Greeks (Anexartitoi Ellines), Panos Kammenos, and the ideologue fascist leader of the Greek political party Golden Dawn (Chrysi Aygi), Nikos Michaloliakos, will be explored. The major goal is to compare similar (electorally successful) phobic discourses articulated by leaders of personality parties with different characteristics as well as to draw conclusions reflecting the different political traditions and environment that these discourses have been developed and deployed. This research intends to open the field for investigation of other European far-right leaders (e.g. Nigel Farage, UKIP), which have articulated, reproduced, overstated and disseminated similar phobic discourses; it may engage, apart from the political science, disciplines such as psychology and law.

3c. Academic Staff: other ongoing research

- Examiliotou Petra. An integrative model of painkillers misuse behaviour.

Pain is an aversive signal system of the body that alerts us of potential tissue damage and injury. Although pain sensation is universal among all humans and has an evolutionary value, its experience and behavioural responses to pain are subjective. Advances in medical science have led to the development of painkillers, substances that are used by national health systems to regulate and control the experience of pain. Nevertheless, painkillers tend to be misused leading to painkiller dependence, an emerging public health challenge.

Research from across the medical and social sciences had provided data on identifying demographics (gender, age, socioeconomic background) related to painkillers use as well as recording users' knowledge of painkillers. However, we know relatively little about the psychological mechanisms underlying painkillers misuse/abuse. As this is a goal directed and intentional behaviour, the analysis of intentions in the decision-making process leading to this behaviour is of vital importance. The main structure of the Theory of Planned Behaviour suggests that attitude towards behaviour, subjective norms, and perceived behavioural control (PBC), together shape an individual's behavioural intentions and behaviours but distinguishes between distal and proximal predictors of intentions and behaviour (Fishbein 2000; 2009).

My study explores four basic themes on painkillers use and misuse. More specifically we look into participants' pattern of painkillers use (frequency, dosage, combination with other substances), their motivations behind it, their expectations and influence factors. We also examine their perceptions on painkillers misuse (definition, frequency, reasons for/against misuse), and finally, on normative and control beliefs regarding painkillers misuse and expected outcomes. The final part of my interview is based on Ajzen's guidelines on TPB questionnaire to elicit beliefs in painkillers misuse (identifying the expected outcomes, normative and personal control beliefs).

3d. Students: dissertations of a distinguished quality

- Gkourtzounis Ioannis. *Urban Mobility Upgrade: Car Sharing Software Platform for Electric Vehicles*[1]

Abstract

Nowadays, more and more people live in the cities as they have access to essential resources that help them make their lives better. As cities get crowded, the need for transport leads to the demand for more journeys, which in turn creates a rapid growth of motorized vehicles. The majority of these vehicles use internal combustion engines and this has some serious negative impacts in our everyday lives like air pollution, congestion and traffic accidents.

Thus, a new personal transportation solution is needed. Our proposed solution consists of two parts. First, the description of a system that tries to bring two "green" ideas together: the use of Electric Vehicles (EVs) and in particular Battery Electric Vehicles (BEVs), as they produce zero harmful emissions and they have a high level of efficiency, in car sharing systems that offer mobility-on-demand. Such schemes reduce vehicle ownership and help mitigating the effects mentioned previously.

The second part of our solution is a software package for car sharing companies with EVs in their fleets. We analyzed use cases of administrators and customers of one-way car sharing schemes. Charging station data were collected related to the city of Bristol and we designed, implemented and tested: (i) a web platform for administrators, where the system can manage user requests and accept or deny them, ensuring that the highest number of users will be served, (ii) a mobile application, that lets users login, select stations and request vehicles.

In order to increase the effectiveness of the system, we developed two algorithms that assign available vehicles to users. We generated simulations of route re- quests with different criteria. The Long mode algorithm performed better with an average gain of 1.83% in efficiency rate in 120 requests per day when compared to the Short mode. We evaluated the system and showed that we offer a software solution that is reliable, secure, universal, maintainable and extensible and this concludes our proposed urban mobility upgrade.

Acknowledgments

I would like to express the deepest appreciation to my advisor Emmanouil Rigas, who continually and convincingly conveyed a spirit of adventure in regard to research and scholarship, and an excitement in regard to teaching. Without his guidance and persistent help this dissertation would not have been possible.

[1] This dissertation has been submitted in partial fulfilment of the requirements for the degree **of BSc (Hons) Computing** in the subject of **General Computing** (University of Northampton, 2018) under the supervision of Emmanouil Rigas.

Introduction

1.1 Background

Today, cities are our homes. Every year more and more people move to new environments for many reasons. Seeking for a better job to advance our careers or for joining new communities, we see urban environments as a pool of opportunities for our lives. Transport is crucial for individual commuters and businesses, so a city should offer reliable means for our personal mobility. Urban development satisfies our needs but the increasing number of residents within a city introduces serious problems. More trips mean more vehicles with internal combustion engines (ICE) on the roads. Unfortunately, this has significant side effects to our environment, health and economy.

1.2 Problem Statement

Urban mobility systems have added the necessary means for people to access essential city resources. The need for transportation was the catalyst for the rapid growing in numbers of motorized vehicles in urban areas and this turned out to have some concerning negative consequences to our lives. Global carbon dioxide emissions are rising every year, while greenhouse gases make global warming tangible to many countries. More cars mean more traffic, more road accidents and more people dead or injured. Congestion harms the economy of the city when the transportation of goods slows down. Time, fuel and money are wasted for every alternative route that drivers have to take caused by traffic jams in peak hours.

New systems have emerged to satisfy our need for mobility-on-demand. In car sharing schemes, people rent and use vehicles only for their trips. Car sharing al- lows low income inhabitants to access vehicles without having to buy them. Reducing the vehicle ownership helps mitigating some of the negative effects mentioned. Such schemes attracted large organizations and now serve a large number of customers every day. But still, the dominant vehicle on the roads is based on internal combustion engines, and this keeps its effects tied to our journeys.

We need a new solution to upgrade our personal mobility. Not only should we adopt a new way of travelling across cities fast, effectively and without the down- sides of an ICE vehicle, but we also need to embrace the sustainable development of the cities. One crucial ingredient for this upgrade is the management of vehicles and resources of the new system with a software infrastructure that should be easy, accessible, effortless and straightforward to install, manage and configure. It should also be universal, maintainable and extensible, so vehicles and transportation related companies will help commuters to eventually change their mobility habits towards a more sustainable future for the cities and its residents.

1.3 Aim & Objectives

Our solution consists two parts. First, the description of a new system that tries to bring two "green" ideas together: the use of Electric Vehicles (EVs) as the enabler of sustainable mobility, and car sharing systems. Those ideas can work together and they both seem promising enough. Second, the implementation of a software solution that will enable businesses to manage the use of EVs in one-way car sharing services. An online platform that will take into account the stations, the charging level and direction of each vehicle, the numbers of EVs at each station and the distances from vehicles to users. This online system will serve users who request a trip with EVs via their mobile phones.

The purpose of this dissertation is to offer a software solution to car sharing companies with EVs in their fleets. The system will be able to manage data from vehicles and users, and decide whether it will accept or deny a user request for a trip with the company's vehicles. To accomplish that, the EVs have to be charged and the scheduling solution should take into account the charging level of each vehicle at any given time, along with their current position and destination. The underlying aim of the proposed system is: to manage user requests for hiring an EV to drive between two locations and accept or deny them, ensuring that the highest number of users will be served in a given time period (e.g. a day). We formulated a set of the most important objectives of our solution. First, the system should store all related data on a server, such as the stations, the vehicle characteristics, the routes and user accounts. Administrators will be able to alter data, like loading car characteristics or a map with station coordinates. Users will be able to create an account, login and make a request for a trip from an Android application in their mobile devices. The system should compute all the factors that affect the number of people that will be served in a given time period. It will handle user requests and decide if it will accept or deny them. Finally, the Android application will inform the user about the status of his request.

1.4 Project Overview

The project consists of developing two applications: a web-based application for administrators to manage stations, vehicle, routes and user accounts, and an Android app to let users create accounts and request a trip from one station to an- other. Monitoring and decision making about whether a request should be ap- proved or not, will be performed by the web application.

The proposed software solution should be easy to be applied on a universal level, so a car sharing company with EVs can install the system and have it up and running, ready to accept customer requests. The most challenging part of this project is to implement the best algorithm in decision making, in order for the system to serve the highest number of users. For this purpose we have developed two algorithms, one that takes into account the future routes of the vehicles in the departure station and decide if these vehicles are free or not, and a more complicated algorithm that also considers the future routes of other vehicles and if they can substitute a current "locked/assigned" vehicle to make it free for use.

In the next chapter we conduct our research on urban mobility through the literature review. We present our findings that lead us to the first part of our solution, the convergence of EVs and car sharing systems. Then we focus on the methodology we followed and the design, implementation and testing of our software pack- age, which is the second part of our solution. We evaluate the web and mobile applications and in the last chapter we summarize the most important ideas. This concludes a thorough exploration on both theoretical and practical aspects of an urban mobility upgrade.

Literature Review

2.1 Research Description

The research of this report is focused on three major subjects and how they influence urban mobility. First, we examine the increasing urban development and the need for transport. As cities get crowded, the need for transport is necessary as it adds value to the everyday life of the residents. This leads to the demand for more journeys, which in turn creates a rapid growth of motorized vehicles. We will concentrate on the effects of the increased motorization in the environment, the city traffic and its financial activities.

Next, we will explore ways for sustainable urban development. Cities need to provide a high quality of life to its residents that should also be eco-friendly. Renewable energy sources and electric-drive technology seem promising enough. Our main interest is the electric vehicle itself, the types of electric vehicles and their impacts in urban mobility, the society and the environment. How can we improve electric vehicles and what challenges await? The third subject of our research is car sharing. Mobility systems that make use of sharing a vehicle between many drivers, have distinct characteristics. We review the benefits they offer and their convergence with electric vehicle technology.

2.2 Urban Mobility Today

Nowadays, more and more people live in the cities as they have access to essential resources that help them make their lives better. Cities offer various events, entertainment, more jobs and commuting experiences to their residents (Milgram, 1970). The attraction of more residents leads to urban growth, so cities and towns are able to support them. In fact, more than 3 billion people spend their lives in cities, which is about half of the world's population and this number constantly increases (Banister, 2005).

Increasing urban development translates into a greater number of passengers and transported goods within the cities (Rodrigue et al, 2006). Rodrigue et al (2006) also claim that travelling on regular basis is realized with faster transport modes, so journeys cover longer distances in the same time. Transport is essential for a healthy economy, so both individuals and businesses can enjoy the benefits of employment and economic growth (Banister, 2005). It is often the only way for residents to access jobs, health and education services that are vital to their well-being (Gwilliam, 2002).

The rapid increase of urban population inevitably boosts the total number of journeys residents make. Urban mobility systems have to satisfy this exploding demand and as Van Audenhove et al (2014) point out, new challenges are presented: "planet-related" like air pollution, noise and ecological footprint, "people-related" like traffic jam and its consequences, and "profit-related" like insufficient transport capacities, increasing motorization and limited parking spaces (Fig. 2.2.1). In- deed, the road transport industry is accountable for 74% of global carbon dioxide emissions, contributing to more greenhouse gases (GHG) and eventually to global warming (Rodrigue et al, 2006). This proportion is still rising in the developing countries as the number of vehicles is growing (Gwilliam, 2002). Additionally, particulate emissions are associated with health problems and transport noise affects the quality of life by disturbing or even traumatizing our ears.

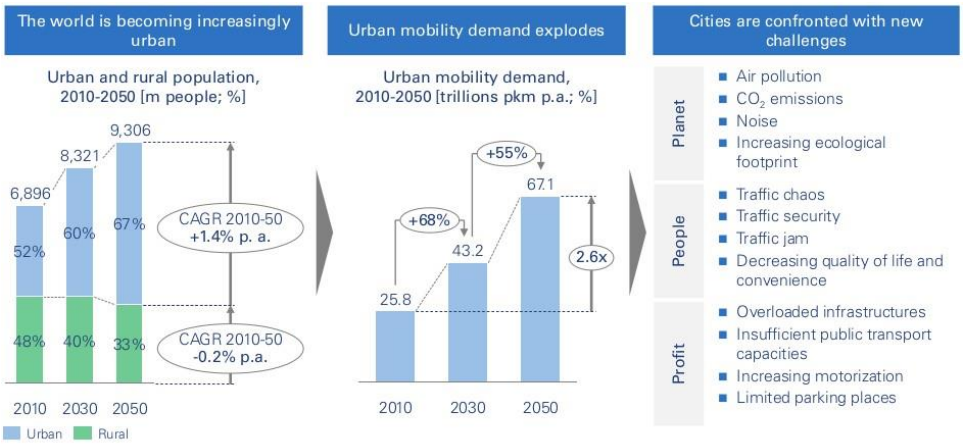

Figure 2.2.1: Urban mobility demand explodes, cities are confronted with new challenges (Van Audenhove et al, 2014).

If we look closely at traffic, transport safety and security, some troubling findings are waiting for us. Almost 500,000 people die and up to 15 million are hurt in urban road accidents every year in developing countries. Road accidents are the 9th cause of deaths worldwide and this figure is believed to climb to 6th by 2020 (Gwilliam, 2002). It appears that urban mobility systems were implemented fast enough to satisfy the demand, while there was no time for safety procedures to be developed.

Motorization rates are also climbing in advanced countries (Fig. 2.2.2). This has some troubling implications such as more GHG emissions, which should be cut by at least 50% by 2050 for the climate to be stabilized (Sperling et al, 2009). Furthermore, Sperling et al also suggest that the more vehicles people own, the more quantity of oil we have to consume. It is expected that the demand will reach 120 million barrels of oil by 2030.

Congestion influences both personal trips and freight shipments in a negative way. Traffic congestion is disturbing to the people who experience it because of the time lost in traffic jams and the frustration due to extremely low driving speeds, causing psychological stress (Downs, 2004). Following the conclusion of Buchanan et al (2015), if we do not deal with the increasing motorization problems, either the residents will stop using vehicles in urban areas, or the enjoyment and safety of surroundings will disintegrate.

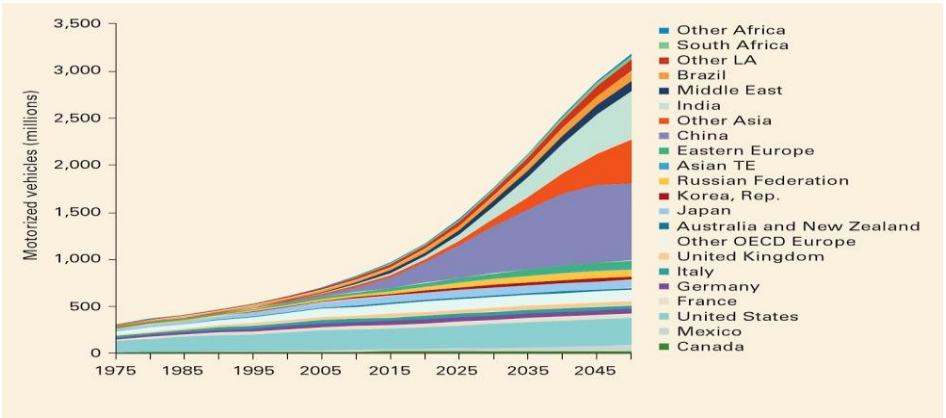

Figure 2.2.2: Number of motorized vehicles in different countries from 1975 (Suzuki et al, 2013).

Today most of the vehicles use internal combustion engines, as a large scale infrastructure is already built supporting this technology. Internal Combustion Engine or ICE vehicles use fossil fuels to generate

mechanical energy but they are not effective, providing a low fuel conversion rate of about 30-35% (Mitchell et al, 2010). Additionally, ICE vehicles produce local air pollution and carbon dioxide emissions. Carbon dioxide concentrations that rise from burning fossil fuel, will lead to greater greenhouse effects and average global temperatures (McKay,2008).

Another disadvantage of ICE vehicles is that fossil fuels are not renewable. There is only a finite quantity of oil and while we continue to consume it, the cost of finding, extracting and utilizing it, increases (Mitchell et al, 2010). Moreover, petroleum sources can be found only in a few geographic locations and this creates important security concerns for nations that import petroleum.

It is obvious that urban mobility today, serves all of us but with some crucial negative impacts in our everyday lives. More people in the cities have more transport needs and more vehicles. Increased motorization causes congestion, maximizing the disadvantages of ICE vehicles. The GHG emissions in the year 2000 were about 34 billion tons of carbon dioxide equivalent per year (McKay, 2008). The consequences of climate change are global and they last for a long period of time, with irreversible changes waiting to occur (King, 2008). Congestion causes frustration, unreliable travel times and accidents. Time, fuel and money are wasted. The poor may encounter social and financial exclusion because of restricted personal mobility. The ICE vehicles are not even effective, providing a very low con- version rate. The demand in finite fossil fuels like oil, is rising like never before. How can we break the chains and create a better and more reliable personal mobility system?

2.3 The Need for Electric Vehicles

Hopwood et al (2005) defines sustainable development as the outcome of the growing awareness of how environmental, social and financial problems affect our future. In order to empower a sustainable mobility system, we need to take into ac- count the transport infrastructure, the technological development of vehicles and the energy system that fuels them (Holden, 2007).

Jenks et al (2005) point out that in order for the residents of a city to reach a high quality of life with ecological characteristics, they have to use renewable energy. This is an essential step to increase energy efficiency. The next logical step is the automobile itself. It is an integral component of the modern city life, so creating a new, effective automobile with a high conversion rate, is necessary for the sustainable development of cities (Kennedy et al, 2005).

Renewable energy sources seem to be the key in unlocking a new era of urban mobility. These are the energy sources that are not finite and will still be avail- able even in continuous supply, like solar power, wind power, geothermics, hydropower and biomass (Herzog et al, 2001). The advantages they offer are that they do not pollute the atmosphere with GHG, they are freely available and their conversion and realization costs are decreasing over time (Droege, 2008). How- ever, the difficulty in using these sources lies in collecting the actual energy, as the devices used for this purpose are not efficient enough (Mitchell et al, 2010).

Moving towards that direction, will allow cities to benefit from renewable energy sources and make them ready to welcome the next generation of automobiles. The solution will be greatly enhanced by moving towards a new personal mobility system powered by electric-drive technology (Sperling et al, 2009). De- spite the fact that 97% of all the vehicles today use combustion engines and burn petroleum fuel, the next generation of automobiles will be propelled by electric motors. Electric-drive technologies include battery electric, hybrid electric, plug- in hybrids and fuel cell vehicles, which we will discuss later.

Now let us look at the main parts of an Electric Vehicle (EV). By studying the report *Basics of Electric Vehicles* from the Volkswagen Academy (2013), we recognize the following systems: a high voltage battery

with a unit for regulation and charging, one or more electric motors and their cooling system, and a regenerative brake system. Reading further in this report, we acknowledge that the heart of the EV is the battery. It supplies voltage to the electric motors and they generate the mechanical energy needed to move the vehicle. By-wire systems transmit the electrical energy to the motors. In case of fuel cell vehicles, a fuel cell stack and hydrogen tanks are also parts of an EV (Fig. 2.3.1).

One of the most important advantages of EVs, is that electric motors are not only eco-friendly with very low to none harmful emissions and noise, but they also provide good acceleration with a high level of efficiency (Volkswagen Academy, 2013). They effectively utilize more than 90% of the supplied energy, in contrast to the ICE vehicles where this proportion is no more than 37% (Sperling et al, 2009). Moreover, no energy is wasted when the car is at rest or when braking, instead the battery is recharged. If we use renewable energy sources to charge the battery, an EV can run emission-free in its lifecycle.

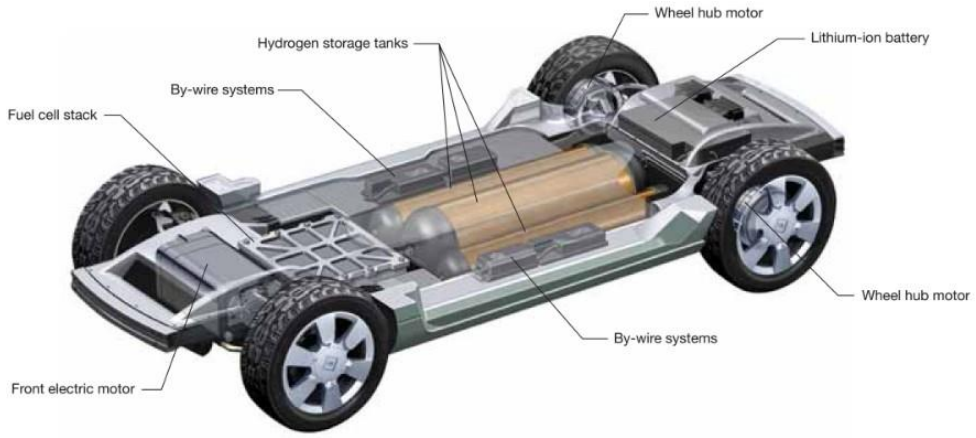

Figure 2.3.1: Basic parts of electric vehicles (Mitchell et al, 2010).

On the other hand, there are some important disadvantages as well. EVs offer a limited mobility range due to their battery size, charging can take up to 10 hours, and the charging infrastructure is sparse (Volkswagen Academy, 2013). This can create "range anxiety" and the driver will be influenced in a negative way, keeping in mind that he has to charge the vehicle before reaching its maximum range. So, fuel distribution systems is one of the biggest challenges for incorporating EVs in our urban mobility lifestyle (Sperling et al, 2009).

By upgrading our EVs with the necessary connectivity features, we can add substantially to its positive impacts. We can combine GPS and wireless communications to provide real time navigation, traffic information, remote diagnostics and automatic crash notifications to authorities (Mitchell et al, 2010). The combination of EVs and connectivity improves traffic flow, reduces the number of crashes and it also reduces air pollution and energy consumption. With vehicle-to-vehicle communications, each car can broadcast its position and velocity, resulting in greater knowledge of the external environment while driving. Timely traffic information will make the trips of drivers shorter, predictable and less stressful.

From the above, we reach to the same conclusion that Helmers et al (2012) state at the end of their article: the electric car is an essential ingredient for a more sustainable mobility future, although it has some drawbacks. Electrification provides higher efficiency, lower energy costs for personal mobility and enables energy diversity. Mitchell et al (2010) characterize EVs as clean, compact vehicles with a pleasurable driving experience where their cost becomes high only when they are required to provide a range of 100 miles or more at high speeds. This is not a dis- advantage at all, as trips in the cities tend to be shorter and in low speeds.

Electric-drive technology includes many types of vehicles. We will now present them along with their basic features as they are stated in the report *Electric Vehicles in Europe* by the European Environment Agency (2016). Battery Electric Vehicles (BEVs) are powered only by an electric motor that uses electricity stored in a battery. The battery should be charged regularly by plugging in to a charging point. BEVs provide the highest energy efficiency with zero emissions, but they have a limited driving range and they need a long time to recharge.

Hybrid Electric Vehicles (HEVs) use both an internal combustion engine and an electric motor that assists the engine during driving. In those vehicles the battery cannot be charged from the grid, it is charged only when the car is coasting, or during regenerative braking. HEVs have lower fuel consumption and emissions than ICE vehicles but they still rely on fossil fuels. Plugin Hybrid Electric Vehicles (PHEVs) share the same characteristics as HEVs with the difference that the battery can be charged from the grid, so they provide a longer driving range.

Fuel Cell Electric Vehicles (FCEVs) are powered only by electricity generated by fuel cells that combine hydrogen from tanks and oxygen from the air. FCEVs have significantly longer driving range and are faster in refuelling. However, fuel cells technology is in an early stage of development and FCEVs commercial availability is limited.

In this report, we consider the BEVs that use energy from renewable sources as the next step to our urban mobility upgrade. They have excellent room for progress, we can design lithium-ion batteries with ranges up to 240km and they present a satisfactory acceleration performance (Burke, 2007). Mitchell et al (2010) and McKinsey (2014) show that those vehicles can be recharged in less than 3 hours (fast charging) with a 240V outlet or in about 8 hours (slow charging) with a standard 110V outlet. Mitchell et al also add that with zero emissions, BEVs are the most affordable solution for limited range urban applications.

2.4 Car Sharing Systems

Nowadays, most consumers care about the sustainability of their mode of travel and are willing to adapt new mobility systems such as car sharing and bike sharing. Van Audenhove et al (2014) mention in their study that car sharing has emerged from a community-based collaboration, to a big business that attracts major vehicle manufacturers and younger customers.

Usually, an organization purchases a fleet of cars and makes them available to the residents who access them on an as-needed basis for their mobility demands. In these systems the vehicle usage is booked in advance, customers access the cars themselves and rentals are for short periods of time (Millard-Ball et al, 2005). They differ from ride sharing or carpooling as their provided access is about short trips and the charge is valid only for the duration of the trip (Katzev, 2003).

Three basic car sharing types are examined by Laarabi et al (2016). In two-way systems the vehicles can be picked up from any of the preconfigured stations, but they have to be dropped off at their initial station. In one-way systems (e.g. Zip- car, Modo) the vehicles can be picked up or dropped off at any of the stations. Free floating car sharing systems (e.g. Car2go, DriveNow, Enjoy) allow for maxi- mum flexibility as there are no stations and the customer can use any public parking within the area of operation. In such mobility-on-demand schemes, we can apply algorithms to increase the number of customers being served, thus making those schemes even more effective (Rigas et al, 2015).

In this report we will concentrate in one-way car sharing service. In this paradigm the customer looks for the closest station and when an available vehicle is found, he proceeds on booking the vehicle for a trip. He picks up the vehicle, makes his short trip, books the closest station to his destination and finally drops

off the vehicle (Laarabi et al, 2016). This service can also be used with EVs. If we use BEVs, we just have to make sure that the stations can also charge the vehicles and that the vehicles are available only if their charge level is above a certain threshold.

Adopting car sharing systems in urban mobility has many positive impacts. It is referred as the missing link of the alternatives to the private vehicle, like taxis, cycling and walking (Millard-Ball et al, 2005). Vairani (2009) shows in his report one of the most important benefits: the costs for vehicle access are divided among a group of people, so the low-income inhabitants do not need to pay large upfront costs. As Millard-Ball et al (2005) add, costs that depend on driving time is a strong financial incentive to drive less. The need for privately owned vehicles along with their negative consequences like GHG emissions, traffic, congestion, parking, etc. are reduced, which essentially means more efficient land use.

Car sharing offers great mobility to people by allowing them to travel without owning a car and it is most cost effective for intermediate length trips (Millard-Ball et al, 2005). Consumers do not want to buy or own things, they prefer to pay for temporary accessing them (Bardhi et al, 2012). A reduction in vehicle ownership leads to a 28% - 45% reduction in vehicle miles travelled and 19% - 54% lower GHG emissions for the average driver (Shaheen et al, 2007). Fellows et al (2000) show that those benefits, along with increased speeds and fuel savings, are comparable to major road schemes with just a fraction of the implementation costs. Studies suggest that each vehicle from car sharing removes 6 to 23 cars from US roads and 4 to 10 cars from European roads (Vairani, 2009). As we saw, relying on sharing cars rather than owning them, will be the greater environmental benefit of car sharing (Katzev, 2003).

Car sharing started gaining large ground in Switzerland and Germany, where the first programs served their residents in the late 1980s (Millard-Ball et al, 2005). Since then, more and more people and businesses participate in these programs. In 2007, car sharing was a viable solution in 600 cities around the world with 348,000 drivers sharing roughly 11,700 vehicles (Shaheen et al, 2007). As Shaheen et al inform us, some of the largest organizations became multinational operators as seen in Fig. 2.4.1, like Zipcar, Greenwheels, Cambio Car and CityCarClub. The biggest car sharing company now is Zipcar which by the end of 2011 had more than 650,000 members and 8,900 cars in urban areas worldwide (Bardhi et al, 2012).

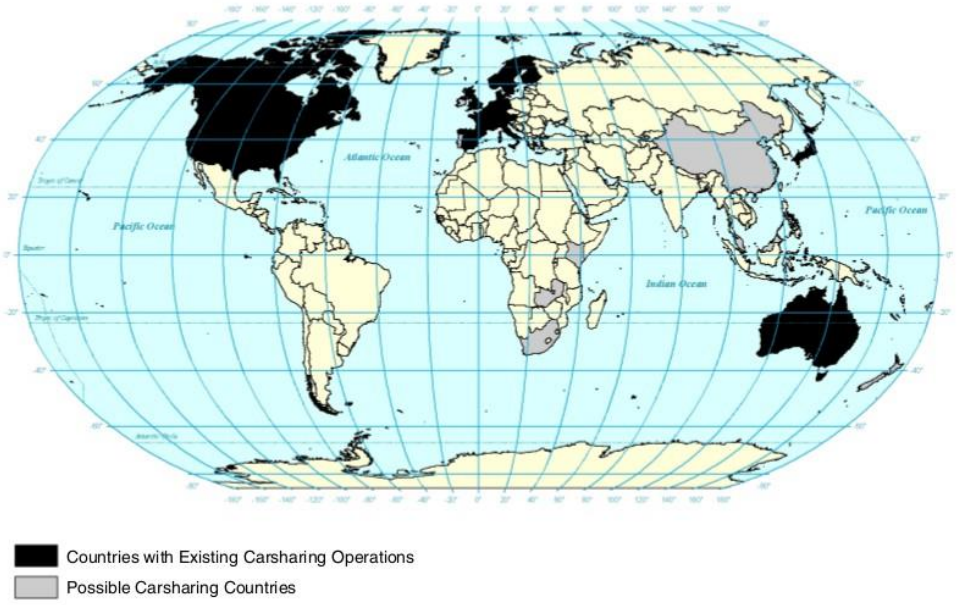

Figure 2.4.1: State of car sharing worldwide (Shaheen et al, 2007).

The convergence of EV technology and car sharing is also taking place. Some of the companies that include EVs in their fleets are Car2Go, DriveNow, Flinkster and Autolib (McKinsey, 2014). Both technologies are growing and influence one another with great positive impacts to urban mobility. More people get familiar with EVs and that will lead to a bigger pool of potential buyers. Taking into account the advantages of BEVs, we get the best of the EV world, and utilizing them in one-way car sharing schemes allows us to benefit from both worlds. Car sharing can multiply the positive impacts of EVs to the society as a whole. It can also be the solution to "range anxiety" of drivers when thinking of purchasing an EV, allowing them to use BEVs for distances that they feel comfortable (McKinsey, 2014). So, renewable energy, BEVs and car sharing can be the next big thing in our urban mobility upgrade.

2.5 Software Platforms

Many car sharing companies include EVs in their fleets for their customers' trips. Although they have EVs available, their mobile applications are general and not tailored around EVs and their special needs, like charging stations and individual vehicle charging level. This is a major drawback, as the true benefits of EVs and car sharing schemes can be revealed only if the software solution is tailored to EVs and their special characteristics.

Our research for companies that offer car sharing services with EVs ended up with just a few car sharing schemes that offer mobile applications to their users. From Paris, London and Indianapolis, to Boston, Michigan, Vilnius and Sofia, companies are offering their services through their customized applications for their customers' mobile phones as seen in Table 2.5.1.

CAR SHARING APPS	CHARACTERISTICS
Autolib	A full EV service with Bluecars in Paris
Bluecity	London's first full EV scheme
Blueindy	EV car sharing scheme in Indianapolis
Bonzer from Instacarshare	Car sharing with mini EVs in Boston
MDrive from Rent Centric	With three Ford Focus EVs in Michigan
SPARK	EV car sharing in Vilnius and Sofia

Table 2.5.1: Car sharing mobile apps and their characteristics.

As we can see, each company has developed its own software platform and a mobile application that manages requests from the users. Their software solutions are applicable to their fleets and their specific business objectives. Our purpose is to expand that and offer a universal solution which can be easily customized for any car sharing company.

A universal solution means that an online platform for managing administrators, users, stations, vehicles and routes will be ready to be delivered to a company, along with a working mobile application that will let the users request a vehicle for a trip. Instead of having each company develop their own software, a universal solution could speed up the establishment and operation of new companies interested in "one-way car sharing with EVs" schemes. Software development costs could be reduced and extensibility would ensure that those companies could expand their operations seamlessly. Another advantage of having many different car sharing schemes use the same platform is the opportunities for data analytics and improvement of algorithms used to assign vehicles to users, when two or more companies analyse and compare their data together.

After the review of research, in the following chapter we describe the methodologies used to elicitate the requirements for this project. Next, we design, implement and test our software solution, which consists

of a web-based application as the online management platform and a mobile application for Android devices.

2.6 Review of Research

Our research starts with urban mobility, where the article *The Experience of Living in Cities* (Milgram, 1970) presents the characteristic qualities of city life. Rodrigue et al in their book *The Geography of Transport Systems* (2006), examine how transportation helps in the development of cities, but when the number of vehicles increases, there are serious urban and environmental impacts. The *Cities on the move: a World Bank urban transport strategy review* (Gwilliam, 2002) focuses on the relationship between urban transport and the city development. It shows that transport and increased motorization affects the financial life of commuters and hurts their health not only by the rising GHG, but also with road accidents.

Congestion is the subject thoroughly examined in the book *Still Stuck in Traffic: Coping with peak-hour traffic congestion* (Downs, 2004), with its causes and consequences. *Traffic in Towns: A study of the long term problems of traffic in urban areas*, a popular study by Buchanan in 2015, acknowledges the long term problems of traffic in urban areas and it proposes policies for reducing congestion in favour of the quality of life of the commuters.

The links between transport and sustainable urban development are identified and analysed by Banister (2005) and Suzuki et al (2013). The idea of sustainable development is defined and further explored in the article *Sustainable Development: Mapping Different Approaches* by Hopwood et al (2005). Kennedy et al (2005) recommend the *Four Pillars of Sustainable Urban Transportation*. Policies for achieving sustainable mobility are evaluated by Holden (2007). *Future Forms and Design for Sustainable Cities* by Jenks et al (2005) concentrate on the planning and design of cities, while Sperling et al (2009) tell us why and how we need to transform transportation now more than ever, in their book *Two Billion Cars: Driving toward sustainability*.

Renewable energy technologies are presented in the article *Renewable Energy: A Viable Choice* by Herzog et al (2001). Droege in his book *Urban Energy Transition: From Fossil Fuels to Renewable Power* in 2008, explains how we can make the change and shift from cities dominated by the fossil-fuel systems of the industrial age, to a renewable-energy based urban development framework. Preparing for that change on a personal and international scale is also the main subject of the case study *Sustainable Energy: Without the hot air* (McKay, 2008). The report *The King Review of Low-Carbon Cars* Part I in 2007 talks about the potential of the reduction of car- bon dioxide emissions, where Part II in 2008, presents policy recommendations in regard to renewable energy.

Sustainable urban development inevitably leads us to a new era of vehicles. Van Audenhove et al (2014) presents an in-depth exploration about the future of urban mobility with *The Future of Urban Mobility 2.0: Imperatives to Shape Extended Mobility Ecosystems of Tomorrow*. Earlier in 2009, Vairani in his report introduced *bitCar*, a design concept for a collapsible stackable city car powered by electric motors. The book *Reinventing the Automobile* by Mitchell et al (2010), provides a great insight of a long-overdue vision for a new automobile era. The Automobile is reimagined and at the heart of a more convenient and sustainable urban mobility lies the EV. EVs, their characteristics and types are described in the study *Basics of Electric Vehicles* by Volkswagen Academy (2013).

Helmers et al (2012) focus on the environmental impacts of BEVs with their article *Electric Cars: Technical Characteristics and Environmental Impacts*, while Burke (2007) explores the potential of batteries and ultracapacitors and how PHEVs can be designed with effective all-electric ranges. Charging EVs cause extra electrical loads that impact the distribution grid.

EVs are increasing rapidly mainly because of increased consumer awareness, cost reduction and home charging installations prioritization. McKinsey in *Electric Vehicles In Europe: Gearing up for a new phase?* (2014), also show that OEMs, suppliers and governments should work together to tackle implications related to the grid and the charging stations in order for new business models and market opportunities to arise with the wide adoption of EVs. *Electric Vehicles in Europe*, a report by the European Environment Agency (2016), presents the results of such policies: the number of charging stations is constantly increasing and this boosts the number of EV stock globally as shown in *Beyond One Million Electric Cars* by Global EV Outlook (2016).

Our research concludes with car sharing, described in the articles *Car Sharing : A New Approach to Urban Transportation Problems* (Katzev, 2003) and *Access-Based Consumption: The Case of Car Sharing* (Bardhi et al, 2012). The basic schemes of car sharing are discussed, with their environmental benefits and their greater adoption from companies in many countries.

Rigas et al in their article *Algorithms for Electric Vehicle Scheduling in Mobility-on-Demand Schemes* (2015) showed that in such mobility-on-demand schemes, we can apply algorithms to increase the number of customers being served. Car sharing is evaluated and its environmental, economic and social impacts are presented in *Car-sharing: Where and how it succeeds* (Millard-Ball et al 2005), while Shaheen et al (2007) forecast continued growth, particularly among new and emerging markets.

Methodology

3.1 Service Description

The objects that need to be saved and managed in a car sharing software solution are the stations, vehicles and routes. Routes are essentially a combination of a station, a vehicle and a user. Requests are used to create routes and administrators need to be managed and added. Requests, user accounts and administrator accounts should also be saved. Our proposed solution is a system that consists of an online web application (platform) and a mobile application. Its purpose is to serve two kinds of audiences, the administrators and the users, and manage their data.

The online web platform is the backend interface to manage the system. It can be installed on a server and allows the administrators to manage users, stations, vehicles, routes and accept or deny user requests. Administrators can login, save, access or change data related to those objects. The mobile application is the frontend of the system and is intended for mobile use. Users can perform actions like register, login, see the available stations in their area and send vehicle requests for trips to the web platform. All requests and actions are handled by the platform, which processes the data and sends the appropriate responses, like the user or station data and the status of the user request (accepted or denied). Users can see the status of the vehicle requests in their history page on the mobile application. A system overview of the web platform and the mobile application is depicted in Fig. 3.1.1.

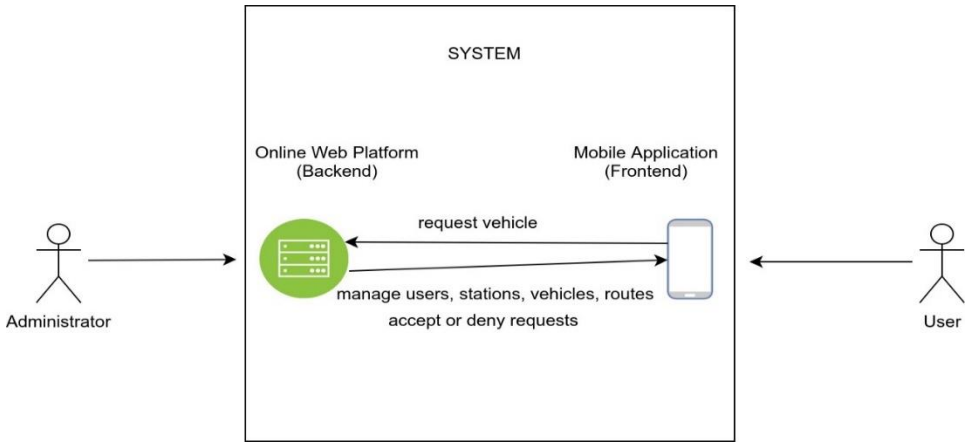

Figure 3.1.1: System overview of the web platform and the mobile application.

A car sharing company with EVs in their fleet can benefit from our software solution in multiple ways. The web platform can be easily installed on a server. Man- aging and configuring various components is straightforward, like uploading a map or vehicle characteristics with just two steps: creating and uploading a simple XML file. Users can easily install the mobile application on their Android mobile devices and the system is universal, maintainable and extensible.

We designed, implemented and tested an online web platform for managing various aspects of a car sharing service, and a mobile application for Android devices.

The deliverables of the project are the following:

- source code in zip format of the web application project file
- source code in zip format of the Android application project file
- a video demonstration showing the functionalities of the system

3.2 Use Cases

Use cases are accepted in the industry, as they are a useful method of describing how a business operates, uncovering many scenarios and their pre-conditions and post-conditions. Capturing requirements will be easier after exploring use cases from unified modelling language (UML) diagrams. These diagrams are easy for others to understand and very useful to software engineers, as they help them decide on how to create the classes and objects in object-oriented programming languages.

In order to extract all the functional and non-functional requirements we created use cases and treated the proposed system as a black box. We focused on how the system should behave, without making decisions about its internal structure. Our aim and objectives are then translated into a list of *what the system can do* and *what an actor can do*. In our case the actors are the administrators and the users.

The target audience of the online web platform is the administrators. Administrators are responsible for adding, editing and deleting data. They monitor real time information about the system and act on it if needed. In case of an error or a vehicle malfunction, they can mark the vehicle as unavailable or even stop the service of the system. Administrators have the profile of tech savvy people, they have used backend systems before and they are familiar with client-server communication technology.

From the use case UML diagram (Fig. 3.2.1) we see that administrators can: (1) upload a map that contains stations in XML format, (2) upload a list of vehicles in XML format, (3) add, list, update and delete other administrators (name, role), (4) add, list, update and delete users (name, gender, date of birth), (5) add, list, update and delete stations (name, latitude, longitude, traffic level), (6) add, list, update and delete vehicles (model, charge level, availability), (7) add, list, update and delete routes (user, start station, finish station, start time, end time, vehicle).

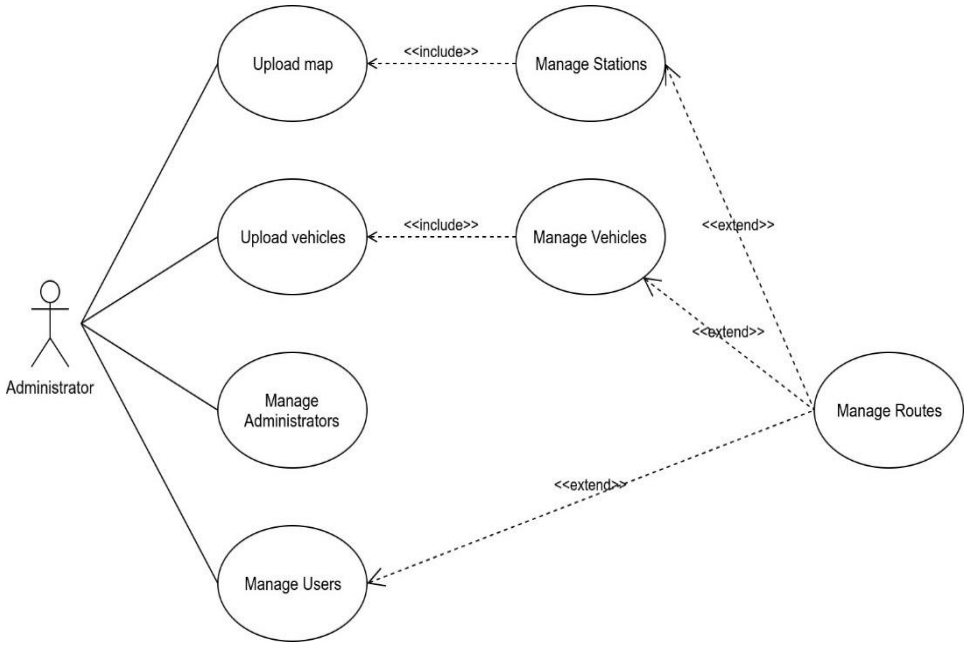

Figure 3.2.1: Administrators use case UML diagram, showing what administrators can do.

The target audience of the mobile application is the users. Users are the customers of the car sharing company and they rent vehicles for their every day trips in the city. They use the services of the company, like creating an account, accessing and editing their account data, and making vehicle requests. Users

are the everyday people who have an Android mobile device with access to Google Play Store. They know how to install an application and the registration and login processes are very familiar to them.

From the use case UML diagram (Fig. 3.2.2) we see that users can: (1) register with their account details (name, gender, date of birth, username, password), (2) login with a username and password, (3) access their profile details and edit them (name, gender, date of birth), (4) access the history of their vehicle requests (date, time, status), (5) delete the history of their vehicle requests, (6) change the application settings (server IP address, port number), (7) select stations from a map (start station, destination station), (8) request a vehicle for a trip (start station, destination station, time), (9) get the response from server regarding whether their request is accepted or denied.

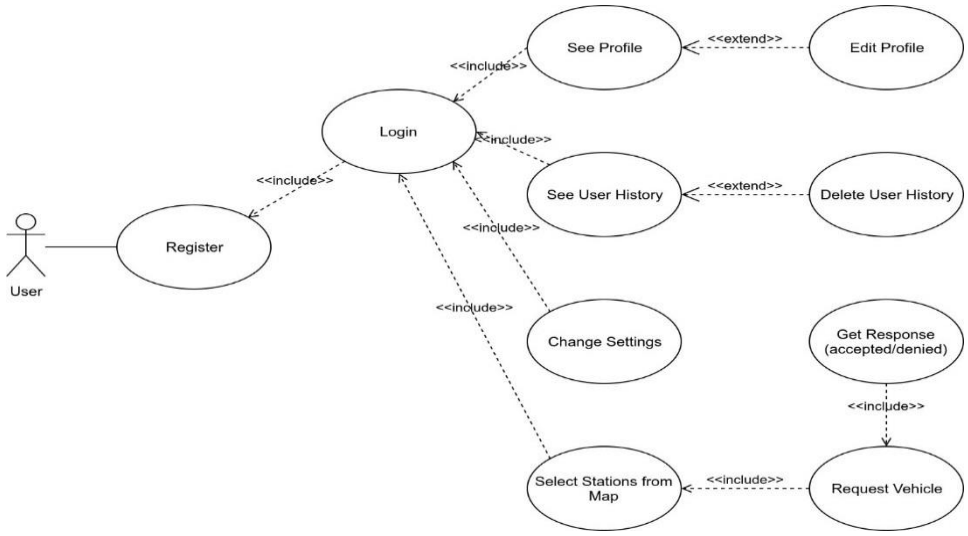

Figure 3.2.2: Users use case UML diagram, showing what users can do.

3.3 Data Collection

To show the web platform and mobile application functionalities in action, we needed to select a city as an example and collect some data, like the number and the locations of the charging stations, and the number of vehicles and their characteristics for a typical car sharing company with EVs. These data are used to create an XML file for loading a map with stations and an XML file for loading the vehicle characteristics in the web platform.

Our research showed that Bristol is an excellent and realistic candidate as a city to host a car sharing scheme. The City Council in Bristol has already recognized the benefits of car clubs in urban mobility and provided technical and financial support to the Bristol Environmentally Sustainable Transport organization (Cox, 2001). Bristol is also the city that recently shared £40 million with Nottingham, Milton Keynes and London as a part of the "Go Ultra Low City Scheme", so significant investing will be available for EV car sharing support and charging infrastructure (Tietge et al, 2016).

The charging stations and their locations were drawn from *opendata.bristol.gov.uk*. We downloaded the CSV file with the longitude and latitude details and compared them with the most up to date list of Bristol charging points in *www.zap-map.com*. In the final list we kept only the stations with public access and used them in our example to showcase the functionality of the system. We ended up with 27 stations as the potential stations of a new car club with EVs in its fleet and we chose the number of EVs to be 18, a 60% of the total number of stations, as this is a typical ratio in car clubs in the UK.

3.4 Requirements Analysis

The requirements for this project are the functional, that define the function of a system or its component and the non-functional, that specify criteria like security and performance. We will first focus on the requirements for the web platform and the functionalities for administrators and then on the requirements for the mobile application and the functionalities for users.

Functional requirements for administrators include all actions described in the administrators use case UML diagram. Additionally, the web platform should also accept requests from the mobile application, compute all the factors that affect the number of people that will be served in a given time period, handle user requests from the mobile application and decide if it will accept or deny them. Other data that will be sent to the mobile app include user account and station details. Non-functional requirements focus on security. This is a major concern, as many users will interact with the system. For this reason, we had to make sure that all pages are protected from malicious actions like SQL Injection attacks and that passwords must be hidden (hashed and "salted") to protect the administrator and user ac- counts. Moreover, the performance should be fast and reliable, allowing for an uninterrupted service to administrators and users (Table 3.4.1).

TYPE	ACTIVITY	PRIORITY
Functional	Login with a username and password	1
Functional	Add/list/update/delete administrators	1
Functional	Upload a map with stations in XML	1
Functional	Upload a list of vehicles in XML	1
Functional	Add/list/update/delete users	1
Functional	Add/list/update/delete stations	1
Functional	Add/list/update/delete vehicles	1
Functional	Add/list/update/delete routes	1
Functional	Handle requests from users	1
Functional	Send request status to mobile app	1
Functional	Send user account details to mobile app	1
Functional	Send station details to mobile app	1
Security	Protect against SQL Injection	1
Security	Store only hashed values of passwords	1
Performance	Fast load and response rate	1
Performance	Offer uninterrupted service to users	1

Table 3.4.1: Functional and non-functional requirements for administrators and the web platform.

Functional requirements for users include all actions described in the users use case UML diagram. Additionally, the mobile application should send requests to the web platform and accept the status of the request. It should also access user account and station details from the database. Non-functional requirements focus on security. User authentication must be safe by transmitting only encrypted messages to the platform. The performance and response of the mobile application should be fast, offering a pleasant user experience to its users (Table 3.4.2).

TYPE	ACTIVITY	PRIORITY
Functional	Register with account details	1
Functional	Login with a username and password	1
Functional	Access/edit profile details	1
Functional	Access/delete history of requests	1
Functional	Change the application settings	1
Functional	Get station details from platform	1
Functional	Select start/finish stations from a map	1
Functional	Select specific time for a request	1
Functional	Request a vehicle for a trip	1
Functional	Get request status from the platform	1
Functional	Save request status to history	1
Security	Send encrypted messages to the platform	1
Security	Authenticate users when requesting data	1
Performance	Fast load and response rate	1
Performance	Offer uninterrupted service to users	1

Table 3.4.2: Functional and non-functional requirements for users and the mobile application.

3.5 Technology Resources

In order to achieve the goals of an easy maintainable and extensible software solution, we examined various web application frameworks. Laravel, with modular packaging and relational database mapping, CakePHP with great plugins and community support, and CodeIgniter, powerful with a very small footprint, are very popular PHP frameworks. Java based frameworks used for web development are Spring MVC, for modern enterprise applications, JavaServer Faces, for building great user interfaces, and Struts, extensible with plugins. For the implementation of the web platform we chose the Java Spring MVC framework, as it comes with important technologies that helped us accomplish our objectives.

Java Spring is a very popular open source development framework. It allows developers to create easily testable and reusable enterprise Java applications with excellent performance. It simplifies development with bundled modularity and the use of Plain Old Java Objects (POJOs). Simpler code becomes easier to test and maintain. Some of the most important characteristics of the Java Spring framework are Inversion of Control (IoC) and Dependency Injection (DI). IoC enables Spring to control the flow of the program and make calls to our custom code. This feature makes it easier to switch between different implementations and offers greater modularity and easier testing by isolating dependencies. IoC can be achieved by various mechanisms, like Dependency Injection. With DI, objects are injected into other objects by the framework itself.

The Spring framework has great community support and comes ready with very important technologies that help developers create better applications. Some of those technologies are: Spring MVC, Spring Security, Spring Batch, Spring JDBC and DAO, Spring ORM, Spring AOP. Spring MVC is a web framework built on the Servlet API that follows the Model View Controller design pattern. Spring Security is used for protecting applications with extensible authentication and authorization support. Spring Batch simplifies and optimizes the processing of high volume batch operations, while Spring JDBC and Data Access Object (DAO) modules provide translations from specific API exceptions to the DAO hierarchy. The Spring Object Relational Mapping (ORM) module provides an abstraction layer for other APIs that map objects to tables in a relational database, such as Hibernate. Lastly, Spring Aspect Oriented Programming (AOP) offers

another mode of modularity, the "aspect", allowing developers to decouple code that implements functionality that should be separated.

For the Android application development, we had to ensure proper data exchange between the application and the web platform on the server. We found two options that can serve this purpose: implementing a RESTful web service or using WebSockets technology. A RESTful web service is based on the REpresentational State Transfer (REST) technology, an abstraction for creating APIs for applications in a standardized way. With REST endpoints, an application can receive requests and respond to them. Requests come from a client that uses common HTTP verbs like GET, POST, PUT, DELETE for retrieving, submitting, updating and deleting data. Responding to requests is usually realized by sending data back to the client in XML or JSON format.

WebSockets is a protocol between a client and a server that runs over a persistent TCP connection. A TCP socket connection can be opened, and bidirectional and full-duplex messages can be sent between the client and server and then the connection can be closed. The opening and closing creates overhead, but the connection offers reliability in the exchange of messages. The major advantage of creating a connection is that developers do not need to handle a server-side service that is always listening and ready to perform specific tasks based on extra criteria from a client request. Instead, the TCP connection handles the delivery of the data and then it is up to the application layer to apply certain security criteria be- fore sending the appropriate response message to the client (Table 3.5.1).

CHARACTERISTICS	REST SERVICE	WEB SOCKETS
What is sent and received	HTTP messages	TCP messages
Creates connection (state)	No	Yes
Full-duplex communication	No	Yes
Managing resources is defined	Yes	No
Scaling capability	Horizontally	Vertically
Performance	Good	Slightly better

Table 3.5.1: Characteristics of different data exchange methods between the platform and the mobile application.

Mainly because of the different scalability and the stateful/stateless capabilities of these exchange methods, we incorporated both of them, but in different situations. Communication via RESTful web services is used for registering, logging in, and sending station information to the mobile application. When the user sends the request for a vehicle to the server through the app, we use WebSockets technology in order to have a stable connection until the platform sends its response back to the mobile app. Sending messages to an IP address and port number with the TCP protocol is slightly faster and more efficient than web services, so this method fits better to the vehicle requests functionality.

The software resources for the design and implementation of the project are: (1) Eclipse Java EE IDE for Web Developers Oxygen Release for developing with Java, (2) Tomcat Server 9.0 to run the Spring MVC project on the localhost, (3) MySQL Workbench 6.2 to create and manage the platform database, (4) Android Studio 2.3.3 for developing the Android application, (5) Atom 1.15 for fast search in directories and refactoring code, (6) GitHub as a version control software, (7) Photoshop for creating and editing graphics and images, (8) Google Drive for manual backup (e.g. after every milestone).

The hardware resources for this project are: a laptop with latest I7 7700HQ CPU 2.80Ghz and 12GB of DDR4 RAM for developing the system in our local machine, an online server for hosting the web platform, and an Android device for testing purposes (we used a Samsung Note 3 mobile phone). The

commercial re- sources needed for bringing the project online and making it available to users are: domain name from GoDaddy (cost of 12 EUR), hosting service in DigitalOcean (cost of 100 EUR for one year of hosting), and Android developer account (cost of 20 EUR) to publish the application to Google Play marketplace. Commercial resources are optional and should be acquired by the car sharing company.

System Design

4.1 Architecture

In the previous chapter we presented the functionalities of administrators and users in the web platform and mobile application respectively. We will now examine the architecture of the system and how the parts communicate and exchange data with each other. Those functionalities fulfil the basic operations of a car sharing company that offers EVs to their clients.

The web platform is installed on the server and it consists of the web pages presented to the administrators and a MySQL database to manage all the data. Administrators interact with the platform using web pages designed for specific functionalities. So, the interface design of the pages allow them to login, upload a map with stations, upload vehicles details and manage administrator and user accounts, stations, vehicles and routes.

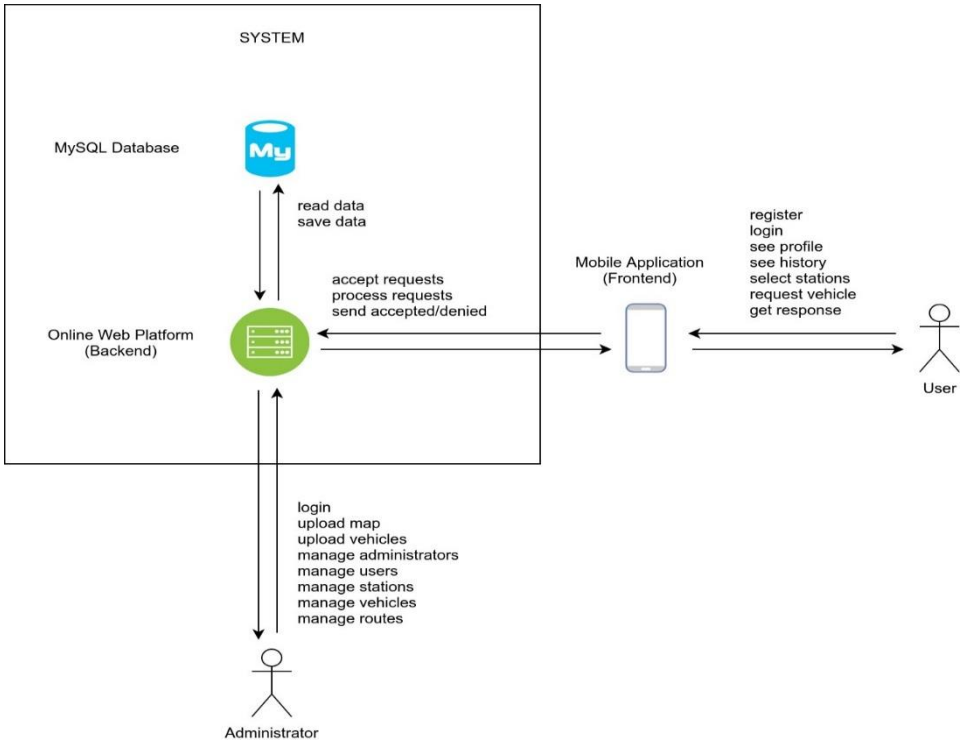

Figure 4.1.1: System architecture with web platform, database and mobile application.

All operations submitted through the interface of the pages are implemented as transactions in the MySQL database. MySQL database is made up of tables with attributes and values. Rows of data are saved within these tables, so administrators can manage the saved objects. The mobile application lets users register, login, access their profile, their request history, select stations and request a vehicle for a trip. Creating an account, and accessing account and station details require access to the MySQL database on the server (Fig. 4.1.1).

Information exchange with the database is done via a RESTful web service that authenticates users and allows them to access, create and edit data on the database. Messages for vehicle requests use WebSockets, so the server listens to a specific port for incoming TCP messages. Those messages will be encrypted and sent from the mobile device to the server through a TCP connection, making the communication safe and reliable. The platform will then apply a decision algorithm that depending on the data in the database at the current time, it will analyse all future routes, station and vehicle information and accept or deny

the user request. The status of the request (accepted or denied) will be sent back to the mobile application as an encrypted message through the TCP connection.

4.2 Web Platform Design

The web pages of the platform let the administrators perform the functionalities discussed earlier. The login page allows administrators to login with their user- name and password. On successful login, they are redirected to the Dashboard Panel. The Dashboard Panel shows route data and contains buttons to update, delete or add a new route. The stations are shown as pins on a Google map and buttons allow administrators to start or stop the service.

The Manage Admins and Manage Users pages show administrator and user data respectively, and contain buttons to update their existing details, delete them or add new administrators and users. The Manage Stations and Manage Vehicles pages offer the same functionalities, but they also allow administrators to upload stations and vehicle details from files in XML format. For each object there are two secondary pages, the Add New page and the Update page to provide secondary functionalities like adding and updating objects. All pages of the platform, their activities and their parent page are presented in Table 4.2.1.

PAGE	ACTIVITY/ACTION	PARENT PAGE
1. Login Page	Administrator login	-
2. Dashboard Panel	Access routes data/delete routes	1
3. Add New Route	Add a new route	2
4. Update Route	Update existing route data	2
5. Manage Admins	Access admins data/delete admins	1
6. Add New Admin	Add a new admin	5
7. Update Admin	Update existing admin data	5
8. Manage Users	Access users data/delete users	1
9. Add New User	Add a new user	8
10. Update User	Update existing user data	8
11. Manage Stations	Access stations data/upload XML	1
12. Add New Station	Add a new station	11
13. Update Station	Update existing station data	11
14. Manage Vehicles	Access vehicles data/upload XML	1
15. Add New Vehicle	Add a new vehicle	14
16. Update Vehicle	Update existing vehicle data	14
17. Simulation Panel	Access simulation data/upload XML	1
18. Live Charts	Access live charts and statistics	1

Table 4.2.1: The pages of the web platform and the functionalities performed by administrators.

The Graphical User Interface (GUI) of the web platform consists of elements that are similar and shared between the pages. The Login page contains the logo and a small login form. All other pages share the same design. At the top there is a horizontal bar that on the left has the title and, on the right, a personalized welcome message to the administrator. In the left vertical area, we have the logo in rectangular form and just below it, the navigation options link to the most important pages: Dashboard, Live Charts, Admins, Users, Stations, Vehicles, Simulation and Logout.

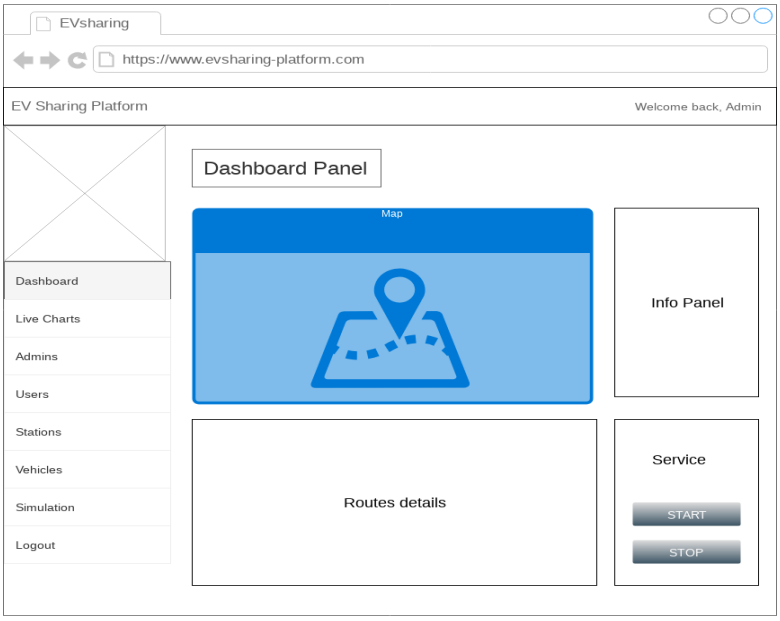

Figure 4.2.1: Mockup design for the Dashboard page. Simulation page shares a similar design.

The centre area is specific to each page and contains the title (the Map area for Dashboard and Simulation pages only, as seen in Fig. 4.2.1) and the Details area. The Details area is bigger in Admins, Users, Stations and Vehicles (as seen in Fig.4.2.2), with rows that correspond to each object in the database. The right area on all pages contains an Info Panel, where some useful information is provided for various actions within the page. In the Dashboard and Simulation pages there are buttons for starting and stopping the service and the simulation, and in Stations and Vehicles pages an Upload button allows administrators to upload an XML file with station or vehicle details respectively.

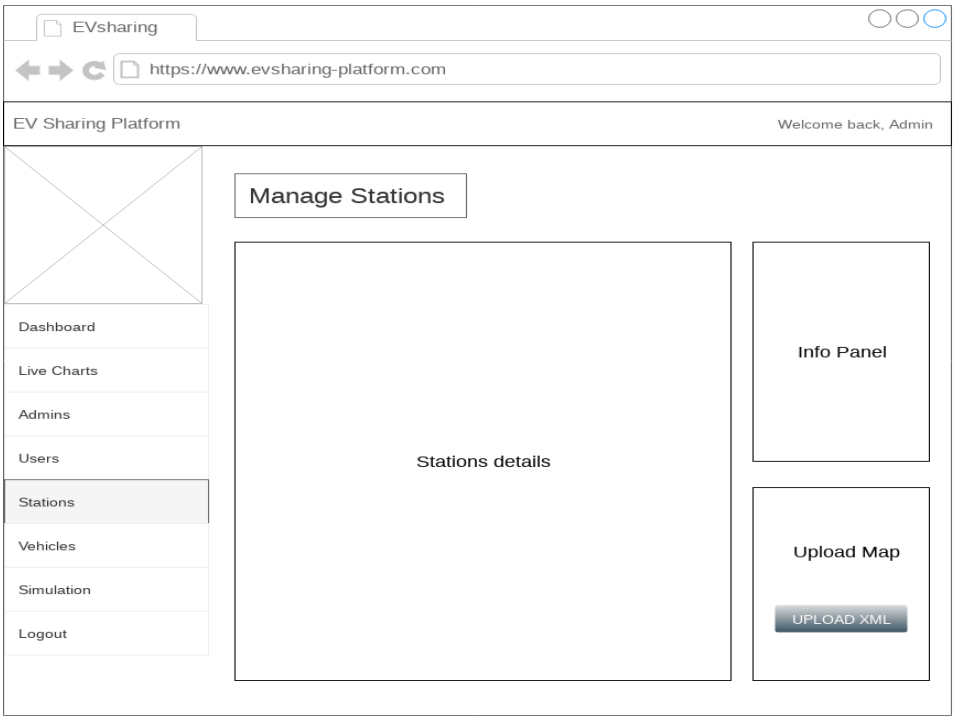

Figure 4.2.2: Mock-up design for the Stations page. Admins, Users and Vehicles pages share a similar design.

4.3 Mobile Application Design

The Android mobile application consists of a set of screens. The Main Login screen allows users to login with their username and password. If they do not have an account, they can click the Register button to create a new account with their details. On successful login, they are redirected to My Profile screen. The Profile screen shows their details and contains buttons to update them and to move on to the next screens, like Open Map and User History.

The Open Map screen initiates the first step for requesting a vehicle and the map is shown with the stations as pins. Users can select the start and finish stations and on the second step, on the Request screen they can select a specific time and send the request to the platform. The platform will process all current data and decide whether to accept or deny the request. The mobile application gets the status of the request from the server and saves it to the device. The User History screen contains the history of requests and the Settings screen allows users to change the application settings. All screens and activities are presented in Table 4.3.1.

SCREEN	ACTIVITY/ACTION	PARENT SCREEN
1. Main Login	User login	-
2. User Registration	Add a new account Access/edit	1
3. My Profile Screen	profile details Access/delete history	1
4. User History	of requests Get and select	3
5. Open Map Screen	start/finish stations Send request,	3
6. Request Screen	get and save response Change the	5
7. Settings Screen	application settings	1

Table 4.3.1: The screens of the mobile application and the functionalities performed by users.

The GUI of the mobile application consists of elements that are similar and shared between the screens. The Main Login screen contains a simple login form and a button for creating a new account. At the top of all screens there is a horizontal bar with a title. On the left there is an icon that opens up the mobile menu. The navigation drawer is the panel that shows the logo in rectangular form and just be- low it, the navigation options link to the most important screens: My Profile, Open Map, Request Vehicle, User History, Settings and Logout. The navigation menu is hidden when the user touches the rest area of the application (Fig. 4.3.2).

The centre area is specific to each screen and contains the title, the Details area and one or more buttons. The Profile screen has buttons that let users open the map, request a vehicle and access their request history. User History has a button to allow navigation back to My Profile and a button to delete the request history that is saved on the device (Fig. 4.3.1). The Open Map screen contains a Map area with the stations (Fig. 4.3.2), and on the Request screen there are buttons for sending the vehicle request and for navigating back to My Profile.

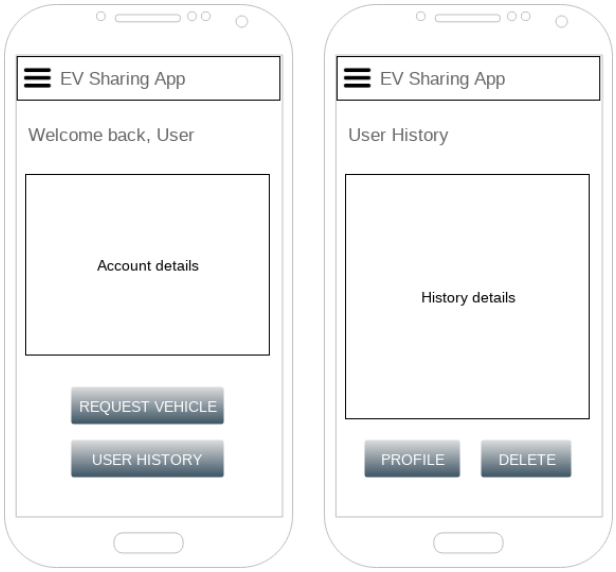

Figure 4.3.1: Mock-up designs for My Profile and User History screens.

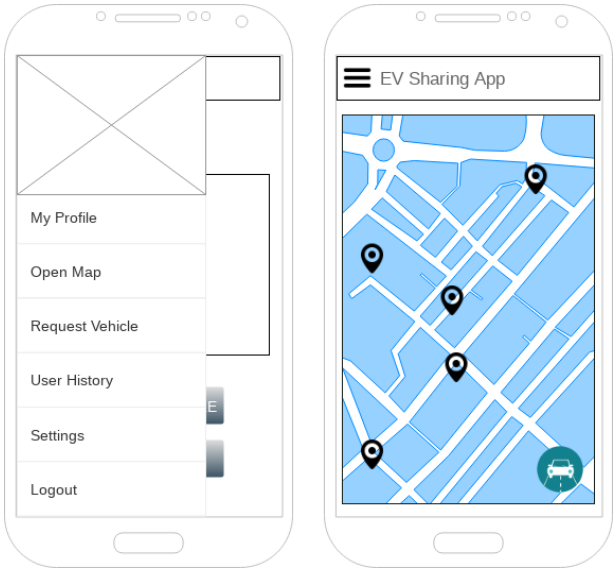

Figure 4.3.2: Mock-up designs showing the navigation drawer menu and the Open Map screen.

4.4 Database Design

The web platform uses a database to manage objects or entities and their characteristics. Those entities are: administrators, users, stations, vehicles, routes and simulations. The database consists of tables that represent each entity and holds a number of attributes. Every object is saved as a row of those attributes and their values. Primary keys are used to uniquely identify a saved object and foreign keys are used to refer to a set of attributes from another table. Primary and foreign keys form the relationships between the tables.

The attributes of the user table are the username, password, name, gender and date of birth. The administrator table holds the username, password, name and role. There are two roles for administrators, the admins that can create new admins and the moderators that cannot add or remove admins from the database. The attributes of the station table are the name, longitude, latitude and traffic level. We

have defined the traffic level as a factor that influences how frequent the routes are at specific stations, and how much time and energy a vehicle needs to fulfil them. There are 5 traffic levels, where level 5 stations are located very close to the centre of the city. As we move further, we encounter stations with traffic levels 4 to 1. The vehicle table holds the license plates, charge level, model, availability and station id. Charge level is a percentage of the energy of a vehicle in a given time, the availability is *true* when the vehicle is available and is set to *false* in case of a malfunction. The station id has the id of the station that the vehicle is currently located.

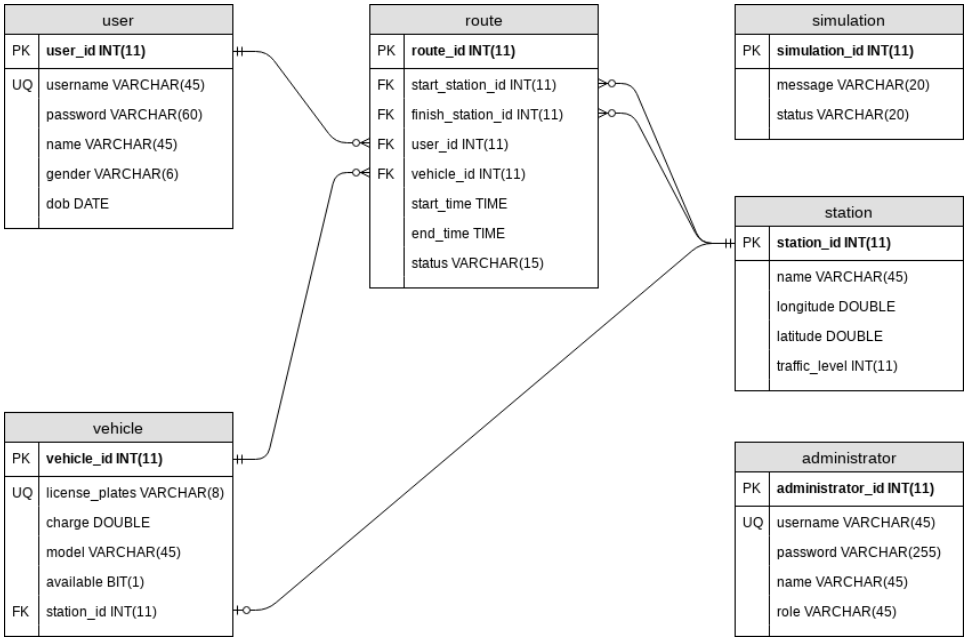

Figure 4.4.1: Entity relationship diagram of the database.

The attributes of the route table are the start station id, finish station id, user id, vehicle id, start time, end time and status. These attributes are used to describe the data of a route (for example user1 requests a route from station A to station B at 16:00). If the status of the request becomes accepted by the system, it will calculate the end time and assign a specific vehicle to this route. The status attribute gets the value of "Accepted" or "Denied", so the system saves the requests that have been denied as denied routes and the valid routes as accepted routes.

The simulation table is used when we want to load a batch of requests from an XML file, thus simulating a specific amount of user requests for vehicles. By loading a simulation file, the system processes all data and decides on the status of each request. The simulation table holds the message of each simulation in the same form as if it had been submitted by the mobile application, along with the status. The status of each simulation is first set to "Ready" and when the system decides about the status, it is set to "Processed".

There are five relationships between the entities: (1) one and only one user can be part of zero or more routes, (2) one and only one vehicle can be part of zero or more routes, (3) one and only one station can be part of zero or more routes as a start station, (4) one and only one station can be part of zero or more routes as a finish station, (5) one and only one station can be assigned to zero or one vehicle (Fig. 4.4.1).

Implementation

5.1 Development Phases

We have grouped the required tasks for the development of the project into the following five phases of development: Phase I (web platform), Phase II (mobile application), Phase III (platform scheduler algorithm), Phase IV (platform decision algorithms) and Phase V (Testing and evaluation). Each phase is an iteration cycle that includes analysis, design, implementation and testing procedures (Fig.5.1.1).

In Phase I we developed the web platform. Specific requirements were analysed in more details, the design was revised and we implemented the platform starting from small components. Before moving to bigger components, we performed manual testing and when adding components, we always tested the communication between them. In Phase II we followed the same steps for developing the mobile application.

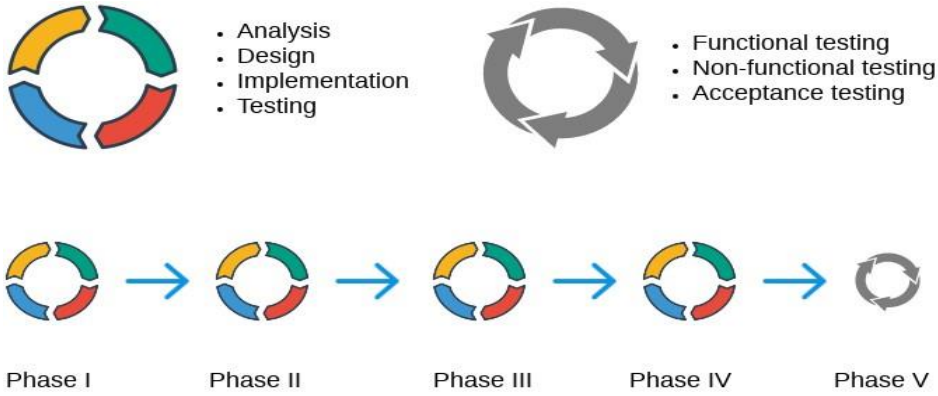

Figure 5.1.1: Phases of development of our software solution.

Phase III was about research and development of the platform scheduler. The scheduler is responsible for making the appropriate calculations of the vehicles directions, charging levels and their distances to nearby stations in order to predict future routes and the efficiency of the system. In Phase IV we created two algorithms for deciding whether to accept or deny a vehicle request. The "short mode" algorithm takes into account the future routes of the vehicles in the start station and decides if these vehicles are free or not, and the "long mode" algorithm considers the future routes of other vehicles and if they can substitute a current "locked/assigned" vehicle to make it free for use.

In Phase V functional and non-functional testing was performed using black box test design techniques to detect possible defects. White box testing was used to check the thoroughness of testing. User acceptance testing was also important, in order to gather user feedback and conclude if the system fulfils its needs. More details about the project Gantt chart and the project plan can be found in Appendix sections 9.1 and 9.2.

5.2 Web Platform Implementation

Spring MVC is a request driven framework. All incoming requests pass through a central servlet, the front controller, that delegates the requests to a specific controller. This controller handles the request and builds the appropriate model, which encapsulates the application data. Then, it sends the model to the view for rendering the data and generating the HTML output for the client's browser. The process of building the model includes the use of a service class that delegates calls to a suitable DAO class. DAO classes

initiate the actual database transactions with the help of entity classes and object relational mapping modules (Fig. 5.2.1).

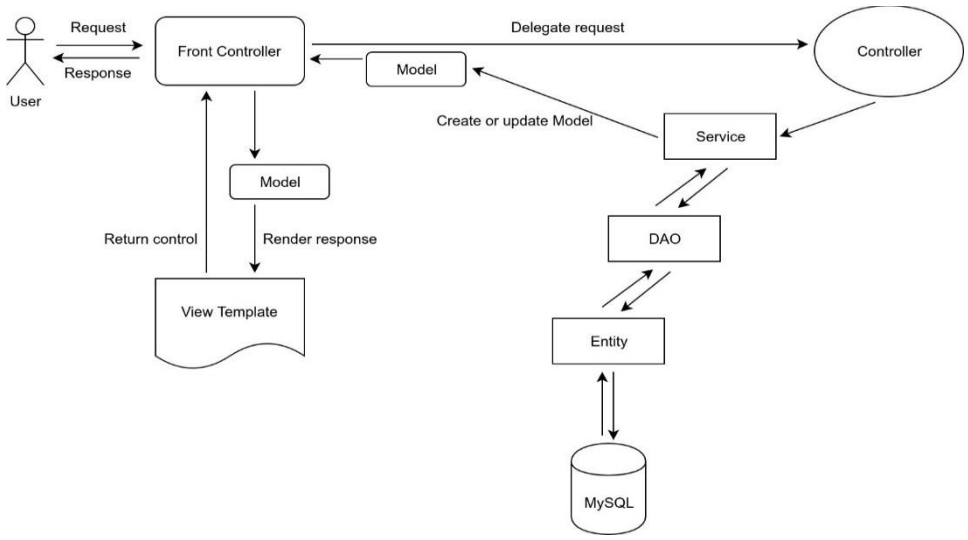

Figure 5.2.1: Overview of Spring MVC architecture for the web platform.

In our application we use a package named Controllers with all controller classes. Each controller accepts as input user data and with the help of services classes, it updates the model and passes it to the appropriate view. Then, a JSP page generates HTML output with the updated model data. We have the following controller classes that handle the user request when accessing a specific web page: Home-Controller, AdministratorController, UserController, StationController, Vehicle-Controller, SimulationController, LiveChartsController. The controllers that handle the RESTful web service for allowing access to user accounts and stations details from the mobile device are: UserRestController and StationRestController.

The Repositories package contains interface DAO classes and their implementations. Those classes read and write data to the database by accessing the POJOs in the Entities package that map objects to specific tables in the database. We have the entities classes: Administrator, User, Station, Vehicle, Route, Simulation and each one has its corresponding class in the Repositories package that calls its methods. We used Hibernate as an object-relational mapping framework.

The services implementations inside the Services package delegate requests to the suitable DAO classes and offer a specific functionality that controllers classes need. The classes in this package are the following: AdministratorService, UserService, StationService, VehicleService, RouteService, SimulationService and they are used to list, save, update and delete administrators, users, stations, vehicles, routes and simulations respectively. LoadMapService, LoadVehiclesService, LoadSimulationsService are used for parsing the uploaded XML files and saving stations, vehicles and simulations into the database. The PopulateDropdownsService creates the data for users, vehicles and stations dropdown lists. ProcessRequestServiceShort and ProcessRequestServiceLong classes implement the ”short mode” and ”long mode” algorithms for processing the requests and RemoteConnectionService is used to create a TCP socket for listening to incoming TCP messages.

The RESTful web service allows access to user accounts and stations details from the mobile device, so we need an authentication and authorization frame- work to restrict this access to registered users that use our mobile application. In order to secure the web service we used OAuth2, where third-party applications can obtain limited access to an HTTP service on behalf of a resource owner. The resource server hosts the protected resources and responds to client requests for accessing them. The

authorization server issues access tokens to the client after authenticating the resource owner and obtaining authorization.

The Security package contains the classes for configuring the authentication and authorization implementation for the RESTful web service. Spring Security helps us integrate OAuth2 and it also filters access to specific web pages in order to protect the administration panel. So, we do not only use session variables to restrict access from not logged in users that try to access the web platform administration pages, but we also check their role when they login and filter their page requests according to custom rules specified in a Spring Security class. The classes in this package are: AuthorizationServerConfiguration, for configuring the authorization server, ResourceServerConfiguration, for configuring the resource server, and SecurityConfiguration, for protecting the administration pages and allowing only ad- mins and moderators to access them.

The Utils package contains some helper classes used by services classes. My-Tasklet, configured as a Spring Batch job, is used to predict future routes and the efficiency of the system. This class is essential for the live charts functionality of the web platform. Future movement of vehicles, charge levels and routes need to be predicted in small intervals, so if a user requests a vehicle in a later time, all data will be recalculated and the live charts will be updated accordingly. We chose to execute MyTasklet as a Batch job every 10 seconds. QuartzTaskScheduler is used for executing the Spring Batch job. ProcessModeHelper and SocketConnectionHelper are just helper classes for accessing the process mode and client socket variables. RemoteConnectionHandler class handles TCP connections when the system processes the user request. StrongTextEncryptorHelper class is used to encrypt and decrypt text, in our case the TCP messages between the platform and the mobile application, with a master password. The class diagrams for the web platform can be found in Appendix section 9.3.

Administrators use the web platform to manage users, stations, vehicles, routes and requests from the users. In order for the system to be able to accept and respond to requests, station and vehicle data should be uploaded, a process mode should be selected and the service should be started. Then a TCP socket is created, listening for incoming requests as TCP messages. For each mobile client that communicates with the server, a new TCP connection is created. When messages are received, they are processed with the selected mode and the responses are sent back to the clients and saved in their User History.

Web server setup is essential in order to create a live environment and test the web platform. We purchased a Virtual Private Server (VPS) from DigitalOcean. We installed Debian 8.9 as the server OS, as Debian releases are very stable and they are widely used in production environments. We upgraded to the latest pack- ages and then installed and secured MySQL Server. We created the same user ac- count that we had when developing the database in MySQL Workbench in our local machine, exported an .sql dumb of our locally developed database and imported it on the sever. The next step was to install Java 8 Development Kit (JDK) and Java Cryptography Extension (JCE) Unlimited Strength, which is needed for TextEncyptor to work. Finally, we installed and configured Tomcat Server 9.0 on the server and uploaded the Web Application Archive (WAR) file of the project that we developed with Eclipse Java EE IDE in our local machine.

5.3 Mobile Application Implementation

Implementing the Android application includes creating the layout XML files with the appropriate graphic elements and controls for each Activity. Activity classes use their corresponding views from the layout files and handle the data input and processing. The communication with the web platform is realized via a REST client for accessing user accounts and station details, and a TCP connection for sending requests and receiving responses.

We organized the classes of the mobile application into four packages: Base, Evsharingapp, Entities and Utils. The Base package contains the BaseActivity class, which is the base for all Activity classes since they inherit its attributes and methods. BaseActivity provides the functionalities for the navigation drawer and tool- bar. It handles clicks on navigation items and starts the corresponding Activity.

The Evsharingapp package contains the Activity classes. MainActivity creates the first screen shown to the user with the login form and the Register button. AsyncTask is used to perform background operations and show the results on the UI thread, without affecting the main thread. Such background operations include all communication functionalities with the server. RegisterActivity allows the user to register a new account and the ProfileActivity gets the account details from the server and presents them on the screen using the REST client (Fig. 5.3.1).

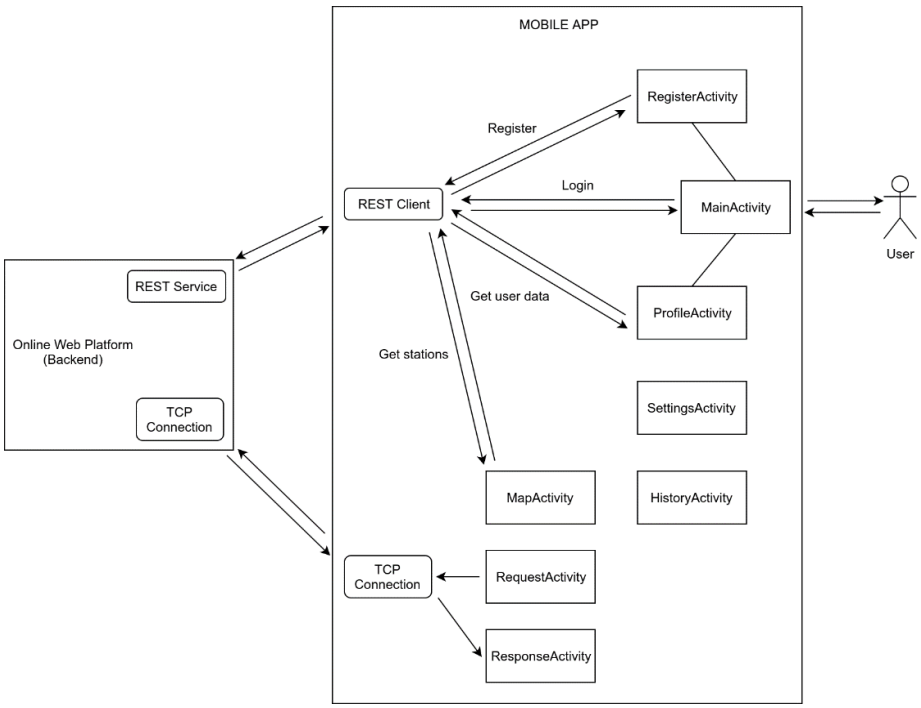

Figure 5.3.1: Interactions between Activity classes, and the communication channels between components of the system.

The MapActivity gets the station details and shows them as pins on the map. When the user selects the start and finish stations, the RequestActivity loads a new screen with the station names in dropdown elements and a control to select the time. When the user clicks on the Send Request button, a TCP message with the encrypted request details is sent to the server. The encrypted text contains the user id, the start station id, the finish station id and the time. When the response is received, the ResponseActivity shows the request status (accepted or denied) to the user, which is then saved in a local database on the Android device. HistoryActivity loads the saved requests from the database into a properly formatted webview component. The SettingsActivity allows the user to configure the IP address and port number of the server.

The Utils package contains the classes responsible for the communication via the RESTful service. AuthTokenInfo represents the token object required for the OAuth2 authorization procedure. The SpringRestClient class implements the authentication and authorization by requesting a token from the resource owner. The authorization server checks the mobile application credentials, issues a token and then the application can access the resources on the server, in our case the user accounts and station

details. The data retrieved from the server are saved as *user* and *station* objects with the POJOs in the Entities package.

The DateDialog and TimeDialog classes in the Utils package are used to create the date and time dialogue boxes. MyTextEncryptor encrypts and decrypts the TCP messages between the platform and the mobile application, using the same master password used on the corresponding class of the platform. The Helpers class includes functionalities related to the management of the database on the Android device, like loading, updating and deleting rows (used in request history with status details). The Utils package also includes methods for validating input data in the login, register, profile and request forms and the Global class contains attributes available globally to all classes, such as the IP address and port number of the TCP server, the current user, the SQLite database and the database file objects. Mobile application class diagrams can be found in Appendix section 9.4.

The workflow of a vehicle request by a user consists of the following steps: (1) the user logs in to his account from the mobile application, (2) he selects Open Map from the navigation menu, (3) he selects the start station and the finish station from the pins on the map, (4) he selects a specific time and clicks on the Send Request button, (5) the encrypted message is sent to the server via the TCP connection, (6) the web platform decrypts the message request, (7) the selected pro- cess mode determines which decision algorithm will be executed (”short mode” or ”long mode”), (8) a route is created and saved into the database with the appropriate status, (9) the request status is sent back to the mobile application.

5.4 The Platform Scheduler

The purpose of the platform scheduler is to provide a way to execute a Batch job in small intervals that predicts the future movement of vehicles, the charge level and the routes of each vehicle within a given time period (e.g. a day). For every incoming vehicle request, the prediction data have to be recalculated, considering the result of the decision algorithm of the system, which is to accept or deny the request. This way, the live charts and statistics are updated every 10 seconds, which is the interval that the scheduler algorithm is executed.

The scheduler algorithm creates and updates three HashMaps: stationsMap, vehiclesMap and chargeMap. The stationsMap has the station id as an integer key and an array of integers as the value, that represent the current sum of vehicles in the station. The vehiclesMap has the vehicle id as an integer key and an array of integers as the value, that represent the current station of the vehicle with the station id. The chargeMap has the vehicle id as an integer key and an array of doubles as the value, that represent the current charge level of the vehicle. We assume that the system will operate for 16 hours within a day in order for low level vehicles to be charged and checked for possible malfunctions. This equals to 192 5-minute segments, so to predict the future values in the HashMaps, we used a size of 192 for all arrays. We can predict, by getting the value of the array at the index that corresponds to a specific 5-minute segment: (1) how many vehicles will be available in a specific station, (2) the current station of a specific vehicle, (3) the current charge level of a specific vehicle.

The platform scheduler algorithm is implemented in MyTasket class. First, the vehicles are assigned to stations with the highest traffic level. Then, the stationsMap, vehiclesMap and chargeMap are created for every station and every vehicle. We update the HashMaps according to the starting positions of the vehicles and if the simulation mode is active, we get all simulation requests and process them according to the selected process mode. Next, we update the HashMaps with the appropriate details from the accepted routes in the system. For each route, the end time and charge cost are calculated, along with the number of vehicles on stations, the current station of the vehicles and their charge level, by updating

the values of the arrays. Now, the stationsMap contains key-value pairs for all stations, and vehiclesMap and chargeMap contain key-value pairs for all vehicles.

Additionally, three arrays of integers are used to calculate the total number of requests, the accepted requests and the denied requests in the system. The size of these arrays is also 192, representing the total 5-minute segments within a day. The HashMaps and the three arrays are then sent to the LiveChartsController class, which sends the data to the Live Charts web page. The Live Charts page shows five statistical diagrams: the efficiency rate, which is the number of accepted user requests against the number of denied user requests, a chart showing the accepted and denied requests over time, the vehicles allocations in stations diagram, the vehicles charge levels over time diagram, and a table showing the current positions of the vehicles over time.

5.5 Short Mode Decision Algorithm

The most important element in the evaluation of the system is to ensure that the highest number of users will be served within a day. We have developed and implemented two decision algorithms that process the user requests and decide to accept or deny them, in order to maximize the number of accepted requests against the denied requests. We will examine those two algorithms and see what their key differences are.

The Short mode algorithm gets the request message and extracts its attributes, the user id, start station, finish station and start time. The trip duration in minutes, and the charge cost for the request trip are calculated. Next, we get the vehicles that are currently in the start station and add them to the candidateVehiclesList. We also get the vehicles that finish at the start station before the start time, and add them to list. If the candidateVehiclesList equals to zero, the "result" string is set to "Denied", else we check if the candidate vehicles have future routes. We add the vehicles without future routes, to the betterCandidateVehiclesList.

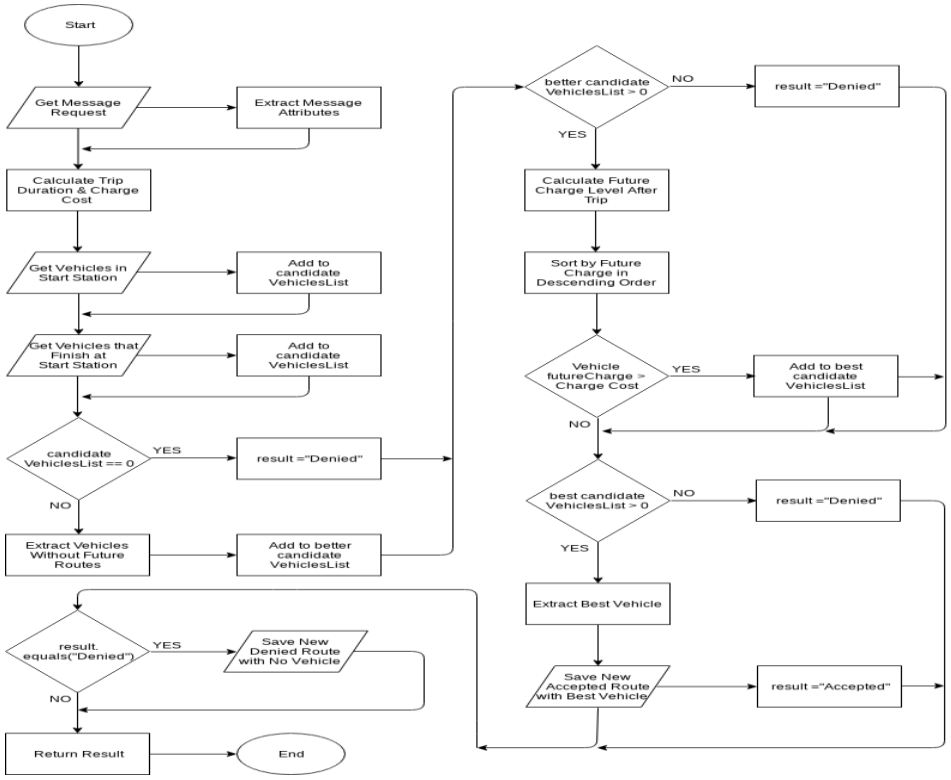

Figure 5.5.1: Short mode decision algorithm flowchart.

If there are no vehicles in the betterCandidateVehiclesList, the ”result” string is set to ”Denied”, else we calculate and set the future charge for each vehicle by subtracting the charge cost from the current charge level of each vehicle. We sort the vehicles by future charge in descending order and if the future charge of a vehicle is bigger than the charge cost, we add it to the bestCandidateVehiclesList. Now, the bestCandidateVehiclesList contains all the vehicles that are suitable for the request trip. The first vehicle in the list has the maximum charge level, so it is the best vehicle. We assign it to the to the new route with the user request details, save the route to the database and set the ”result” string to ”Accepted”. If there are no vehicles in the bestCandidateVehiclesList, the result is set to ”Denied” and the route is saved as a denied route, without any vehicle details. The flowchart for Short mode algorithm is shown in Fig. 5.5.1.

In summary, the Short mode algorithm extracts the message requests attributes, gets the vehicles that currently are, or finish in the start station before start time and adds the vehicles without future routes to a list. We calculate the charge cost for the request trip, get the vehicles with enough charge and assign the best vehicle to the new route with the user request details. We save the route to the database and set the ”result” string to ”Accepted” (Table 5.5.1).

STEPS	SHORT MODE ALGORITHM
1	Extract message requests attributes
2	Get available vehicles in start station
3	Get available vehicles without future routes
4	Get available vehicles with enough charge
5	Assign best vehicle to new route
6	Save new route and result string

Table 5.5.1: Short mode algorithm overview and steps.

The Short mode algorithm has a relatively simple implementation, but its biggest drawback is that if a vehicle is assigned for a route that starts for example, after 6 hours, this vehicle is considered ”locked/assigned” and cannot be used for another route for those 6 hours. One way to tackle this problem is to restrict the minutes in the future that users are allowed to request a trip. For example, in the mobile application we can only allow requests for the next 60 minutes to be sent to the server, by editing the time control in the Request Screen.

5.6 Long Mode Decision Algorithm

A restriction that does not allow users to request vehicles at any time during the day, may not be a viable solution to the ”locked/assigned” vehicles. In order to overcome this problem, we developed and implemented the Long mode algorithm that also considers the future routes of other vehicles and if they can substitute a current ”locked/assigned” vehicle to make it free for use.

The Long mode algorithm gets the request message, extracts its attributes, and adds the vehicles that are currently in the start station and the vehicles that finish at the start station before the start time, to the candidateVehiclesList. Next, we get the vehicles without future routes and the vehicles with one future route and add them to betterCandidateVehiclesList and betterCandidateVehiclesListWithLateRoutes respectively. We sort the vehicles by future charge in descending order and if the future charge of a vehicle is bigger than the charge cost, we add it to the bestCandidateVehiclesList. Now, the bestCandidateVehiclesList contains all the vehicles that are suitable for the request trip. The first vehicle in the list has the maximum charge level, so it is the best vehicle. We assign it to the to the new route with the user request details, save the route to the database and set the ”result” string to ”Accepted”. If there are no vehicles in the bestCandidateVehiclesList, the result is set

to ”Denied” and this concludes first part of the decision procedure that follows the logic of the Short mode algorithm.

At this point there are no vehicles without future routes and with enough charge level to cover the trip. So, we need to find a candidate vehicle with a future route, assign its route to a substitute vehicle and then assign this vehicle, which will not have a future route now, to the user request trip. First, we check the future route of the vehicles in the betterCandidateVehiclesListWithLateRoutes. If this route starts later than the start time plus the trip duration of the user request, we need to find a substitute vehicle. We add the vehicles that are currently in the start station and the vehicles that finish at the start station before the start time of this future route, to the substituteVehiclesList.

Next, we add the substitute vehicles without future routes to the substitutesMap, that holds the better candidate vehicle ids and arraylists of substitute vehicles ids for those candidate vehicles. We sort them by future charge in descending order. If the substitute vehicle of the best candidate vehicle has enough charge for the future trip of the candidate vehicle, we assign the substitute vehicle to the candidate vehicle’s future route and save the updated route to the database. Now, the best candidate vehicle is no longer “locked/assigned” and it is free for use. We assign it to the new route with the user request details, save the route to the database and set the ”result” string to ”Accepted”. The flowchart for Long mode algorithm is shown in Fig. 5.6.1 and Fig. 5.6.2.

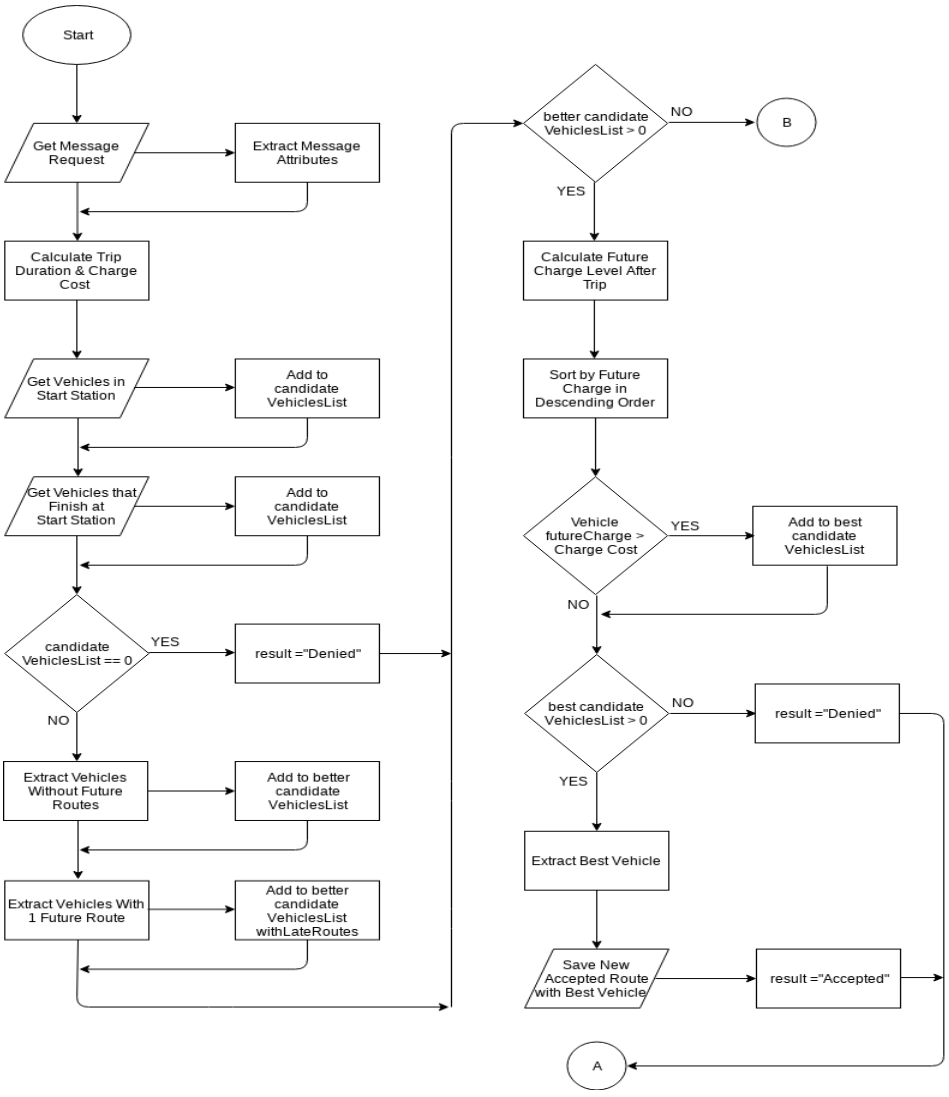

Figure 5.6.1: Long mode decision algorithm flowchart (part I).

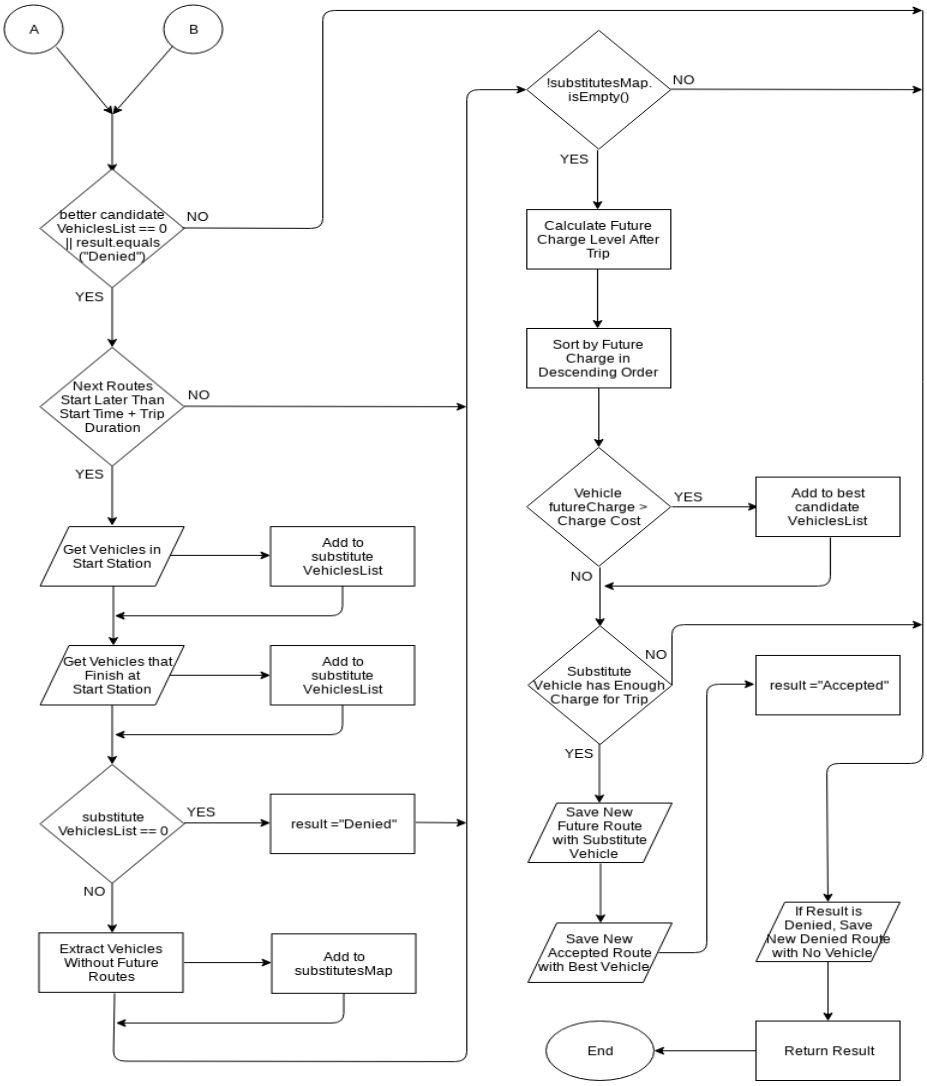

Figure 5.6.2: Long mode decision algorithm flowchart (part II).

In summary, the Long mode algorithm gets the vehicles in the start station with- out future routes and those with one future route and adds them to lists. If there are vehicles with enough charge in the first list, we assign the best vehicle to the new route and save the route to the database, else we search for a substitute vehicle to replace the future route of a vehicle in the second list. We get substitute vehicles without future routes and with enough charge, and we assign the best substitute to the future route of the best vehicle in the second list. Now, the best vehicle in the second list is no longer "locked/assigned" and we assign it to the to the new route, save the route to the database and set the "result" string to "Accepted" (Table5.6.1).

As we shall see later, we tested the two algorithms by generating a high number of requests. Although the Short mode is simpler in its implementation, the Long mode algorithm performed better in all cases with an average gain from 1.17% - 1.83% in the efficiency rate of the system. In general, the higher the number of user requests, the better the efficiency is. This means that more requests get accepted and turned into actual routes and less requests are denied. A more detailed comparison between the two algorithms is available on the next chapter.

STEPS	LONG MODE ALGORITHM
1	Extract message requests attributes
2	Get available vehicles in start station
3	Get available vehicles without future routes
4	Get vehicles with one future route
5	Get available vehicles with enough charge
6	Assign best vehicle to new route
7	Save new route and result string
8	Else, get substitutes vehicles in start station
9	Get substitutes vehicles without future routes
10	Get substitutes vehicles with enough charge
11	Assign substitute vehicle to future route
12	Update future route with substitute vehicle
13	Assign best vehicle to new route
14	Save new route and result string

Table 5.6.1: Long mode algorithm overview and steps.

A car sharing scheme operating in a city with many requests per day, will benefit by converting more user requests to actual routes, thus increasing the customer satisfaction. And this is expected, as we designed the Long mode algorithm to also search for future routes of other vehicles that can substitute a current vehicle that already has a route assigned. This way, the vehicle can be regarded as free, ready to serve a new customer because its route is now assigned to the substitute vehicle.

6.1 Test Strategy

Our test strategy includes three types of testing performed throughout the development procedure, using both black-box and white-box test design techniques. Black-box techniques include equivalence partitioning and boundary value analysis for proper input validation testing. In use case testing the system was evaluated when the most important user scenarios were executed. With white-box techniques, we measured the thoroughness of testing by creating test cases to achieve the highest percentage of statement and decision coverage.

Functional testing was performed in all phases of development, targeting all test levels from the smallest functional unit to the whole software system. During Phase V, we created a tool to generate routes with many different configurations and examined the results. Those randomly generated test cases were an excellent way to assess the efficiency of the platform decision algorithms. In non-Functional testing we focused on security, performance and usability of the system. Alpha testing was also performed, where test scenarios were given to a small number of users in order to assess the system readiness and reveal possible problems in user experience. A summary of test cases is available in Appendix section 9.5.

6.2 Functional Testing

The functional testing includes the testing and evaluation of the system functionalities and its components. Test conditions and test cases are derived from the requirements list and they can be divided into the following categories: navigation links, input validation, data consistency and interface testing. Navigation links functionality should always point to the specified web page, input validation includes checking the behaviour of the system with empty, invalid and valid values. Creating, accessing, editing and deleting objects from the database ensures data consistency and interface testing verifies that communication is done properly.

Functional testing was performed in all levels of testing. The levels of testing are: component, integration, system and acceptance. In Phase I and Phase II where the main subsystems were developed, the testing of every component took place at each last step, before proceeding to the next phase. We made sure that the behaviour of the objects, classes and methods worked as expected before moving on to the next steps of development. In Phases III and IV we designed test cases for system integration testing. The platform scheduler and decision algorithms required that the interface communication between the two subsystems, the web platform and the mobile application, was working according to specifications. The web service and TCP connections tests were crucial, as these components are responsible for proper data exchange between the subsystems. Phase V included functional, non-functional, and acceptance testing in order to assess the readiness of the whole system, which we will discuss later during evaluation. An overview of functional testing with the test cases, their levels and phases are presented in Table 6.2.1.

In the last phase, to better evaluate the behaviour of the system, we developed a tool to generate random routes based on different criteria. Our purpose was to also evaluate the platform decision algorithms, Short mode and Long mode, and how some different criteria could affect the efficiency rate. Those criteria are: the maximum number of route requests in a day, the maximum amount of minutes that a user is allowed to request a vehicle in the future, and the start times density factor, that essentially means how "close" or how "further away" in time, the start times of the route requests are. We generated 100 test cases for 60 maximum requests per day and 100 cases for 120 maximum requests per day, with different configurations and assigned them to the Short mode and Long mode algorithms. We found that

the Long mode algorithm performed better in all the tests, while the Short mode had very good performance, slightly behind Long mode, especially when used in test cases with 60 routes as the day limit.

TEST LEVEL	ACTIVITY/TEST CASE	PHASE
1. Component	Administrator login	I
2. Component	Manage administrators	I
3. Component	Manage users	I
4. Component	Manage stations	I
5. Component	Manage vehicles	I
6. Component	Manage routes	I
7. Acceptance	Web platform functionalities	I
8. Component	User login	II
9. Component	Manage user accounts	II
10. Component	Send vehicle requests	II
11. Component	Update existing user data	II
12. Component	Save request response to history	II
13. Acceptance	Mobile application functionalities	II
14. Integration	Access user accounts details	III & IV
15. Integration	Access stations details	III & IV
16. Integration	Send request to server	III & IV
17. Integration	Get response from server	III & IV
18. Component	Scheduler functionality	III
19. Acceptance	Scheduler functionality	III
20. Component	Short mode algorithm	IV
21. Component	Long mode algorithm	IV
22. Acceptance	Desicion algorithms functionality	IV
23. System	Web platform functionalities	V
24. System	Mobile application functionalities	V
25. Acceptance	User acceptance testing	V

Table 6.2.1: Overview of functional testing with the test cases and their corresponding levels and phases.

6.3 Non-Functional Testing

Non-functional is used to assess the quality characteristics of an application that can be quantified. Our non-functional testing includes three areas: security, performance and usability. In security testing, we tried different scenarios to gain access to restricted content without the valid credentials and also tried to manipulate the system with different actions from the mobile application. Possible vulnerabilities of the web server setup were exposed with automated scanning from external websites like Tinfoil, which informed us about the overall security of the server and its defence against some very popular attacks, such as cross-site scripting and unencrypted password submissions.

The performance of the web platform was assessed with the automated test cases from our route generator tool and the very popular online tool from GTmetrix. With our tool, we generated the data for performing load testing with up to 120 simultaneous user requests. GTmetrix generated a report with the most important performance issues, including statistics about loading time, total page size and a

waterfall chart with loading behaviour. The mobile application overall performance was also tested both during development and during acceptance tests to evaluate the response time of the whole system.

TEST TYPE	ACTIVITY/TEST CASE	PHASE
1. Security	Try to bypass administrator login	V
2. Security	Try to bypass user login	V
3. Security	Web server online test	V
4. Performance	Load testing with route generator	V
5. Performance	Web server online test	V
6. Usability	Accessibility testing	V
7. Usability	Identity testing	V
8. Usability	Navigation testing	V
9. Usability	Content testing	V

Table 6.3.1: Overview of non-functional testing with the test cases and their corresponding types and phases.

In usability testing our objective was to identify usability problems related to accessibility, identity, navigation and content. With a series of heuristic rules, we evaluated how well the system is designed to be accessible by users with different browsers and devices. Identity in usability testing is about communicating the system purpose to the users with a consistent design. The navigation aspect of usability is to provide the user an easy way for navigating to different areas of the platform or the mobile application. The content fonts and sizes should also be consistent and descriptive for fast information locating and retrieving. Usability testing was performed primarily by us in the last phase of development. An overview of non- functional testing with the test cases, their types and phases are presented in Table 6.3.1.

6.4 User Acceptance Testing

User acceptance testing or alpha testing, is performed to identify all possible issues before releasing a product to the public. It is done by possible users of the product, while developers observe them and analyse their behaviour. The tasks that need to be performed are a mix of the most important functional and non-functional requirements. It involves conducting a user testing with two groups of users. One group performed acceptance testing as administrators on the web platform and the other group tested the mobile application functionalities.

The first step was to choose the most important functionalities of the system in order to create a list of tasks, from easier to harder, that the testers needed to perform. Then we documented other test specification details (Table 6.4.1), such as the number of testers, the number of tasks and the time allowed for the testers to complete them. During the testing procedure, we observed the behaviour of the testers and took notes to see if they succeeded or failed at the tasks given. When they finished, we conducted a small interview to learn more about how they felt at specific occasions, how they reacted and why.

This procedure of testing our system gave us valuable insights about areas that might need improvements, or weaknesses that have not been recognized from previous testing activities. Ideally, after that process we would be ready to perform open beta testing, allowing a bigger number of users to evaluate our software solution.

CHARACTERISTICS	SPECIFICATIONS
Type of testers	Inexperienced and experienced
Number of groups	2 (web platform + mobile app)
Number of people per group	5
How the tasks are revealed	One at a time, from easier to difficult
Maximum time allowed	30 minutes
Users can leave anytime	Yes
Questions allowed during the test	No

Table 6.4.1: Specifications for alpha testing.

6.5 Decision Algorithms Results

With the route generator tool, we had the opportunity to see how the decision algorithms produce different efficiency rate results. With 60 maximum requests per day, we experimented with 60 - 600 minutes between the requests and different values of the requests allocation density within a day. This factor shows how "concentrated" or close, the start times of the requests are, and we tested with 5 different density factors.

First, we tested with 60 maximum requests per day. The Short mode produced an efficiency rate (the percentage of the requests that get accepted by the system) from 41.00% - 54.33% and the Long mode from 42.33% - 55.33% and it performed better with an average gain of 1.17%. When testing with 120 maximum requests per day, the Short mode produced efficiency rate from 27.67% - 45.50% and the Long mode from 27.83% - 47.83% and it performed better with an average gain of 1.83%.

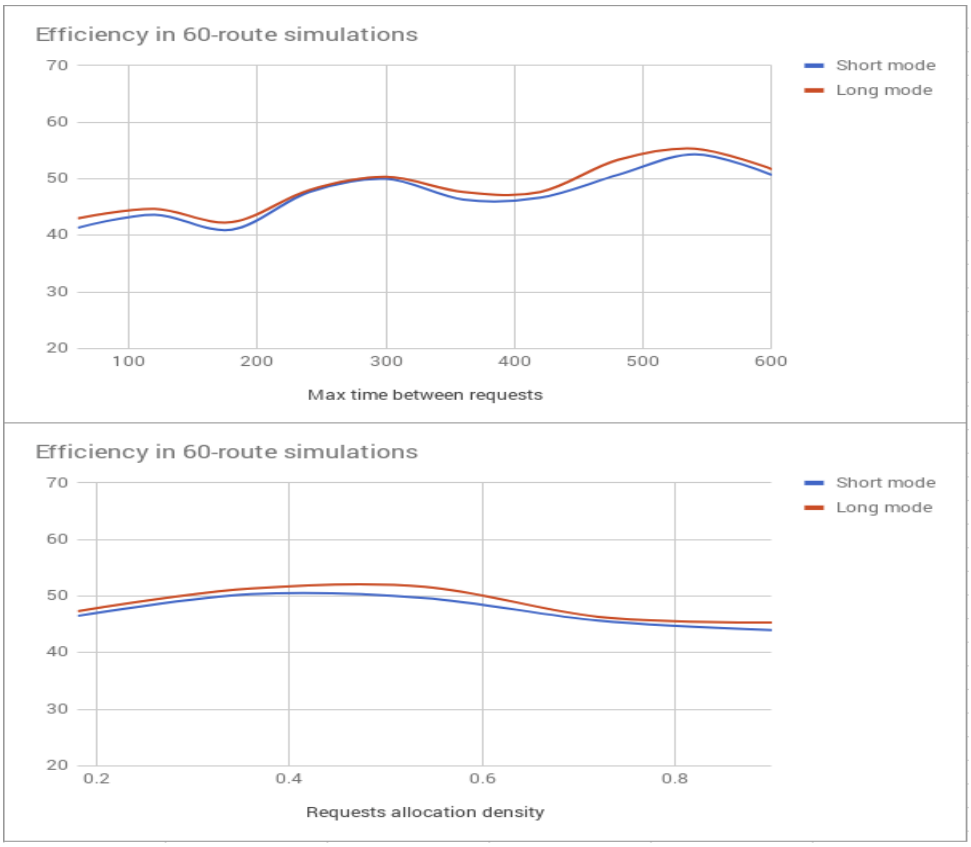

Figure 6.5.1: Efficiency rate graphs when the system accepts 60 requests for routes. The graphs show the efficiency related to the maximum time between requests and the requests allocation density.

Looking closer at the charts in Fig. 6.5.1 and Fig. 6.5.2, we can draw some interesting observations: (1) the Long mode algorithm performs better than the Short mode in all tests, (2) the Long mode offers more gain in the efficiency of the system when the maximum number of requests increase, (3) when the maximum time between the start times of the requests increases, the efficiency increases, (4) the overall efficiency seems not to be influenced by the requests allocation density within the day, (5) when the requests within the day increase, the efficiency of the system drops (for more detailed results see Appendix section 9.6)

The above observations are not conclusive because we have not tested extensively with the generator tool (200 test cases are not enough). But we can take them into account and say that in most cases, and especially when we have a higher number of requests, the Long mode algorithm is preferred and should be used.

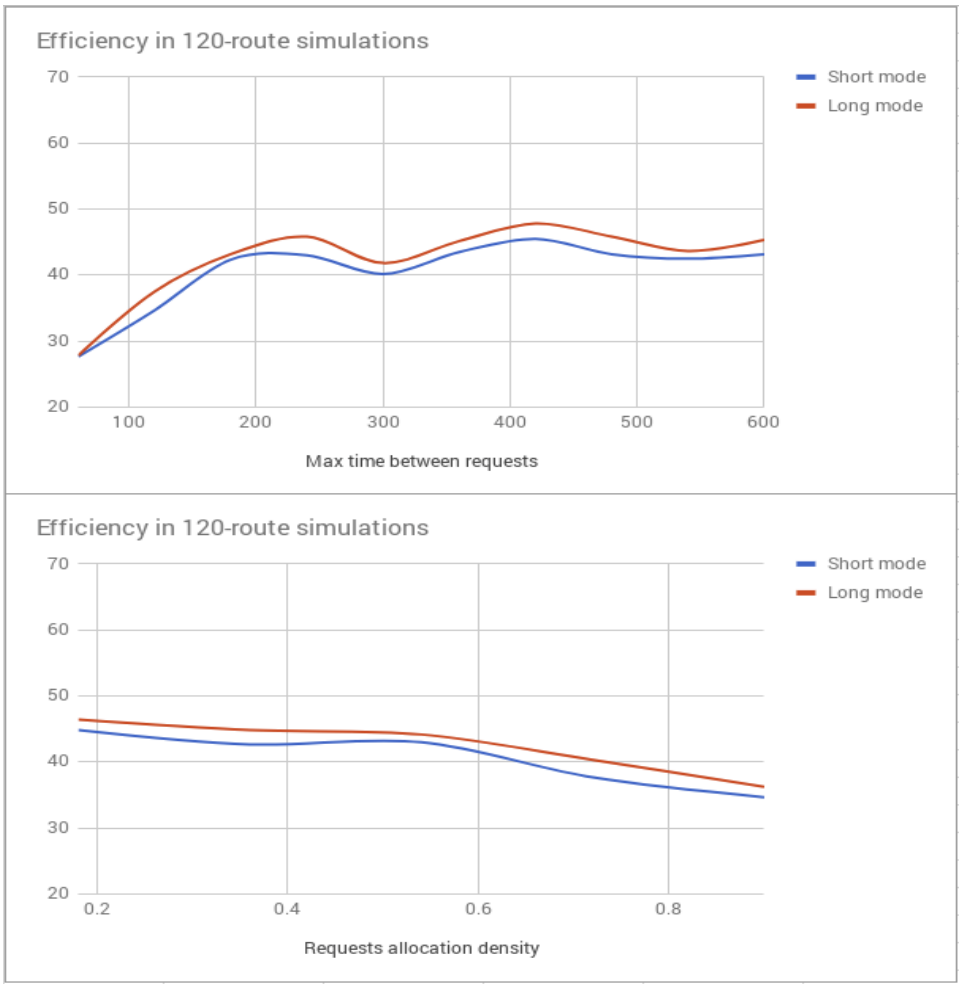

Figure 6.5.2: Efficiency rate graphs when the system accepts 120 requests for routes. The graphs show the efficiency related to the maximum time be- tween requests and the requests allocation density.

6.6 Evaluation

The functional testing throughout the development lifecycle revealed a few bugs that were mostly easy to fix. All test cases in component, integration, system and acceptance level were characterized as "Passed". The web platform works as expected, managing administrators, users, stations vehicles and routes. The mobile application functionalities exchanged the correct information with the platform and

the database. The areas with the most risk were the platform scheduler and the decision algorithms. Exploratory testing exposed some minor bugs, which were also fixed.

Non-functional testing revealed that the security implemented, protects the administrator and user accounts from unauthorized access. Spring Security success- fully filters out malicious requests and session variables allow only logged in administrators to browse the web platform. The communication between the web platform and the mobile application is realized via a RESTful web service, protected by an OAuth2 framework that uses expiring tokens, so accessing user ac- counts and station details is very secure. Vehicle requests from the mobile applications are sent as encrypted messages via a TCP connection and even if someone could steal the traffic from the communication medium, the information from the encrypted messages would be useless. Web server assessment did not reveal any security concerns with the way the server was setup and configured.

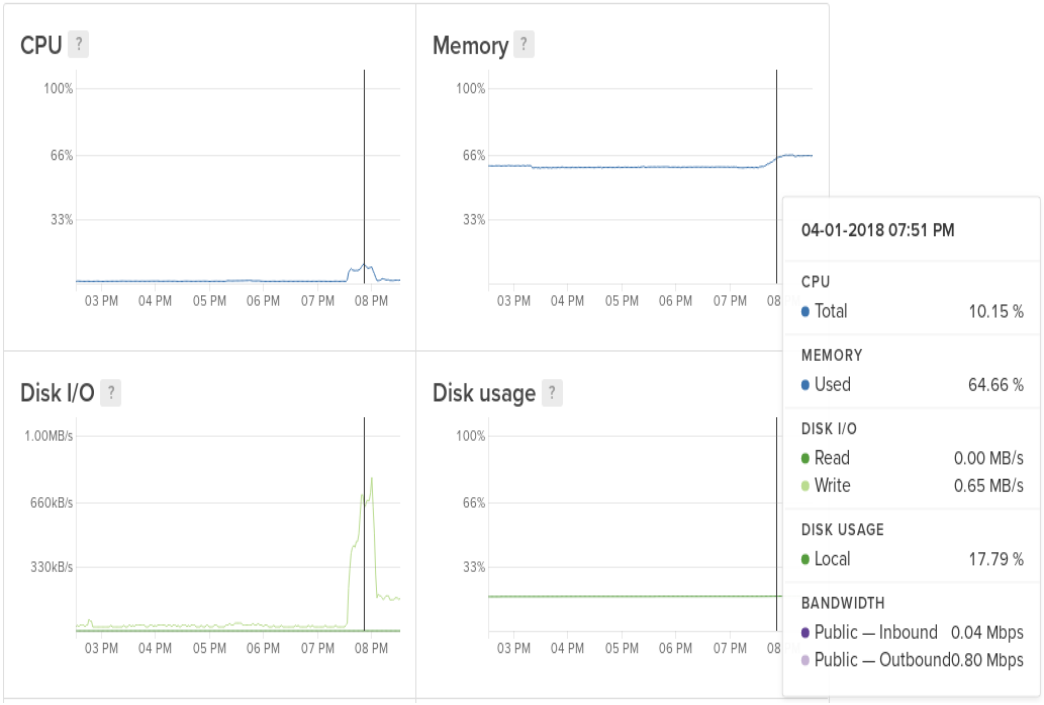

Figure 6.6.1: Server monitoring graphs during continuous and standby web platform operation modes.

Performance testing was done in two modes: a continuous mode where the system was processing simulation XML files for a period of 30 minutes, and a standby mode where the service was running, waiting for incoming requests. Looking at the monitoring graphs we can see that the server CPU usage was in the range of 6.50% - 10.15% when the system was processing simultaneous requests. Memory usage increased from 59.70% to 65.85% and local disk usage reached 17.79%. In standby mode, CPU usage dropped to 1.66% (Fig. 6.6.1). GTmetrix showed a web page load time of 1.3 seconds and a total page size of 325KB. The performance of the web platform was great, and we manually assessed the mobile application speed and responsiveness and we were completely satisfied.

In usability testing, we assessed the accessibility, identity, navigation and content. All functionalities are accessible from different browsers and devices. The layout of the web platform is optimized for full HD widescreen monitors. The mobile application was tested on different phones and proved very easy to use and make requests to the server. Alpha testing evaluated the functionalities and usability of the whole system. Users accomplished all tasks without any difficulties. Especially mobile users expressed that the mobile application was very easy with a nice user interface.

Taking all tests into account, we can say that our software solution is thoroughly tested and achieves its aim and objectives. The web platform is easy to install and configure and a car sharing company can manage its assets, like stations, vehicles and routes, easily. The mobile application allows users to select a start station, their destination, send their request for a vehicle and receive the response from the server in a fast, reliable and secure way.

The overall evaluation of the software system is almost excellent, fulfilling all the requirements of the project. We have produced a backend and frontend system that only needs beta testing in order to be ready for production and serve car sharing companies with EVs. From the mock-up designs to implementing the user interface and every functionality, we offer a software solution with a great user experience. Fig. 6.6.2, 6.6.3 and 6.6.4 show screenshots of the Dashboard page, the Manage Stations page and the Live Charts page in the web platform. Fig. 6.6.5 and Fig. 6.6.6 show screenshots of My Profile, User History, Open Map screens and the navigation menu in the mobile application.

The deliverables of the project are freely available in the following links:

- source code of the web application project file: https://github.com/ioannisgk/evsharing-platform3-release
- source code of the Android application project file: https://github.com/ioannisgk/evsharing-app-release
- video demonstration: https://youtu.be/flyixErIE-A

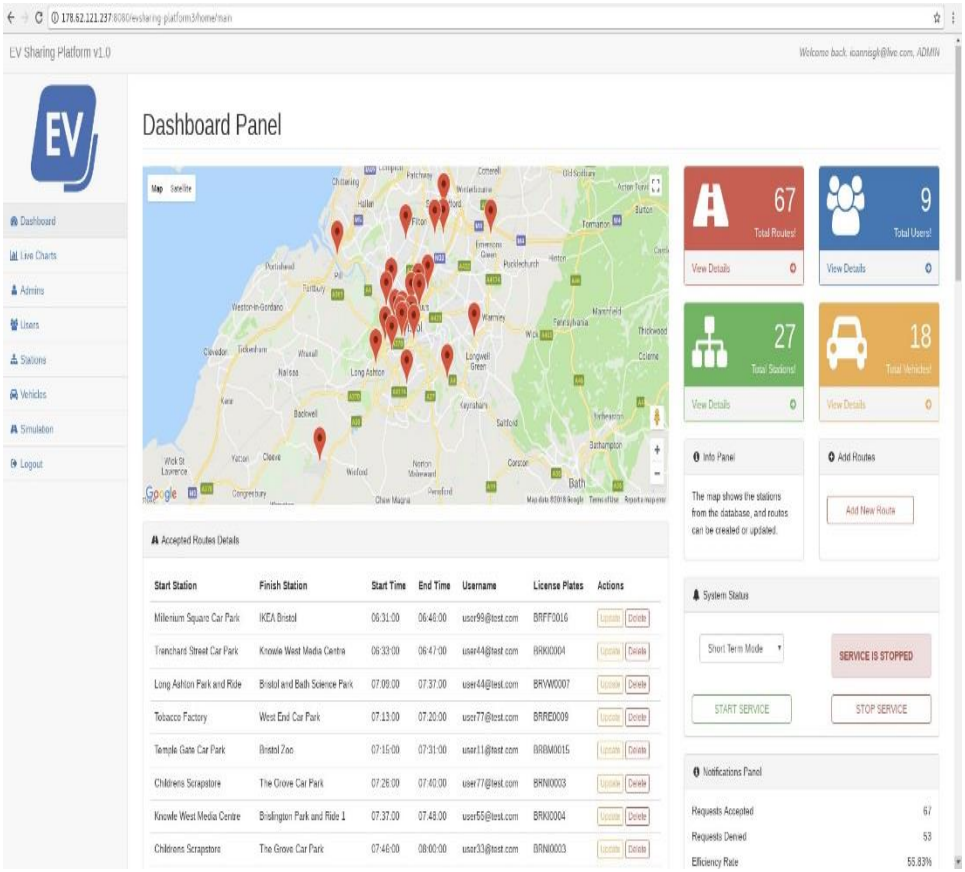

Figure 6.6.2: Screenshot of the Dashboard page in the web platform.

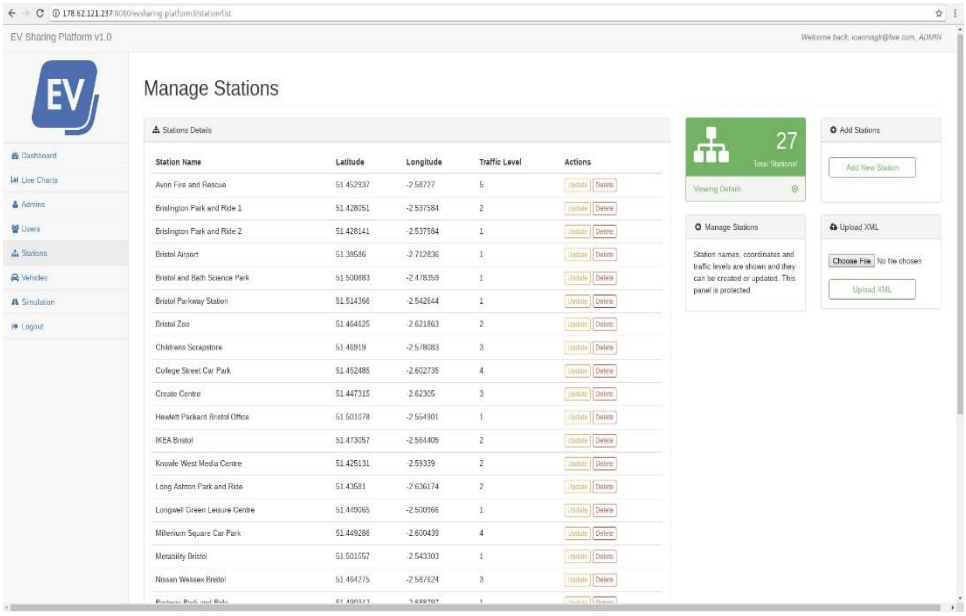

Figure 6.6.3: Screenshot of the Manage Stations page in the web platform.

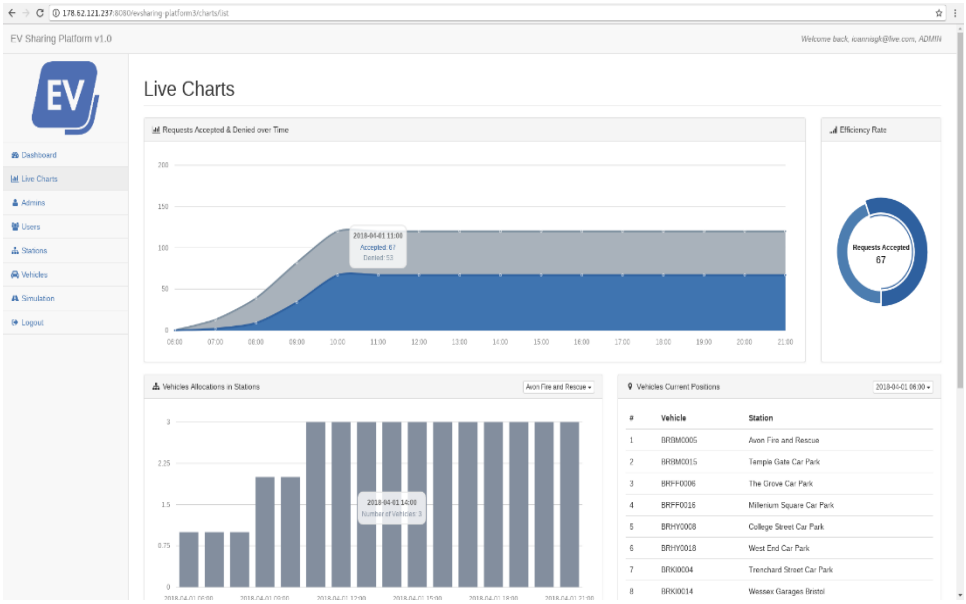

Figure 6.6.4: Screenshot of the Live Chats page in the web platform.

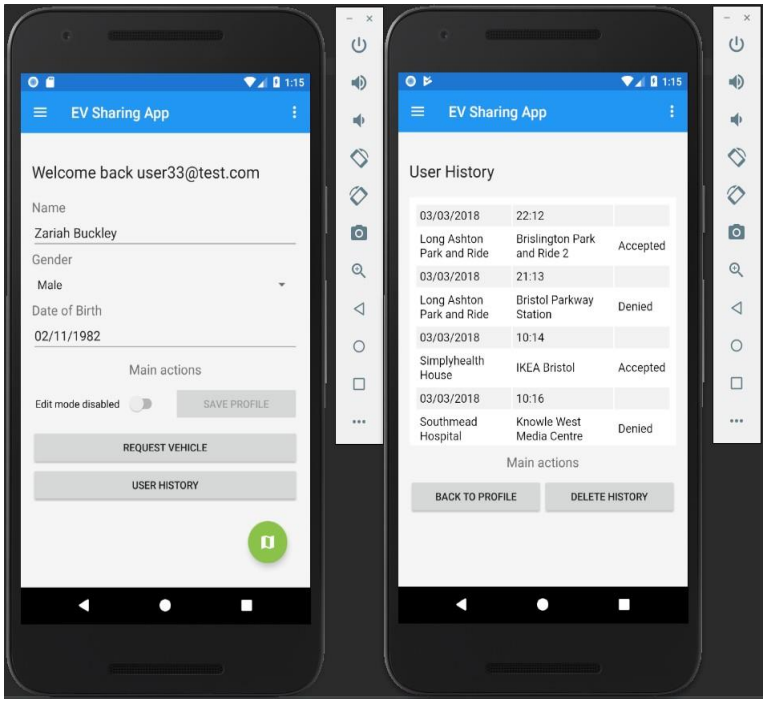

Figure 6.6.5: Screenshots of My Profile and User History screens.

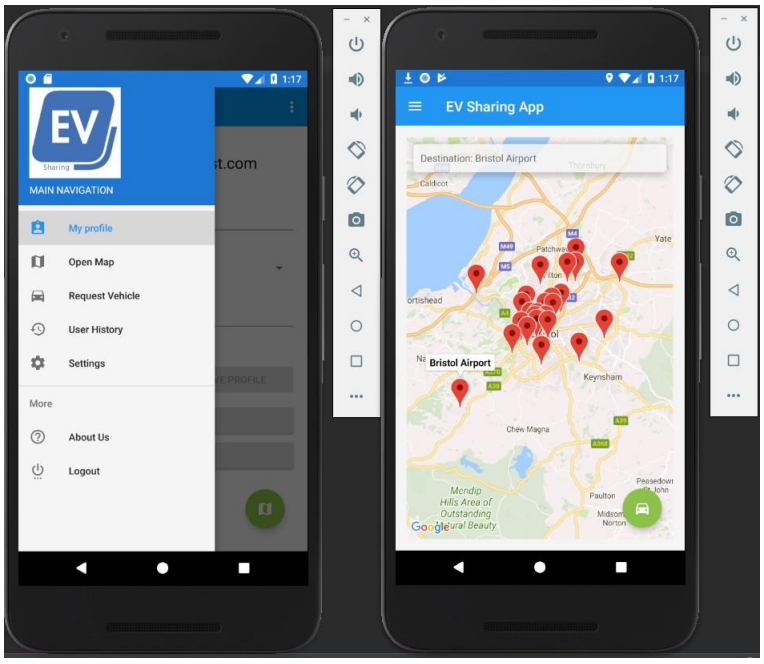

Figure 6.6.6: Screenshots showing the menu and the Open Map screen.

6.7 Limitations

There are some limitations identified in the server configuration level and in the overall system level, as an application intended to consumers. During testing, we noticed a couple of times that the server socket could not be bound to the web platform. This usually happens when using a VPS and not a dedicated server, because a VPS shares its resources with other virtual machines and applications. This

issue happens rarely and a workaround is to stop Tomcat service on the server and restart it. It is a very easy procedure but in our server it takes around 20 minutes for Tomcat to restart and reload the web platform. A dedicated server would be the best solution for a car sharing company.

In the system level, the web platform serves users that request a vehicle during a given time period, which is a day. Users can not make requests for a specific date, e.g. one or two days in the future. This is mainly due to the special needs of EVs: they have to be fully recharged and to be relocated to the optimal stations so that the car sharing fleet will be ready for the next day of operation. The mobile application allows users to select only a start station, a finish station and a time within the day of operation and this is an important disadvantage.

Another limitation is that the mobile application is intended for users with Android devices only. There is a significant market share with iOS phones that could benefit from the service. A car sharing company should not just ignore those users. Urban mobility upgrade depends on all of us and we should all be a part of it.

Conclusions

7.1 Summary

Urban mobility has been essential for the well-being of its residents, as transport is necessary to their everyday lives. So, cities started to get more crowded and that led to increased motorization. As a result, too many vehicles in urban areas created a burden that is bound to a city and becomes heavier and heavier every day. Air pollution, noise, the ecological footprint, congestion, road accidents and insufficient transport are just some of the negative consequences. Our main medium for travelling is the ICE vehicle, which uses fossil fuels and it is energy ineffective.

Cities need a new kind of automobile. A vehicle that uses renewable energy can help greatly in their sustainable development. EVs, and in particular BEVs with no harmful emissions and a high level of efficiency, seem like an excellent solution. They can benefit from connectivity and wireless networks, and offer real time traffic information, remote diagnostics and crash notifications. However, there are some challenges that we need to overcome for a wider adoption of BEVs, like the battery cost, the charging time and the charging infrastructure. Worldwide initiatives help the EV industry, and governments with OEMs pushed the number of EVs on the roads to about 1.26 million (Global EV Outlook 2016).

Car sharing is an alternative personal mobility system for urban environments. With one-way, two-way or free-floating car sharing schemes, the costs of the vehicle is divided to a large group of people, making it the most affordable option for low income inhabitants. Shared vehicle ownership is the most important advantage of car sharing as every shared car removes 4 to 23 cars from the roads (Vairani, 2009). This means decreased GHG emissions, traffic, accidents, more parking and a great efficiency in vehicle use. Although car sharing faces important challenges like the equal distribution of the vehicles at all times and location privacy, it is considered as an excellent alternative that protects the environment and diminishes all the negative effects of traffic and congestion.

From all those findings, the necessary ingredients for our mobility upgrade are obvious. We need EVs that use energy from renewable sources, to be integrated with car sharing systems. BEVs are the most suitable for this job and car sharing companies are in a position to give EV technology the boost it needs so much. Zipcar and other companies can achieve this goal and that will release positive impacts to our personal mobility, the environment and the economy of our cities. The convergence of EVs and car sharing systems will help us build better, sustainable cities with better and more reliable personal mobility. Bringing two "green" ideas together, the use of EVs and the car sharing systems, concludes the first part of our proposed urban mobility upgrade.

The second part of our proposed urban mobility upgrade is a software solution that will enable businesses to manage the use of EVs in one-way car sharing services. We designed, implemented and tested a system that consists of an on-line web platform and a mobile application. The web platform allows administrators to manage users, stations, vehicles, routes and accept or deny vehicle requests. The mobile application lets users register, login, see the available stations in their area and send vehicle requests for trips to the web platform. The platform executes an algorithm in order to decide whether to accept or deny incoming requests, ensuring that the highest number of users will be served within a day. For this purpose, we developed two algorithms, the Short mode and the Long mode, where the system searches for free vehicles or vehicles that can substitute current "locked/assigned" ones so that it can serve the maximum number of users.

The platform scheduler gathers the required data from the database and predicts the number of available vehicles in a specific station, the current station of a specific vehicle and its current charge level. All predicted data are updated every 10 seconds and displayed in the Live Charts page with diagrams and

charts. The simulation functionality on the web platform allowed us to test multiple generated requests at once and examine the behaviour of the system when using the Short mode or the Long mode algorithms. Results showed that Long mode performed better in all tests, especially when we had a higher number of requests within a day. It presented an average gain of 1.83% in efficiency rate in 120 requests per day when compared to the Short mode.

Our software solution successfully fulfils its aim and objectives. Carefully designed algorithms process user requests, ensuring that the highest number of users are served within a given time period. Both the web platform and the mobile application were thoroughly tested, offering a system that is:

- Reliable, easy to use by administrators and users, with great user experience
- Safe and secure, by protecting user accounts with OAuth2 framework and encrypting messages between the platform and the mobile application
- Easy to install and configure with the use of XML files for maps & vehicles
- Universal, allowing effortless adoption by car sharing companies with EVs
- Maintainable and extensible, since it is developed with Spring MVC, a well-known open source development framework

A video demonstration is available at youtu.be/flyixErIE-A

7.2 Future Work

The future work for this project should be focused on optimizing the platform decision algorithms. We have tested the Short mode and the Long mode algorithms but there are many options and room for experimentation ahead. Should we use only one algorithm? Should we develop an "engine" to detect specific parameters and apply the best algorithm for each situation? There are many possibilities to increase the system efficiency and serve more users.

The algorithms accept as input the user request parameters, process data and decide if a request should be characterized as "Accepted" or "Denied". We can measure the performance of the algorithm by checking its efficiency rate. With a vast search field as input, Evolutionary Algorithms seem like a very good choice for improving our system. We can develop a system that creates a population of solutions (parameters to our decision algorithms), evolve it and generate new solutions that can be tested and evaluated. Applying Evolutionary Algorithms to optimize the effectiveness of our system, is one of the recommended paths for future work.

Moving closer to the field of Artificial Intelligence, we can benefit from Machine Learning techniques and Neural Networks. We can improve the performance of existing algorithms that learn from experience and previous encounters with the input data. Using our tool generator to create a large pool of user requests, will give us the opportunity to train our algorithms with this data and make them better over time. We can even use Genetic Algorithms to generate the optimal settings to train a Neural Network and generate new sets of feature selections that will help greatly in further increasing the efficiency rate of the system.

Concluding, the future work should be focused on how Evolutionary Algorithms and Machine Learning can improve the efficiency of our software solution. We live in a new era of technological evolution and a car sharing company with EVs can offer great value to the sustainable development of the cities. With our proposed software solution, the urban mobility upgrade will make our everyday lives in the cities healthier, eco-friendly and pleasurable.

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Appendices

9.1 Gantt Chart

The project Gantt Chart shows the various activities and tasks over time (Fig. 9.1.1). The main phases of development are the following:

- Phase I - Web platform
- Phase II - Mobile application
- Phase III - Platform scheduler algorithm
- Phase IV - Platform decision algorithms
- Phase V - Testing and evaluation

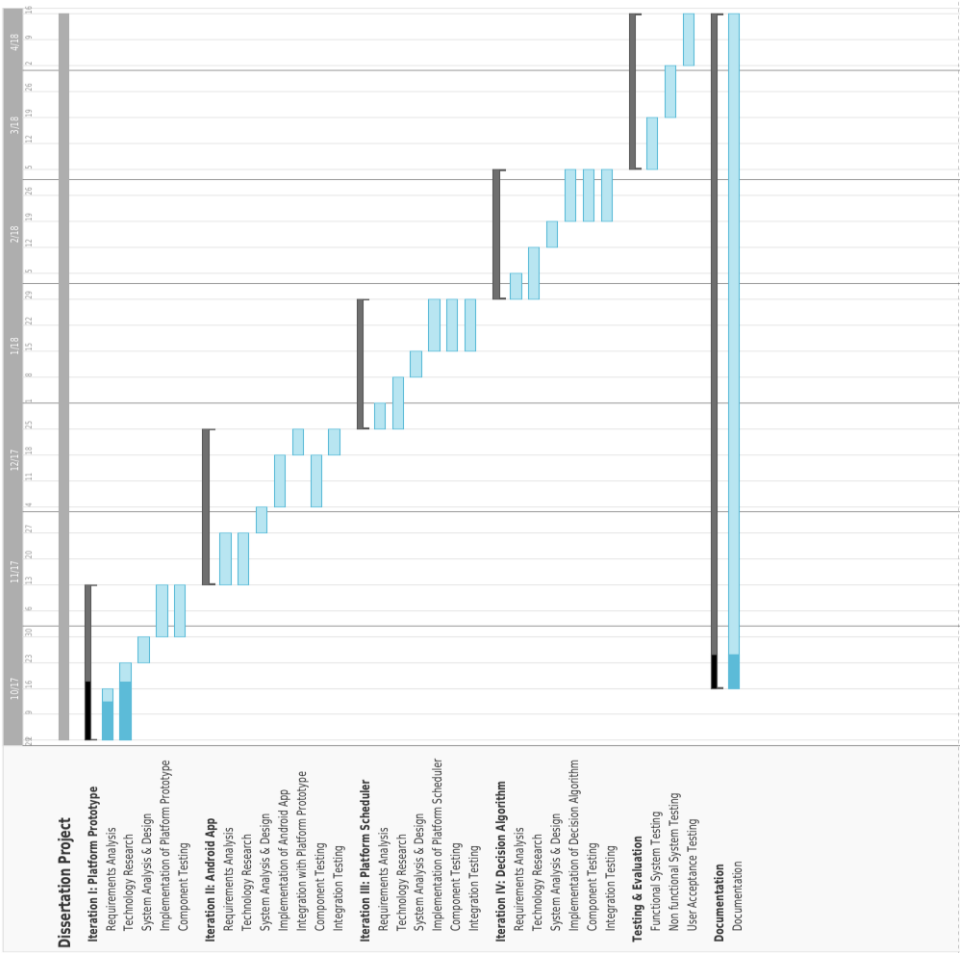

Figure 9.1.1: Project Gantt Chart.

9.2 Project Plan

Tables 9.2.1 - 9.2.4 show the tasks allocations during all phases of development. The dependent task is also shown along with the estimated time in weeks. The proposed milestone dates are the following: Phase I - 10 Nov 2017, Phase II – 22 Dec 2017, Phase III - 26 Jan 2018, Phase IV - 2 March 2018, Phase V - 13 April 2018.

TASK	PHASE I - WEB PLATFORM	DEPENDS ON	WEEKS
A1	Requirements analysis	-	2
A2	Technology research System	-	3
A3	analysis & design	A1, A2	1
A4	Implementation of platform	A3	2
A5	Component testing (milestone)	concurrent A4	2

Table 9.2.1: Tasks allocation for Phase I. Milestone date 10 Nov 2017.

TASK	PHASE II - MOBILE APP	DEPENDS ON	WEEKS
B1	Requirements analysis	-	2
B2	Technology research System	-	2
B3	analysis & design	B1, B2	1
B4	Implementation of Android app	B3	2
B5	Integration with platform	A5, B4	1
B6	Component testing	concurrent B4	2
B7	Integration testing (milestone)	concurrent B5	1

Table 9.2.2: Tasks allocation for Phase II. Milestone date 22 Dec 2017.

TASK	PHASE III - SCHEDULER	DEPENDS ON	WEEKS
C1	Requirements analysis	A5	1
C2	Technology research System	A5	2
C3	analysis & design	C1, C2	1
C4	Implementation of scheduler	B7, C3	2
C5	Component testing	concurrent C4	2
C6	Integration testing (milestone)	concurrent C4	2

Table 9.2.3: Tasks allocation for Phase III. Milestone date 26 Jan 2018.

TASK	PHASE IV - DECISION	DEPENDS ON	WEEKS
D1	Requirements analysis	C6	1
D2	Technology research	C6	2
D3	System analysis & design	D1, D2	1
D4	Implementation of decision	C6, D3	2
D5	Component testing	concurrent D4	2
D6	Integration testing (milestone)	concurrent D4	2

Table 9.2.4: Tasks allocation for Phase IV. Milestone date 2 March 2018.

Phase V includes three tasks: functional testing, non-functional testing and user acceptance testing, where we allocate 2 weeks per task in order to have enough time to fix possible bugs.

9.3 Web Platform Class Diagrams

The web platform class diagrams are below:

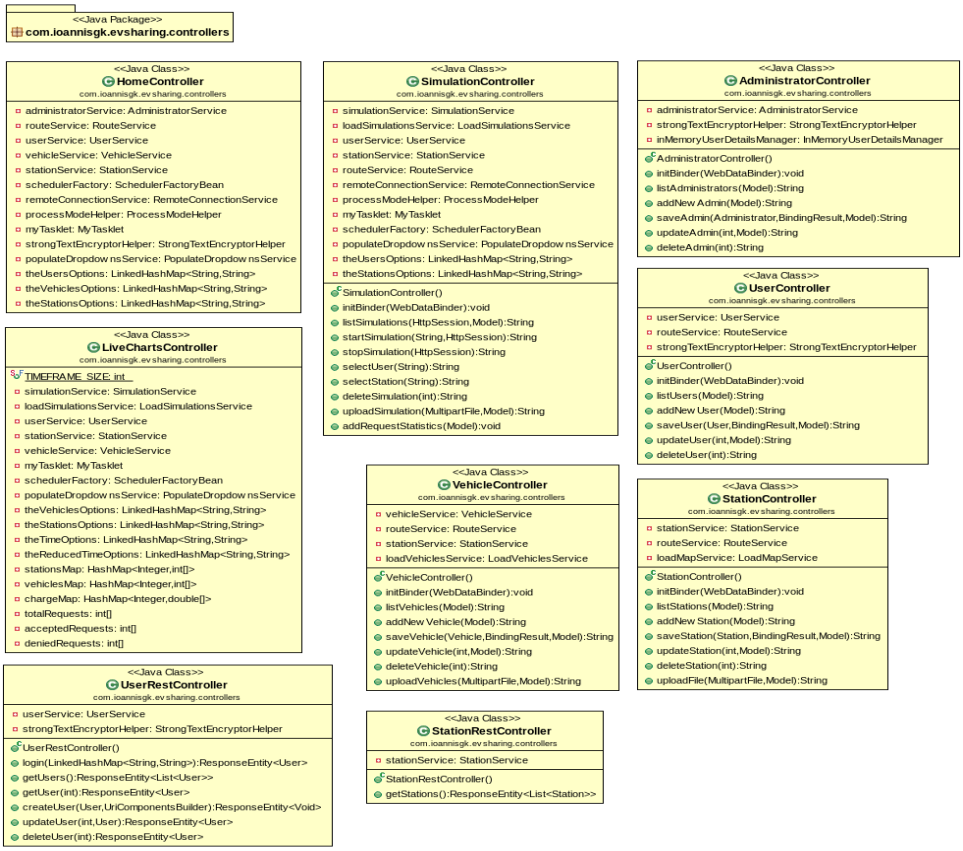

Figure 9.3.1: Class diagram for Controllers package.

Figure 9.3.2: Class diagram for Entities package.

Figure 9.3.3: Class diagram for Repositories package.

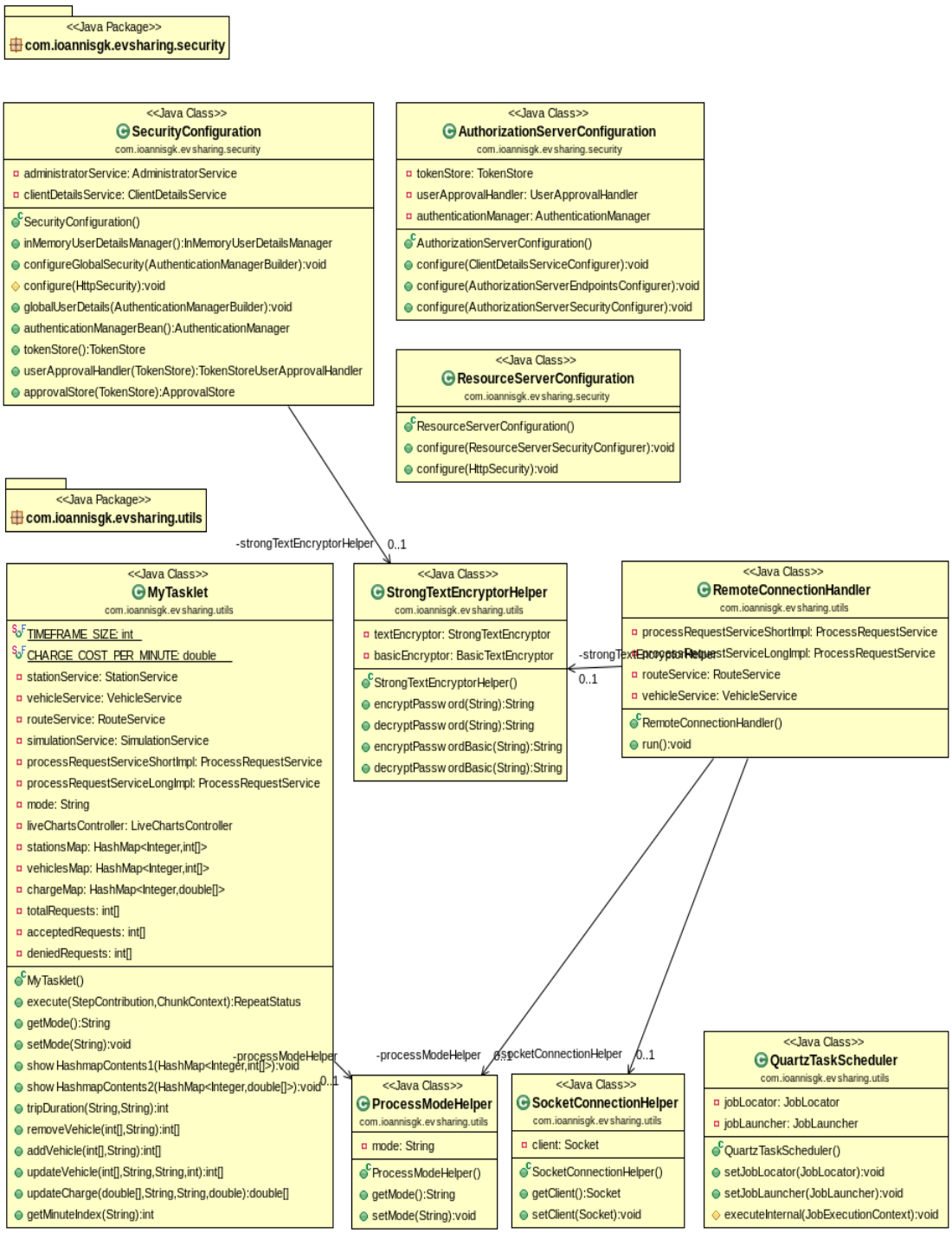

Figure 9.3.4: Class diagram for Security and Utils packages.

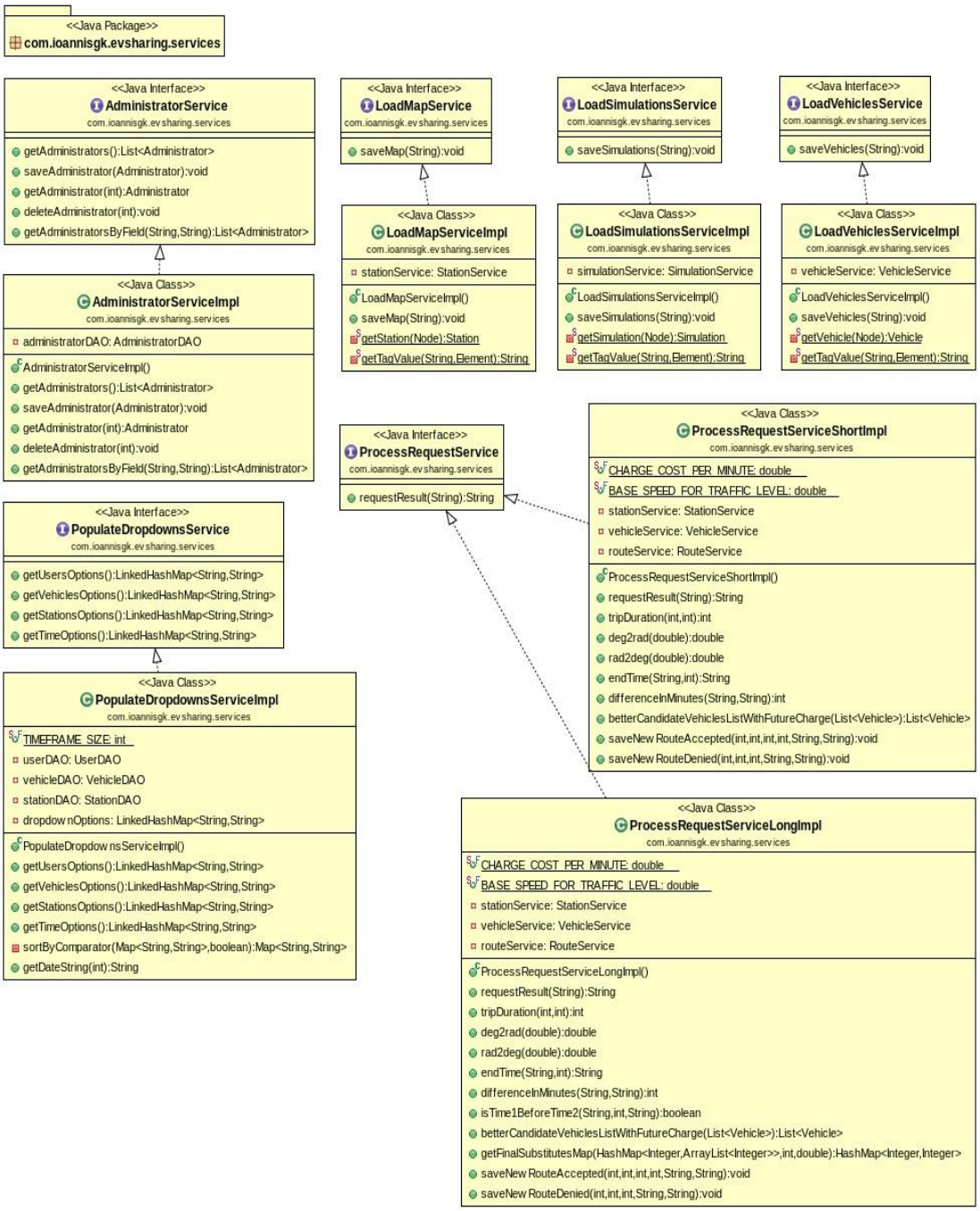

Figure 9.3.5: Class diagram for Services package (part I).

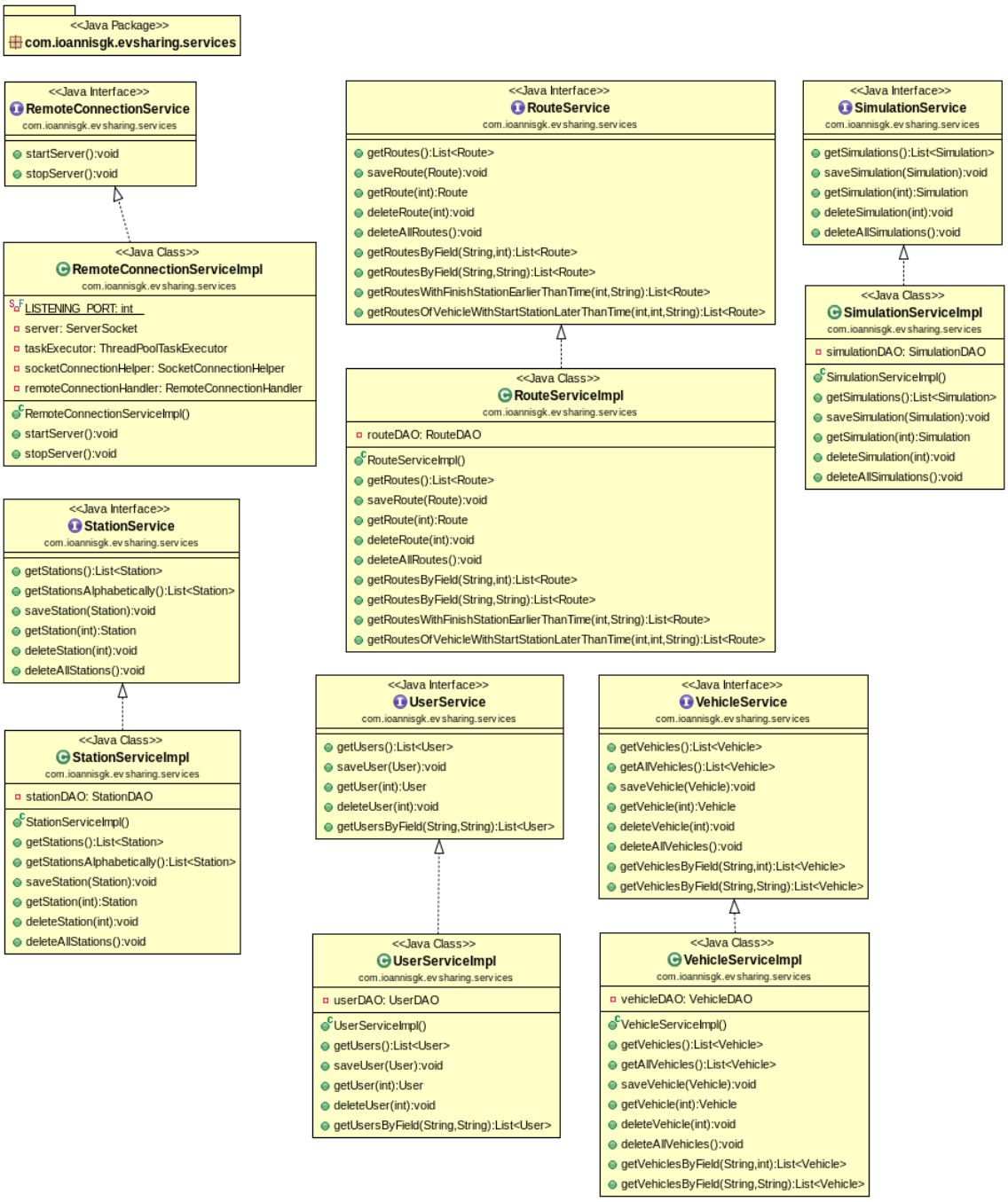

Figure 9.3.6: Class diagram for Services package (part II).

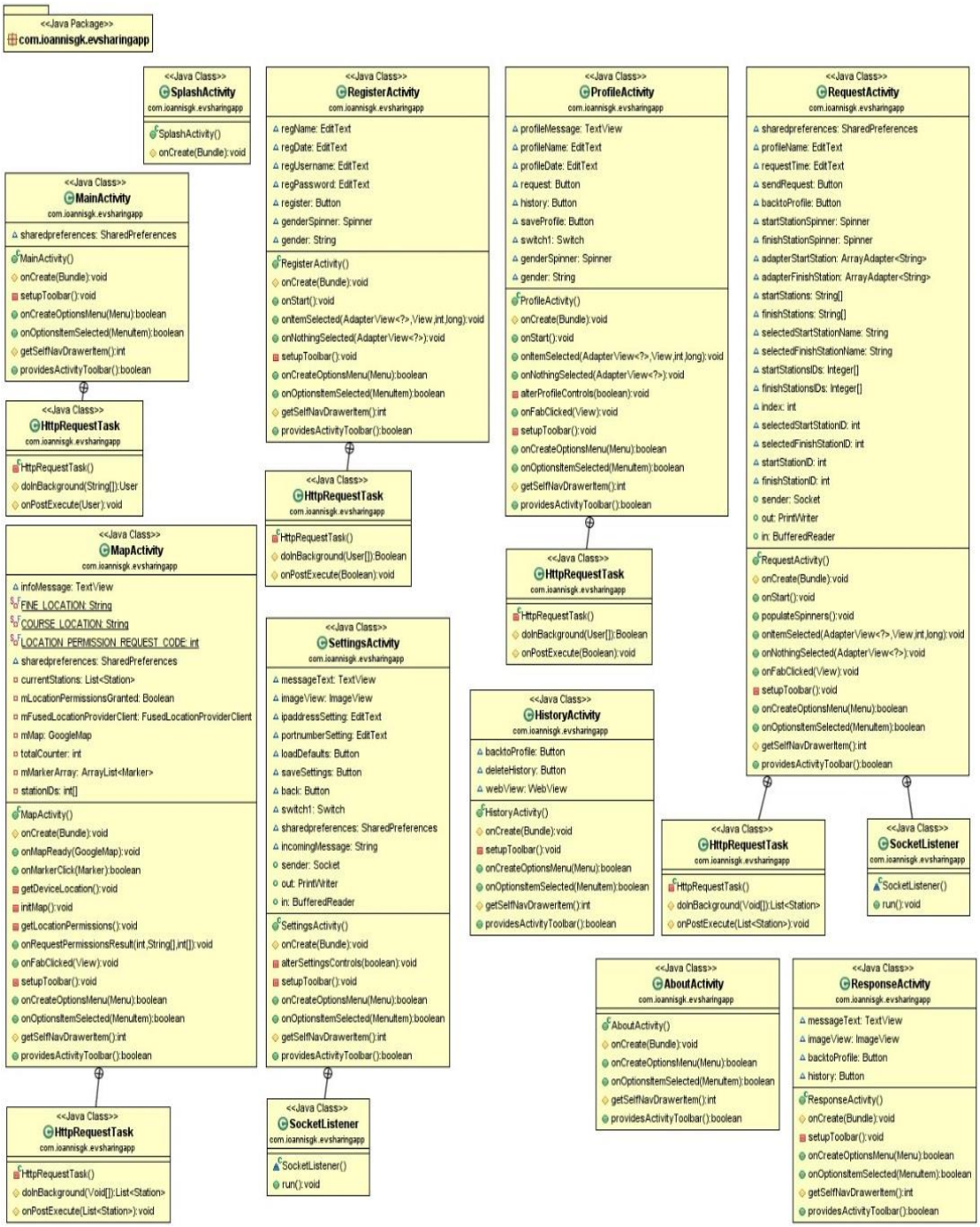

Figure 9.4.1: Class diagram for Evsharingapp package.

9.4 Mobile Application Class Diagrams

The mobile application class diagrams depict the classes that are inside each package: Evsharingapp (Fig. 9.4.1), Base (Fig. 9.4.2), Entities (Fig. 9.4.2) and Utils (Fig. 9.4.3).

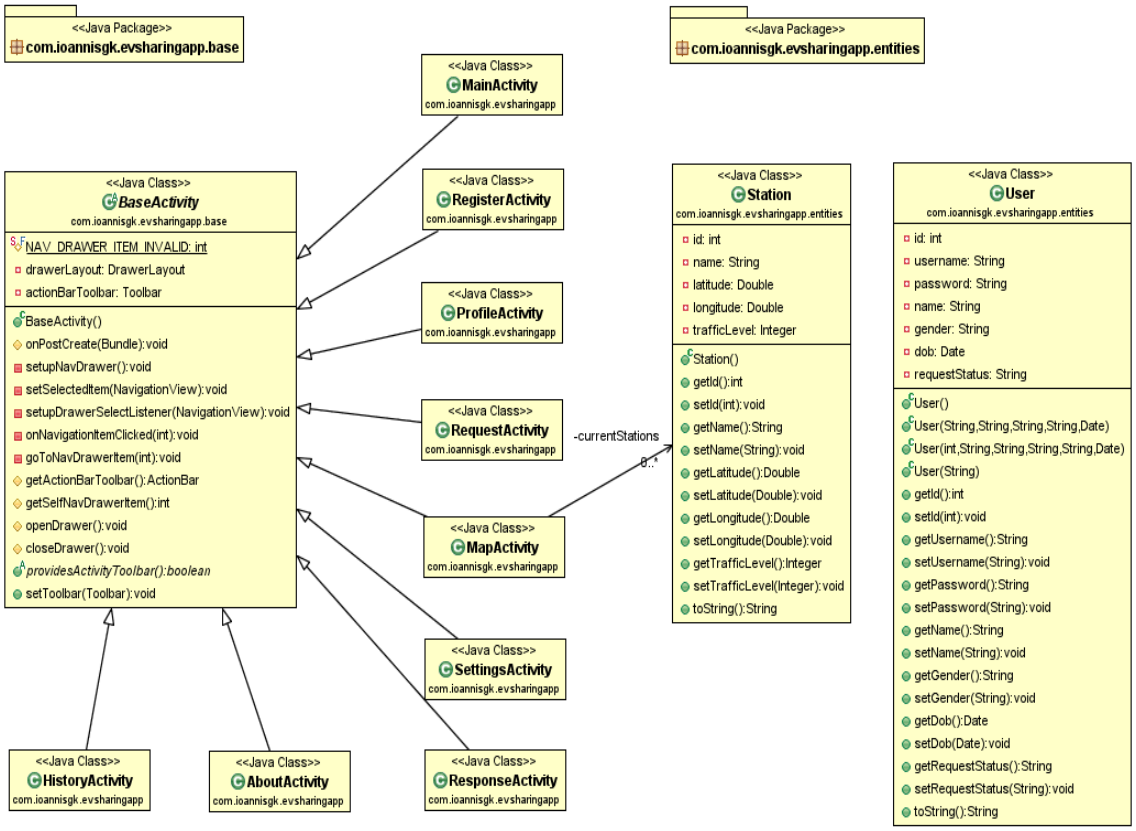

Figure 9.4.2: Class diagram for Base and Entities packages.

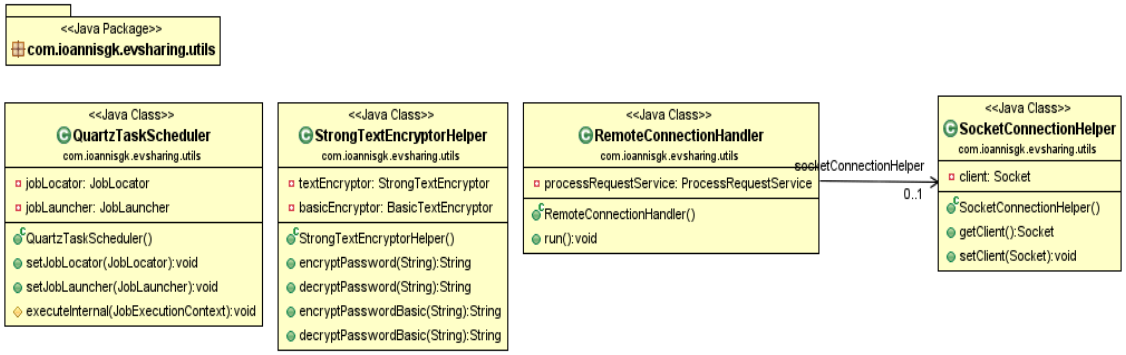

Figure 9.4.3: Class diagram for Utils package.

9.5 Summary of Test Cases

A summary of functional and non-functional test cases for the web platform and the mobile application is presented in Tables 9.5.1 and 9.5.2 respectively. All test case results are characterized as "Passed".

PAGE	TEST CASE	RESULT
1. Login Page	Administrator login	PASS
2. Dashboard Panel	Access routes data/delete routes	PASS
3. Add New Route	Add a new route	PASS
4. Update Route	Update existing route data	PASS
5. Manage Admins	Access admins data/delete admins	PASS
6. Add New Admin	Add a new admin	PASS
7. Update Admin	Update existing admin data	PASS
8. Manage Users	Access users data/delete users	PASS
9. Add New User	Add a new user	PASS
10. Update User	Update existing user data	PASS
11. Manage Stations	Access stations data/upload XML	PASS
12. Add New Station	Add a new station	PASS
13. Update Station	Update existing station data	PASS
14. Manage Vehicles	Access vehicles data/upload XML	PASS
15. Add New Vehicle	Add a new vehicle	PASS
16. Update Vehicle	Update existing vehicle data	PASS
17. Simulation Panel	Access simulation data/upload XML	PASS
18. Live Charts	Access live charts and statistics	PASS
(security)	Protect against SQL Injection	PASS
(security)	Store hashed values of passwords	PASS
(performance)	Fast load and response rate	PASS
(performance)	Offer uninterrupted service to users	PASS

Table 9.5.1: Summary of functional and non-functional test cases for the web platform.

SCREEN	TEST CASE	RESULT
1. Main Login	User login	PASS
2. User Registration	Add a new account Access/edit	PASS
3. My Profile Screen	profile details Access/delete history	PASS
4. User History	of requests Get and select	PASS
5. Open Map Screen	start/finish stations Send request,	PASS
6. Request Screen	get and save response Change the	PASS
7. Settings Screen	application settings	PASS
(security)	Send/receive encrypted messages	PASS
(security)	Authenticate users on requests	PASS
(performance)	Fast load and response rate	PASS
(performance)	Offer uninterrupted service to users	PASS

Table 9.5.2: Summary of functional and non-functional test cases for the mobile application.

9.6 Route Generator Results

In order to better evaluate the behaviour of the system, we developed a tool to generate random routes based on different criteria. Those criteria are:

- The maximum number of route requests in a day
- The maximum time that a user is allowed to request a vehicle in the future
- The start times density factor, that essentially means how "close" or how "further away" in time, the start times of the route requests are

Detailed results are presented in Fig. 9.6.1 and Fig. 9.6.2.

Max time betwee	Requests allocat	Short mode	Long mode
60	0.18	31.67	33.33
60	0.36	58.33	58.33
60	0.54	35	35
60	0.72	40	41.67
60	0.9	41.67	46.67
120	0.18	40	43.33
120	0.36	51.67	53.33
120	0.54	50	50
120	0.72	36.67	36.67
120	0.9	40	40
180	0.18	36.67	36.67
180	0.36	46.67	48.33
180	0.54	43.33	48.33
180	0.72	41.67	41.67
180	0.9	36.67	36.67
240	0.18	51.67	51.67
240	0.36	50	50
240	0.54	55	55
240	0.72	36.67	36.67
240	0.9	45	46.67
300	0.18	58.33	58.33
300	0.36	50	50
300	0.54	58.33	60
300	0.72	41.67	41.67
300	0.9	41.67	41.67
360	0.18	51.67	51.67
360	0.36	45	45
360	0.54	48.33	51.67
360	0.72	46.67	46.67
360	0.9	40	43.33
420	0.18	51.67	51.67
420	0.36	48.33	48.33
420	0.54	36.67	40
420	0.72	56.67	58.33
420	0.9	40	40
480	0.18	43.33	46.67
480	0.36	50	53.33
480	0.54	58.33	63.33
480	0.72	55	55
480	0.9	46.67	48.33
540	0.18	45	45
540	0.36	58.33	60
540	0.54	55	55
540	0.72	50	53.33
540	0.9	63.33	63.33
600	0.18	55	55
600	0.36	45	46.67
600	0.54	56.67	58.33
600	0.72	51.67	51.67
600	0.9	45	46.67

Max time betwee	Short mode	Long mode	
60	41.334	43	
120	43.668	44.666	
180	41.002	42.334	
240	47.668	48.002	
300	50	50.334	
360	46.334	47.668	
420	46.668	47.666	
480	50.666	53.332	
540	54.332	55.332	Average gain %:
600	50.668	51.668	1.1662

Requests allocat	Short mode	Long mode
0.18	46.501	47.334
0.36	50.333	51.332
0.54	49.666	51.666
0.72	45.669	46.335
0.9	44.001	45.334

Figure 9.6.1: Detailed efficiency rate results for 60 requests per day.

Max time betwee	Requests allocat	Short mode	Long mode		Max time betwee	Short mode	Long mode	
60	0.18	30	30.83		60	27.666	27.832	
60	0.36	26.67	26.67		120	34.666	37.5	
60	0.54	25	25		180	42.334	43.166	
60	0.72	33.33	33.33		240	43	45.834	
60	0.9	23.33	23.33		300	40.166	41.832	
120	0.18	28.33	28.33		360	43.498	45.166	
120	0.36	40.83	45		420	45.5	47.832	
120	0.54	42.5	45		480	43.166	45.832	
120	0.72	32.5	40		540	42.5	43.666	Average gain %:
120	0.9	29.17	29.17		600	43.166	45.332	1.833
180	0.18	49.17	52.5					
180	0.36	46.67	46.67		Requests allocat	Short mode	Long mode	
180	0.54	45.83	45.83		0.18	44.833	46.416	
180	0.72	41.67	42.5		0.36	42.667	44.832	
180	0.9	28.33	28.33		0.54	42.999	44.166	
240	0.18	48.33	49.17		0.72	37.666	40.333	
240	0.36	50	55.83		0.9	34.666	36.249	
240	0.54	44.17	44.17					
240	0.72	41.67	45					
240	0.9	30.83	35					
300	0.18	45	45					
300	0.36	41.67	45.83					
300	0.54	45.83	48.33					
300	0.72	33.33	34.17					
300	0.9	35	35.83					
360	0.18	53.33	54.17					
360	0.36	43.33	47.5					
360	0.54	43.33	43.33					
360	0.72	37.5	37.5					
360	0.9	40	43.33					
420	0.18	45.83	45.83					
420	0.36	35	35.83					
420	0.54	56.67	58.33					
420	0.72	45.83	52.5					
420	0.9	44.17	46.67					
480	0.18	41.67	47.5					
480	0.36	50.83	50.83					
480	0.54	47.5	48.33					
480	0.72	32.5	36.67					
480	0.9	43.33	45.83					
540	0.18	56.67	57.5					
540	0.36	45	45.83					
540	0.54	38.33	39.17					
540	0.72	37.5	38.33					
540	0.9	35	37.5					
600	0.18	50	53.33					
600	0.36	46.67	48.33					
600	0.54	40.83	44.17					
600	0.72	40.83	43.33					
600	0.9	37.5	37.5					

Figure 9.6.2: Detailed efficiency rate results for 120 requests per day.

Colophon

A video demonstration is available at (live link) youtu.be/flyixErIE-A. All project files can be found online at github.com/ioannisgk or from the author at ioannisgk@live.com.

- Devletoglou Emmanouil. *The Homophobic and Transphobic Peer to Peer Bullying in Schools, as a violation of the Right to Non-Discrimination of LGBTI students*[1]

Abstract

This paper examines the so important and too widespread phenomenon of peer to peer homophobic and transphobic bullying in schools under the ECHR and the CRC, with focus on the violation of the right to non-discrimination and by making reference to the UK. It is submitted herein that LGBTI victims cannot enjoy their human rights, and children's rights in particular, because of their sexual orientation. Apparently, the violation of the right to non-discrimination renders a direct and express legal response to this acute human rights issue necessary.

[1] This dissertation has been submitted in partial fulfilment of the requirements for the degree of **Bachelor of Law (Hons)** (University of Northampton, 2018) under the supervision of Yannis Sygkelos.

Introduction

The phenomenon of the homophobic and transphobic peer to peer bullying in schools (hereinafter the 'homophobic school bullying') is a daily, '*universal and the most fundamental*'' (Chan 2009, p.143) problem which affects Lesbian, Gay, Bisexual, Transgender and Intersex (LGBTI) students around the world. This paper makes references to the UK, one of the most liberal states in relation to LGBTI rights; yet, despite being '*at the forefront of the campaign against sexual orientation discrimination both internally and externally,'* (McGoldrick 2016, p.653) 'homophobic school bullying' is too widespread. Schools have turned into a hostile and dangerous environment for LGBTI students, since it is more likely that they may experience homophobic and transphobic violence there than in their friends' circle, home or society (UNESCO 2016, p.35). Initially, the effects of bullying were undermined. Degrading the importance of this phenomenon, O'Neill (1992, p.39) had argued that the main remedy for a bullied child would be to grow up and this trauma would simply pass. However, in the last years, global organisations, such as UNESCO (2016, p.35), have focused on this huge problem of bullying in general and 'homophobic school bullying' in particular, along with its severe consequences. Unfortunately, as Chan (2009, p.155) has emphasised, those who profess the law, such as legal scholars and researchers, lawyers and judges, do not address the problem, while, despite its frequency, as Rodkin and Hodges (2003, p.395) have deduced, even teachers and parents usually ignore this problem.

Nevertheless, the legal aspect of this problem should not be ignored. The 'homophobic school bullying' is the most fundamental problem of LGBTI students and is connected with the violation of human and in particular children's rights. This paper focuses on the right to non-discrimination, taking into consideration that for its violation other rights of the same human rights convention must be violated or at least interfered; hence it is a significant human rights issue, which also burdens too much LGBTI students' life, taking into account *inter alia* the general social pressure to them by virtue of their sexual orientation.

Although researchers disagree on an all-embracing definition, there is consensus about certain elements of the phenomenon of **bullying** (Mishna 2012, p.5). These elements are also at UNESCO's (2017, para 2.1) definition of bullying in 2017, under which, firstly, there must be an intentional and aggressive behaviour which, secondly, must be occurred repeatedly against a victim, and, thirdly, this victim must feel vulnerable and powerless to defend herself, namely, there must be a real or perceived power imbalance. The focus herein is specifically on the peer to peer bullying in schools, motivated by homophobia and transphobia, namely, the fear, discomfort, intolerance or hatred of LGBTI, which lead to bullying behaviours and target the students of different sexual orientation (LGBTI), whose sexual identity/expression differs from the socially constructed dominant gender norm (UNESCO 2016, p.9-10).[2] The bullying behaviours can be physical and/or verbal and/or relational; indicatively, if the bully hits, kicks the victim or destructs his property; and/or teases, insults or threatens the victim; and/or spreads rumours for the victim or excludes him from a group, respectively (Olweus 1993, p.9). The homophobic and transphobic bullying involves such bullying behaviours by bullies to LGBTI victims (UNESCO 2016, p.25), with instances of social exclusion and verbal bullying most widely reported (UNESCO 2017, para 2.2.3); while grievous instances of psychological bullying under threats, coercion and arbitrary deprivation of liberty have been emphasised (UNESCO 2016, p.34). Nonetheless, it is crucial to note that the aforementioned disinclination for a legal examination of such issues is demonstrated *inter alia* in the absence of a strong, effective and more protective legal definition

[2] The Sexual Orientation is defined as '*a person's capacity for profound emotional and sexual attraction to, and intimate and sexual relations with, individuals of a different gender, the same gender or more than one gender'.*

of bullying, insofar that the application of the above criteria in a legal case may be very problematic (Greene 2006, p.64 and Cornell & Cole 2011, pp. 289-294).

The right to non-discrimination concerns the exclusion or unfair treatment against a particular individual or group because of a specific characteristic, such as race, colour, ethnicity, **sexual orientation** etc.; whereby the victims of this treatment are prevented from enjoying the same rights as other people (UNESCO 2016, p.10). The right to non-discrimination can protect different rights and/or the same rights in a different way, depending on the convention which is incorporated into.

The overall aim of this paper is to examine the violation of the right to non-discrimination of the LGBTI students-victims by the too widespread phenomenon of 'homophobic school bullying', under two international human rights conventions, by making reference to the UK. First (in **chapter one)**, this violation shall be examined under the *European Convention on Human Rights* (ECHR) governed by an international court, that is, the European Court of Human Rights (ECtHR), which applies specific legal criteria for the application of the right to non-discrimination and takes legally binding decisions. Second (in **chapter two)**, this violation shall be examined under the *United Nations Convention on the Rights of the Child* (CRC), the most widely ratified human rights convention, governed by a quasi-judicial treaty monitoring body, that is, the Committee on the Rights of the Child. It is submitted herein that the 'homophobic school bullying' violates the right to non-discrimination of LGBTI students, under both conventions.

Chapter One

The 'homophobic school bullying', as a violation of the LGBTI students' right to non-discrimination, under the ECHR.

ECHR, Article 14

The right to non-discrimination is protected under the art.14 of the ECHR. It prohibits any discrimination on any ground *'such as sex, race, colour… birth or other status',* for the protection and in consequence the enjoyment only of rights and freedoms which are included in this convention. Despite the absence of an express reference to the ground of sexual orientation in the art.14, the terms *'such as'* and *'other status'* confirm that the list is non-exhaustive and the ECtHR has affirmed repeatedly that the sexual orientation is included among the protected grounds.[3] Furthermore, it is noteworthy that the prohibition of discrimination is limited only to those rights and freedoms guaranteed by the Convention itself. Therefore, a claim cannot be brought solely under the art.14, but only in conjunction with another right or freedom of the Convention (ECtHR & FRA 2010, p.85). Nevertheless, the violation of the Convention rights or freedoms is not a condition for the application of art.14; but it may apply even if the case falls at least within the 'ambit' of the Convention rights or freedoms, according to the ECtHR broad interpretation of the art.14.[4] Otherwise, the right to non-discrimination would have been deprived of its effectiveness,[5] given that the ECtHR had tended not to focus on it, in cases where there was a violation of another right in conjunction with it, for *'reasons of procedural economy'* (Partsch 1993, p.583), preventing the development of the art.14 through the case-law. However, this tendency has been, to some extent, reconsidered after *Chassagnou* (Rainey et al. 2017, pp.637-641).[6]

The UK has signed the legally binding ECHR, which contains the right to non-discrimination.[7] It was incorporated into the UK's national legal system via the Human Rights Act (HRA) 1998. Therefore, it is applicable in domestic courts, which also *'must take into account'* the Strasbourg jurisprudence.[8] Additionally, despite the vertical effect of the human rights protection under the ECHR, the enactment of the HRA 1998 provides horizontal protection; namely, individuals are protected by the courts regarding their rights violations by other individuals. In spite of the debate about this issue, the evidence for the horizontal effect is strong enough (Morgan 2002). More specifically, firstly, under s.6 HRA 1998 public authorities, including courts and tribunals, should act compatibly with the Convention rights; secondly, the UK courts have already recognised the

[3] *Salgueiro Da Silva Mouta* v *Portugal* App No *33290/96* (ECHR 21 Dec. 1999); *L. and V.* v *Austria* App no 39392/98 & 39829/98 (ECHR 9 Jan 2003) and *P.V.* v *Spain* App No 35159/09 (ECtHR 30 Nov 2010) Transsexuality as protected ground under article 14.

[4] *Abdulaziz, Cabales and Balkandali* v *the United Kingdom* Series A no. 94 (ECHR, 28 May 1985) [71]; *Karlheinz Schmidt* v *Germany* Series A no. 291-B9 (ECHR 18 July 1994) [22]; *Haas* v *the Netherlands* App no 36983/97 (ECHR 13 January 2004) [41].

[5] *(Belgian Linguistic Case (No. 20)*, (Apps. 1474/62, 1677/62, 1691/62, 1769/63, 1994/63, and 2126/64)), 23 July 1968, Series A No 6, (1979–80) 1 EHRR 252.

[6] *Chassagnou and others v France*, (Apps. 25088/94, 28331/95, and 28443/95), 29 April 1999 [GC], (2000) 29 EHRR 615, ECHR 1999-III, [89]; *V.C. v Slovakia*, (App. 18968/07), 8 November 2011.

[7] However, the UK has not signed the optional protocol No.12 of the ECHR, under which the 'basic principle of prohibition of discrimination' collectively and generally applies to any situation of discrimination, in order to promote the fundamental principle of equality, ensuring 'the enjoyment of any right set forth by law' in general and hence going beyond the convention rights (Renucci 2005, p.19).

[8] HRA 1998, s.2(1).

indirect horizontal effect;[9] and thirdly, the ECtHR obliges the states to provide effective legal protection to individuals in cases of violation of their rights by other individuals,[10] under the so-called 'third-party effect' legal doctrine (Markesinis & Enchelmaier 1999). Therefore, peer to peer homophobic bullying behaviours may form violation of the ECHR, including the right to non-discrimination. In this chapter, it is argued that 'homophobic school bullying' satisfies all the three criteria that establish this right.

Criteria of Direct Discrimination.

Direct discrimination may occur when there is '*a difference in the treatment of persons in analogous, or relevantly similar, situations…* (which is) *based on an identifiable characteristic'.*[11] More thoroughly, according to the ECtHR this definition is divided into three criteria (ECtHR & FRA 2010, p.22). Firstly, there must be an unfavourable treatment to an individual, which, secondly, is examined *'by comparison to how others, who are in a similar situation, have been or would be treated';* namely, the alleged victim has not only to prove that he was treated unfavourably, but also that the others were or would be treated better than him; and thirdly, the reason for the unfavourable treatment must be the particular characteristic that the alleged victim holds, which must fall under a *'protected ground'* (ECtHR & FRA 2010, p.22). It is submitted herein that the 'homophobic school bullying' satisfies these criteria.

First Criterion: Unfavourable Treatment

All bullying behaviours constitute unfavourable treatment to the victims, satisfying the first criterion that the *'individual must be treated unfavourably'* (ECtHR & FRA 2010, p.22), since they are hostile, unlawful and socially unacceptable. More specifically, they are **hostile**, since they are aggressive and intend to hurt the victim. Secondly, most of them, if not all, are **prohibited by law**.[12] For instance, in the UK bullying behaviours may violate *inter alia* ss. 1 and 7(2) and (4) Protection from Harassment Act 1997, which prohibits a person to *'pursue **a course of conduct'**[13]* [including speech], *'which amounts to harassment of another and which he knows or ought to know amounts to harassment of the other'*, while '*harassing a person include(s) alarming the person or causing the person distress*'. Such a conduct satisfies the necessary first definitional criterion of a bullying behaviour, that is, **intention** and **aggression**.

Additionally, being motivated by the ground of sexual orientation, homophobic and transphobic bullying is an unwanted conduct and creates *'an intimidating, hostile, degrading, humiliating or offensive environment for'* the LGBTI victims, that is, an offence under s 26(1) and (5) Equality Act 2010. Thirdly, the bullying behaviours are **socially unacceptable** between the members of a society, and especially in schools. Under the general social rules that govern the UK's society, the policy in schools prohibits any form of bullying, according to the statutory

[9] *Douglas* v *Hello! Ltd* [2001] 2 All ER 289; *Campbell* v *Mirror Group Newspapers Ltd* [2004] UKHL 22; *A* v *B* [2002] EWCA Civ 337 [4].
[10] *Young, James and Webster* v *United Kingdom* [1981] ECHR 4.
[11] *Carson and others* v *UK (GC)* App No 42184/05 (ECHR 16 March 2010), [61].
[12] Offences Against the Person Act 1861, ss 18, 20, 47 (for physical and verbal aggressive behaviours); Protection from Harassment Act 1997; Public Order Act 1986, ss 4,18,29 (mainly for verbal behaviours); Malicious Communications Act 1988, s.1 (for cyber-bullying which can take place in schools); Communications Act 2003, s.127 (for cyber-bullying); Equality Act 2010.
[13] Emphasis added.

guidance of '*Preventing and Tackling Bullying*' which must be applied in all schools (Department for Education 2017, p.13). On top of that, the occasions of violent physical and verbal bullying can be included among the ECtHR indicative instances of unfavourable treatment, namely, when one is *'subject to verbal abuse or violence'* (ECtHR & FRA 2010, 22).

The bullying behaviours, which constitute unfavourable treatment, violate or fall at least within the 'ambit' of the enjoyment of rights and freedoms guaranteed by the ECHR, as the art.14 requires. More specifically, such unfavourable treatment violates the right to education of LGBTI victims. The UK has recognised, hence protects, the **right to education** which '*no person shall be denied'.*[14] Due to the incidents of homophobic and transphobic bullying, LGBTI students are afraid to go to school, since they do not feel, and may not be, safe because of the physical violence and psychological threats against them or other LGBTI (UNESCO 2017, paras 1.1 & 2.3.1; UNESCO 2016 p. 29). Nevertheless, even if they continue to go, despite the bullying behaviours, '*the atmosphere of anxiety, fear and insecurity',* which dominates in school, is incompatible with learning and interferes with their concentration in classroom and their participation in school activities (UNESCO 2017, paras 1.1 & 2.3.1; UNESCO 2016 p. 29). Moreover, Irina Bokova (2012), UNESCO's Director General, emphasised the importance of this violation, stating that such bullying is '*an unacceptable infringement of basic human rights',* whereas when it happens in schools, it is *'a direct violation of the right to quality education'*. Acknowledging the importance of the right to education in connection to the phenomenon of bullying, Olwues (2001, pp.11-12) stated that '*it is democratically fundamental and… a human right'* for all children to feel safe at schools and '*not be afraid of the repeated oppression and intentional humiliation caused by peer… bullying*'. Additionally, bullying behaviours may fall at least within the ambit of other rights and freedoms secured by the convention, as for instance, repeated beatings, teases and insults may fall within the ambit of the **freedom form inhuman and degrading treatment** (art.3 ECHR), as well as the repeated gossiping and spreading of rumours may fall in the ambit of **the right to privacy** (art.8, ECHR).

Second Criterion: Comparison

The LGBTI victims are treated unfavourably *'**by comparison**[15] to how others in a similar situation have been or would be treated'* (ECtHR & FRA 2010, p.22),[16] satisfying the second criterion of direct discrimination. This criterion gives prominence to a comparator. As concerns instances of bullying against the group of LGBTI students, the comparator is the group of students who conform to the promoting stereotypes of a heterosexual man or woman and differ to the LGBTI students only as to their sexual orientation. According to UNESCO, the LGBTI children and adolescents, as well as children whose gender identity or expression does not comply with the promoting heterosexual gender stereotypes, disproportionately experience school bullying (UNESCO 2016, p.8). Additionally, it is from three to five times more likely that the LGBTI students may experience bullying and violence by other students than their non-LGBTI peers (UNESCO 2016, p.9). In the UK, according to the UK *'department for education',* the LGBTI students are in higher risk of 'school bullying' and victimisation than their peers (Department for Children, Schools and Families 2018, p.42). Therefore, LGBTI students are **disproportionately**

[14] ECHR, Protocol No.1.

[15] Emphasis added.

[16] The comparator group has to be in 'similar situations', see *Marckx v Belgium*, (App. 6833/74), 13 June 1979, Series A No 31, (1979–80) 2 EHRR 330, [32] ; or in 'relevantly similar situations', see *Burden v United Kingdom*, (App. 13378/05), 29 April 2008 [GC], (2008) 47 EHRR 857, ECHR 2008-nyr, [60]; or in 'analogous situations', see *Stubbings and others v United Kingdom*, (Apps. 22083/93 and 22095/93), 22 October 1996, (1997) 23 EHRR 213, ECHR 1996-IV, [71].

affected by the unfavourable treatment caused by school bullying, **in comparison to non-LGBTI students**.

Third Criterion: Causal link between the treatment and the particular characteristic

The reason for the bullying behaviours which target the LGBTI students and constitute unfavourable treatment to them in comparison to the group of heterosexual students, is the particular characteristic that the LGBTI students hold, which falls under the protected grounds of the right to non-discrimination, satisfying the third criterion of direct discrimination (ECtHR & FRA 2010, p.22), too. Under this criterion, it is necessary to prove that the particular characteristic of LGBTI students, namely their sexual orientation is the reason for the bullying, and therefore, the necessary causal link between the treatment and the particular characteristic exists. Indeed, as O'Flaherty (2015, p.282) has pointed out, LGBTI students face high levels of bullying due to their sexual orientation. Furthermore, UNESCO statistics highlighted that the UK and Cyprus have the highest percentage (76%) of LGBTI students who experience negative comments or conducts at school by other students, due to their particular characteristic of sexual orientation or gender identity (UNESCO 2016. p.44). Furthermore, in the UK the 99% of students heard homophobic insults in schools and between 20% and 55% of LGBTI students experience violence due to their sexual orientation (UNESCO 2016. p.45). Thus, there is the necessary causal link, between the unfavourable treatment, namely the aforementioned instances of negative comments, conducts, school bullying and violence, and the particular characteristic of the protected ground of sexual orientation. Therefore, the LGBTI students would have been treated differently, if their sexual orientation was different (heterosexual), since the aforementioned surveys show that **the bullying instances to LGBTI students are not coincidental, but their sexual orientation is the reasoning.**

Chapter Two

The 'homophobic school bullying', as a violation of the LGBTI students' right to non-discrimination, under the CRC.

Under art.2 CRC, all children are entitled to enjoy all the protected rights set out in it without any discrimination on the basis of their status, including the discrimination on the grounds of sexual orientation.[17] Thus, the right to non-discrimination is connected with the other rights protected by the CRC, since for its violation, the violation of another right is necessary. The CRC has been signed and ratified by the UK but, contrary to the ECHR, has not been incorporated into the domestic legal system by a single legal instrument; nonetheless, the UK considers that these rights are sufficiently protected under the domestic law (Department for Education 2010, pp 4-5). In this chapter, it is argued that the 'homophobic school bullying' violates LGBTI children's rights to **freedom from violence** (art.19 CRC) and to **education** (art.28-29 CRC) and that their violation constitutes **the *desideratum* proof of the violation of the right to non-discrimination.** All in all, this violation inflicts too grievous a burden on LGBTI students.

The violation of the art. 19 CRC

The peer to peer bullying behaviours among children violate art. 19 CRC, which stipulates that all children have the right to be protected, *'from **all forms of physical or mental violence,**[18] injury or abuse… while… in the care of… any other person who has the care of the child'.* The United Nations Committee on the Rights of the Child (hereinafter: Committee), that is, the monitoring body of the CRC, has pointed out that the wording *'…all forms of…'* shows that no exception is acceptable, irrespective of the severity of harm, the intention, or if the perpetrator is another child (hence includes peer to peer behaviours),[19] providing a broad protection to children. The Committee expressly stated that the **physical violence** includes among others the ***'physical bullying… by other children'*** and that the **mental violence** can include *inter alia* '*scaring… threatening… insults, name-calling, humiliation, belittling, ridiculing and hurting a child's feelings*' and '***psychological bullying… by other children'***, including the cyber-bullying.[20] Thus, any behaviour which constitutes **physical bullying** violates art. 19 CRC, as well as the aforementioned instances of **verbal bullying** which fall into the category of mental violence, taking into account that the victim is at the time in the care of the school personnel. Last but not least, the instances of social exclusion of the victim, by the form of **relational bullying**, fall also into the category of prohibited mental violence, since it includes the persistent harmful social interactions with a child, under which the victim feels unloved, unwanted, rejected or ignored.[21]

[17] United Nations Committee on the Rights of the Child, General comment No. 4: Adolescent health and development in the context of the Convention on the Rights of the Child (2003) para 6.
[18] Emphasis added.
[19] United Nations Committee on the Rights of the Child, General comment No. 13: The right of the child to freedom from all forms of violence (2011) 8.
[20] Ibid 9-10, emphasis added.
[21] Ibid 9.

The violation of the right to education

Under art.28 CRC, every child has the right to education. UNESCO stated that *'all forms of… bullying in schools infringe the fundamental right to education'*, since an unsafe school environment reduces the quality of education (UNESCO 2017, p.5). Additionally, the Committee pointed out that a school which permits bullying behaviours to occur does not meet the requirements of the CRC.[22] Indeed, under the CRC, the schools, as state institutions, are directly responsible for the children's protection from bullying instances.[23] Hence, both bullies and schools may have liability for the violation of the right to education. Unfortunately, an old but indicative British study confirmed that the teachers did not act vigorously, and, therefore, indirectly allowed such behaviours. More specifically, the 98.6% of them felt that they had a responsibility in the prevention of school bullying instances, but they did not feel confident in their ability to act, whereas the 87% wanted more training (Boulton, 1997, pp.223 and 229). Another study shows that school personnel were reluctant to intervene even in cases where the victims solicited their help against the harassment by their peers (Rivers & Duncan 2002); a situation, which reinforces homophobic bulling behaviours among students (Kolstrein & Jofré 2013, p.49).

The Committee, also, emphasised that the school environment *per se* must reflect human rights and freedoms. More specifically, the education should be directed *inter alia* to the development of the child's personality, respecting the human rights and the fundamental freedoms and preparing the students to be responsible *'in the spirit of understanding, peace, tolerance, equality of sexes, and friendship among all people'.*[24] The 'homophobic school bullying' is *per se* contrary to the understanding, tolerance and equality of sexes, since the bullying behaviours are motivated by the different sexual orientation of LGBTI students and the social norm that only heterosexuals are normal; contrary to peace, since the bullying behaviours include violence and hostility; and contrary to the value of friendship, since it results in the victim's social exclusion.

The *desideratum* proof of the violation of the right to non-discrimination

The 'homophobic school bullying' violates the right to non-discrimination of the LGBTI students. The violation of art. 19, 28 and 29 by the peer to peer bullying in schools has already been proved. Therefore, in cases where peer to peer bullying in schools is motivated by homophobia and transphobia and targets the LGBTI students, who belong to the protected ground of sexual orientation, the victims' right to non-discrimination is violated, too. The LGBTI students cannot enjoy their rights under the aforementioned articles due to the 'homophobic school bullying', which is based on their particular characteristic of sexual orientation. Nevertheless, the importance of this right is not limited only to a reference as a further violation of a right.

It is paramount that bullying behaviours incur too grievous a burden on the LGBTI adolescents. The Committee acknowledged that the bullying between children is a form of physical and psychological violence and has a severe impact not only on the victim's physical and psychological integrity, but also on their development, education, social integration and well-being; hence, it highlighted that the LGBTI children are in potentially vulnerable situations.[25]

[22] United Nations Committee on the Rights of the Child, General comment No. 1: The Aims of Education (2001) para 19.
[23] Ibid 48.
[24] CRC, art 29(a), (b) and (d).
[25] United Nations Committee on the Rights of the Child, General comment No. 13: The right of the child to freedom from all forms of violence (2011) 11 and 26-27.

Additionally, regarding the psychological implications of school bullying, Herman (1992, p.121) pointed out that a *'repeated trauma in adult life erodes the structure of the personality already formed, but repeated trauma in childhood forms and deforms the personality'*. Herman stands mainly in the psychological implications of such a trauma and, consequently, in the harm caused to victims' mental health. Taking into account in the meanwhile that the homophobia has been entrenched in society so that schools and family and the LGBTI adolescents are confused and pressured from everywhere, the school bullying which is based on the victims' sexual orientation has much more severe consequences than the school bullying not attributable to this ground (Chan 2009, p.154; Adams et al. 2004). According to Stonewall human rights organisation, the 65% of LGBTI students have experienced 'homophobic school bullying' and the 97% of students have heard derogatory and insulting terms against the LGBTI students (Hunt & J Jensen 2007 p.3). As regards the UK, the Committee expressed specific concern over the LGBTI children, who experience substantial discrimination and social stigmatisation (Chan 2009, p.157).[26] Thus, the 'homophobic school bullying' in connection with the pressure of the society to the LGBTI adolescents is a huge and threatening problem for the UK LGBTI students.

[26] See, also, United Nations Committee on the Rights of the Child, Concluding observations: United Kingdom of Great Britain and Northern Ireland (2008) paras 24 and 25(b).

Conclusion

To sum up, the homophobic and transphobic peer to peer bullying in schools violates the right to non-discrimination of the LGBTI students-victims, under the international legal instruments of ECHR and CRC. In the first chapter, it was proven in legal terms that the 'homophobic school bullying' is a direct discrimination against the LGBTI students-victims, hence a violation of their right to non-discrimination under the ECHR, according to the specific legal criteria imposed by the ECtHR. Firstly, the bullying behaviours constitute unfavourable treatment to their victims, violating the right to education and at least interfering with freedom from inhuman and degrading treatment and the right to privacy of LGBTI students-victims. Secondly, the LGBTI students are treated unfavourably in comparison to the group of heterosexual students, who differ to them only regarding their sexual orientation, since the LGBTI students are disproportionately affected by the school bullying in contrast to heterosexuals. Thirdly, 'homophobic school bullying' targets the LGBTI students due to their characteristic and protected ground of sexual orientation; therefore, the necessary causal link between the unfavourable treatment and the protected ground exists. In the second chapter, the violation of the right to non-discrimination of the LGBTI students-victims under the CRC was proven by demonstrating that the LGBTI students-victims do not enjoy freedom from violence and the right to education, due to peer to peer school bullying motivated by their sexual orientation.

Additionally, as it has been shown, the legal aspect of the right of LGBTI students to non-discrimination has been disregarded so far despite its further social implications. More specifically, as it has been argued, bullying behaviours based on the characteristic of sexual orientation may effectuate too grievous a burden on LGBTI students. Evidently, they experience social stigmatisation and pressure in their daily life, since homophobia and transphobia have been entrenched in society, schools and family; and that the school bullying based on sexual orientation has much more severe consequences than the school bullying not attributable to this ground. It seems paradox that the phenomenon of 'homophobic school bullying' is still too widespread in the UK, notwithstanding it being one of the most liberal states in relation to human rights, and of LGBTI rights in particular, and having the legal framework to uphold the right to non-discrimination

Furthermore, it was demonstrated that the two conventions protect the victims in case of their rights violations by the 'homophobic school bullying', in different ways and degrees. The CRC theoretically provides broader protection than the ECHR, since it widely covers social and economic rights and, more especially, the freedom from any form of violence, injury and abuse (art.19 CRC) and the Committee forbids any form of bullying against children. Nevertheless, in practice, the victims' protection, including their remedies, under the ECHR is stronger than CRC. The ECtHR can provide legal protection to individuals by its binding decisions for member-states and by remedying the victims, in cases where their rights are violated, in contrast to the Committee. The Committee has not much actual power, since although it monitors the application of the rights under a constructive dialogue with member-states, it cannot itself remedy the victim or effectively bind a member-state. Therefore, the broad protection under the CRC is mainly on paper, since '*each Convention is only as effective as its monitoring system'* (Verhellen 2015, p.52).

As aforementioned, the legal framework exists; however, it is not so effective, considering the range of the 'homophobic school bullying' in the UK. Therefore, a much stronger legal position is needed. First of all, further legal research is needed in order to highlight the violation of the human rights by the 'homophobic school bullying' and to exert pressure towards the enhancement of the effectiveness of the national legal systems in relation to their international obligations under

the conventions. Given that two strong international human rights instruments render the 'homophobic school bullying' a plain violation of the right to non-discrimination as well as other human rights and that it has severe consequences for LGBTI students, the explicit criminalisation of '(homophobic) school bullying' would be justified. Despite the need of the psychosocial and educational response to this issue, a more direct and express legal response is necessary, too.

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3e. Abstracts of dissertations of highly commendable quality

- Lola Kostandina. *Why is the right to die, and more specifically euthanasia and assisted death, in some countries legal and in others illegal?* [1]

This dissertation attempts to shed light on the ongoing debate over the right to die by investigating why euthanasia and assisted death have been legalised in some countries, whereas in others not. This is a highly controversial, complex and delicate legal issue, because it touches upon religious beliefs, political ideas and considerations, and medical ethics. It is, therefore, interesting to see under what circumstances and in which setting some countries have proceeded with the actual recognition of a right to die by legalising euthanasia as well as which factors still inhibit its recognition elsewhere.

This dissertation is divided into two chapters. In the first chapter, Belgium is taken as a case study, where euthanasia was legalised under the *Act on Euthanasia* 2002, which defines euthanasia as an "intentional life-terminating action by someone other than the person concerned, at the request of the latter". In Belgium, euthanasia was eventually decriminalised despite several factors having had prevented its legalisation: the opposition of the political party of *Christian Democrats*, the largest partner of successive coalition governments, which advocated conservative and Christian moral values; legal concerns relating to the abuse of law on euthanasia by people who want to terminate their life but do not meet the legal requirements to be euthanised; and medical ethics relating to the role of doctors to cure maladies and not to end lives. Nevertheless, human rights issues, such as the right to dignity and autonomy of individuals, as well as a favourable political climate due to the defeat of the Christian Democrats in the general election of 1999 overcome the resistance to euthanasia's legalisation.

In the second chapter, the UK is taken as a case study, where despite the introduction of bills on assisted dying, resistance to euthanasia's legalisation is still strong, as manifested from recent cases, e.g. R (Nicklinson) v Ministry of Justice [2014] UKSC 38 and R (Conway) v Secretary of State for Justice [2017] EWCA Civ 275. Not accidentally, factors that inhibit the legalisation of euthanasia are similar to those that had prevailed in Belgium prior to the enactment of the *Act on Euthanasia* 2002: the role of the Church of England and the presence of bishops and archbishops in the House of Lords who argue that euthanasia encroaches on Christian morality; legal concerns that legalisation of euthanasia will open the road for the premature death of sick, disabled and vulnerable people; and the option of 'living wills' under the Mental Capacity Act 2005, which offer the opportunity to individuals to refuse life-sustaining-treatment in case that they will happen to be in a critical medical condition. On the other hand, human rights' concerns such as those that prompted the legalization of euthanasia in Belgium, namely the right to a dignified death, dignity, autonomy and privacy, have been raised but without effect.

As legalisation of euthanasia and assisted death imply the recognition of a right to die/death, understanding the similarities and the differences between countries which have given legal effect to such a right and those which have not, allows conclusions on the essential factors that inhibit the universal recognition of a right to die. Does the right to die not enjoy universal recognition because of its alleged opposition to the right to life? Is it not legalised because of cultural

[1] This abstract summarises a dissertation submitted in partial fulfilment of the requirements for the degree of **Bachelor of Law (Hons)** (University of Northampton, 2018) under the supervision of Yannis Sygkelos.

resistance and/or a presumed volatility of relevant legislation and reservations over the implications of legalisation of euthanasia and assisted death?

- **Chelidoni Soultana.** *Contracts come in different shapes and sizes, thus rendering the provision of legal advice a real challenge*[2]

This dissertation explores the fact that contracts come in different shapes and sizes and whether this fact renders the provision of legal advice a real challenge. These are pivotal issues in contract law, insofar as the legal advice, i.e. the practical part of law, is inadequate or wrong when it deals with contract law matters. More specifically, this dissertation argues that the perception of the law of contract as a unified system of law makes the legal advice inflexible as well as disregards recent social and financial developments, legal development, and current legal exigencies. Therefore, legal advice is a real challenge, because contracts have their own and different "shapes and sizes".

This dissertation examines commercial and insurance law under the scope of implied and express terms. It scrutinises the doctrine of good faith, some sections of the Sale of Goods Act 1979, and the specificities of conditions and warranties to distinguish crucial differences between commercial and insurance contracts. It concludes that these differences make them unique.

Insurance law uses and implies the doctrine of good faith. However, courts are reluctant to imply good faith in commercial contracts and use other methods in order to achieve fairness. Nevertheless, there are some exceptions such as the case of Yam Seng Pte Ltd v International Trade Corporation Ltd [2013] EWHC 111, which shows that every contract is unique and subject to different legal considerations and provisions.

Besides, uncertainty exists when conditions and warranties are considered. In charterparties there is a difference in definitions-nomenclature and sometimes terms which do not go to the root of the contract are named conditions, thereby changing the usual effect of that term in a case of breach. Moreover, in insurance contracts a breach of warranty has the same impact as a breach of a condition in the general law of contract.

Despite the aforementioned particularities in the field of contract law, lawyers are sometimes still operating by taking the law of contract as a unified system of law. As a result, lawyers apply the same rules and principles for every type of contract, which makes the legal advice a real challenge leading to inadequate and inapplicable results. Therefore, as the above particularities have demonstrated, this is unstable and unworkable to operate in practice, because of the special and different nature of each contract. It is therefore necessary for the law to treat contracts differently, moving away from a unified theory of a law of contract and finally developing a system of law of contracts.

[2] This abstract summarises a dissertation submitted in partial fulfilment of the requirements for the degree of **Bachelor of Law (Hons)** (University of Northampton, 2018) under the supervision of Alkiviadis Agapidis.

- Gkartzios Menelaos. *Measuring the performance of a listing company using managerial and financial tools: the case of Toyota*[3]

This dissertation takes "TOYOTA" as a case study in order to measure the performance of a listing company using managerial and financial tools. It investigates the performance of TOYOTA through performance analysis, financial analysis, ratio analysis and managerial analysis. It measures the profitability, productivity and the assets of the TOYOTA company, that is, values very important for the shareholders. The main goals of this research are to analyze the financial position of the company including the sales and to scrutinize opportunities that the firm exploits in order to increase its profits and become a very strong and healthy organization.

TOYOTA was chosen for a set of reasons. First, the philosophy of the firm is to use its Guiding principles in order to create the best and the most reliable cars in the market. Second, TOYOTA is a multinational company that it cares about the environment and helps the world by manufacturing innovative and high-quality products and services. They have many Corporate Social Responsibility (CSR) programs that show a good face to the society and make many clients to purchase its products. Third, they like to give the best quality with low prices because they do care about their customers. From the sales of the organization, it is completely understandable that is a healthy and sustainable enterprise showing considerable economic growth in the last decade.

A set of methodological tools were conducive to empirical results. Financial ratios were helpful to measure the profitability, productivity and the assets of TOYOTA company. SWOT analysis was proved helpful to collect information about the internal and external environment of the firm. PESTEL analysis contributed to a more careful examination of the external environment of TOYOTA. Last, Porter's five forces were conducive to the exploration of potential threats from other car industries and more generally the competition in the market. This research concludes that TOYOTA is very profitable despite the ups and downs of its productivity rates.

[3] This abstract summarises a dissertation submitted in partial fulfilment of the requirements for the degree of **BA Business Studies (Hons)** (University of Northampton, 2018) under the supervision of Eirini Lazaridou.