Urban Exploration Game – An EPS@ISEP 2022 Project

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Abstract. Tourists nowadays tend to avoid 'tourist traps' and are looking for an engaging way to explore a city in the limited time they have. It is difficult to navigate all the possible options without external help or recommendations. The existing options to explore cities seldom offer a combination between efficiency and fun. Furthermore, if one was to Google 'exploration city app' this person would end up in an unlimited supply of lookalike websites and apps that all claim to be the best option for them. In this paper, the development of a product is discussed that solves all these issues. QRioCity by Dragonics offers tourists an efficient and exciting way to explore cities with a direct approach in real life: QRioCity offers users the option to sign up for a playful tour through Porto using a public kiosk with an interactive touchscreen. There is no limit in the amount of teams playing at the same time and also no need to provide personal information. The teams will be led through the city using clues. Throughout different parts, the teams will get assignments like scanning QR codes to earn points. At the end of the game, every team receives certain discount coupons for local shops or stores depending on their score, even when they play alone. This way QRioCity supports tourists in enjoying the local life in a city as well offering municipalities a chance to strengthen their local economy.

Keywords: European Project Semester · Gameification · Tourism · Smart Cities · Web Development

1 Introduction

The European Project Semester (EPS) offers students the opportunity to participate in a project at a partner university under academic supervision for one semester. It is intended to prepare (engineering) students for the challenges of today's world. Students work on a project in multinational and interdisciplinary teams. Project participants communicate in English and receive guidance and feedback from supervisors on both the product and the project. For this project five students from different European countries came together in Porto, Portugal to work on an EPS at Instituto Superior de Engenharia do Porto.

The chosen project was "Our City Experience" and its goal was to make a (smart) city more accessible and inclusive. From this topic we formulated the following problem statement: tourists are overwhelmed by the vast amount of possibilities when visiting a new place. They want to avoid tourist traps and prefer a personalised tour visiting local spots. The target audience is people between the ages of 18 and 40 years old. Seeing as this group is most likely to use the internet as an information source used to plan their trip, together with being the most receptive to gamification, this is the perfect target audience. After extensive market- and state-of-the-art research, the proposed solution was a web application that takes tourists on a tour throughout the city in a playful way. It will include a competitive element to facilitate bigger groups who want to compete with each other. The web application will have support from a public kiosk to attract users on the street. This way the game will actively attract users instead of vanishing in between all the other options the internet has to offer. The game including its public kiosk will be offered as a service to cities or municipalities. The product has been given the name QRioCity, combining terms QR (Quick Response), city and curiosity, all related to our concept. This present work documents the product development and is structured in preliminary studies, including the related work, in this case rather the market research and concepts included in the solution, ethical concerns, marketing approaches, and sustainability. Next, the proposed solution is looked at in detail with the concept and design. Following this, the prototype is introduced leading to the conclusion.

2 Preliminary Studies

This chapter summarises the preliminary studies made before and during the development of the concept and product. Starting with the related work, followed by the ethical concerns, marketing strategies, and finally sustainability.

2.1 Related Work

The related work section is a summary of the conducted market research and insights into some concepts important to the ideation phase.

Concepts Concepts found to be important or useful in modern tourism are personalised (group) experiences, gamification, interaction design, and machine learning in combination with smart devices. In general, tourism organisations are creating experiences, impressions, and magical moments that tourists should experience. Product development in tourism is strongly linked to the creation of unforgettable experiences. Understanding travel as a social and psychological phenomenon (longing for rest, relaxation, adventure, a counter-world to everyday life, enriching experiences, valuable encounters, and memories) is the basis for aligning tourism product experiences with guests' travel motivations.

When considering modernising and digitising the tourism sector there are certain trends. At first, there were mobile applications that came with the rise of the smartphone. Now there are a plethora of applications that make travelling easier. From booking a flight to finding a hotel and getting reviews on every place you could visit. Nowadays apps are innovating by for example using deep learning in recommending systems. Rani (2021) [13] produced an application with case-based reasoning, so the user was asked to enter personal information, choose some preferences and then got recommended the matching attractions. Due to the sheer overload of information available, recommending systems are becoming increasingly popular. Although these and other deep learning methods can be very powerful, the downside to them is that it's not easily adaptable due to the workload and data masses necessary for implementation.

Another big trend in tourism is gamification, ratification, and interactive installations. Making an experience extra enjoyable through games or art, engaging the user through added incentives. Gamification in tourism does not only attract tourists and engages them to co-create experiences but also helps to build destination loyalty [9]. In various phases of travelling, gamification is known to bring benefits not only for the consumer but the company as well as used as an innovative marketing tool. Tourists might strive for interaction, and simple socialising and games or game-like experiences can offer that. Benefits for the user include creating an entertaining and personalised experience, it also improves retaining information about the destination. For the company, it can provide useful user information, increase brand awareness and bind the customer to the company. A game to combine all these benefits must be based on the customer's motivations and objectives as well as their profile. Gamification is called the cutting-edge trend in tourism [16].

After researching these different tools to create a special tourism experience, gamification and personalised group activities were the main concepts relating to the initial idea of the project. Nevertheless, machine learning and smart devices could be integrated into future developments.

Market Research With the base requirements set possible competitors currently on the market and how the product could stand out, were researched. Table 1 gives a summary of the market research comparing competitors to QRioCity, looking at some main pillars important to the product. These pillars being if the product is free, if it is a game and has educational value or if it is targeted at tourists.

Table 1. Comparison of different products currently available

Product/Company	Free	Game	Educational	For Tourism
[12], [14], [11]	no	yes	yes[3]	yes
[7]	no	yes[2]	no	no
[1]	yes	yes[2]	yes[3]	no
[6], [10]	yes	yes	no	no
[15],map services	yes	no	no	yes
Classic guided tours	no[1]	no	yes	yes
Tourist information	yes	no	no	yes
Traveling agencies	no	no	no	yes
QRioCity	yes	yes	yes	yes

[1] in special cases, yes;
[2] application to build your own game/tour;
[3] depends on the type of game/tour

2.2 Ethics

Ethics and deontology are two very important concepts to take into account when creating a product or service. Indeed, every new thing must be able to respect the moral rules that govern our society. It is therefore necessary avoid all possible solutions that could physically or morally harm someone, to try to include the maximum number of users without discrimination.

Regarding engineering ethics the team chose to do a safe design for both the user and the maintenance operator who will service the product. As a company, the team has a responsible and supervised sales method to avoid any bad commercial behaviour. To respect environmental ethics, the team has chosen materials whose production, use and recycling have the lowest possible environmental impact. Furthermore, the team has picked repairable and reusable components. Finally, to respect liability the team engages itself to take responsibility in case of problems and commits to the following European directives: Machine Directive [5] , Electromagnetic compatibility [4], Radio Equipment Directive [3] and Restriction of Hazardous Substances in Electrical and Electronic Equipment Directive [2].

2.3 Marketing

The team developed a marketing plan that helped establish goals, target audience, budget, and strategy control. To develop a valuable strategy, the team identified the target audience - young tourists aged 18-40 who want to experience a new city in an engaging and interesting way. Our clients are municipalities of touristic cities who want to increase tourism by making the city more attractive and accessible for tourists. The company intends to promote QRioCity to its clients through meetings, as well as online marketing. Once the project is implemented, QRioCity will promote to the target audience on TikTok and Instagram, where it will be easiest to reach them. In addition, QRioCity plans to

establish cooperation with local businesses (restaurants, cafes, museums, etc.) on a barter basis - promotion in advertising materials, in exchange for vouchers for tourists. Strategy control will be implemented through a Plan-Do-Check-Act cycle. The team will regularly track what works and what does not, measuring the effectiveness of the brand strategy. In this way, the brand will have the necessary tools to not only enter the market with a strong position but also to maintain it for a long time.

2.4 Sustainability

Sustainable development is an economic doctrine that assumes a quality of life at a level that current civilizational development allows. According to the definition given by the Brundtland commission (a commission whose goal is to unite countries in pursuit of sustainable development), sustainable development is "development that meets the needs of the present generation without compromising the ability of future generations to meet their own needs." The Commission has successfully unified environmentalism with social and economic issues in the global development agenda [8]. The idea of sustainable development is based on the constant search for balance between its three key pillars: social, environmental, and economic. The team conducted a sustainability analysis of QRioCity and made choices to best meet the mentioned three aspects that characterise sustainability. For the transportation of the public display, a fitted form will be used, which can be reused for other kiosks. Moreover, the material of the protective packaging is mycelium, an eco-friendly material produced from agricultural waste and mushrooms. Since the offered service contains a public display which consumes energy, the team decided to use solar panels to minimise its environmental impact. From an energy security and sustainability standpoint, it seems logical to maximise the potential space used for solar panels. When designing the solution, special attention was paid to the economic part. Clients of QRioCity will be city authorities, thanks to which the company will gain the image of reliable business partners, which will certainly help in obtaining local partners. Thanks to cooperation on a barter basis, users of the game will receive vouchers to stores, restaurants and other points of interest in the city, and local businesses will gain more customers through promotion in our materials. The team focused on maximising the use of renewable and biodegradable resources, as well as the sustainability of the product itself: Simulations were carried out to ensure that the public kiosk is weatherproof and will therefore last for many years. The material used to build the public display, aluminium, is recyclable.

In conclusion, sustainability is a very important factor that has been taken into account during the development of the project. The team focused on developing the product keeping in mind the three pillars of sustainability. It is important to minimise the impact on the environment. When it comes to the society, it is crucial to be transparent in operations and to establish positive relationships with users. Support from employees is also important. From an economic standpoint, the team strives to make efficient choices that will benefit not only the environment but also the company as a whole. The goal was to

design a durable, long lasting and mostly maintenance free display with easily recyclable parts.

3 Proposed Solution

3.1 Concept

The proposed concept provides tourists with a fun and educational game for experiencing a new city and helps cities develop tourism as well as attracting new visitors. With a public kiosk/display and a web application, a participants' experience when visiting a new city is elevated from conventional methods that have existed for many years - guided tours, paper guides, or bus tours. QRioCity allows groups of friends to compete against each other in an engaging way and thereby explore a city playfully. There's also the option to play solo. A main factor in the game and branding is the QR code. The user searches for QR codes to scan in hidden places, similar to a scavenger hunt, to earn points. While walking from point to point the user will also be presented with information about places or people according to the chosen tour style, for example historic. To get the user interested in the game a public display is designed to grab their attention, encourage and guide them to start playing. Although for the users' convenience, the game can also be launched directly in any mobile browser. The display would be placed in a wide open touristic space but should not be a hindrance to the daily lives of locals.

3.2 Design

Public Kiosk The structure of the kiosk has been made into the shape of an exclamation mark to represent the product logo. Furthermore, the shape can be recognised as a landmark used in digital maps. The use of shape and colour gives the impression of a landmark. The base of the product has been made black while the main casing has been made blue in the shape of a landmark, thus giving this landmark impression. Figure 1 shows the finished design of the display.

The product has been 3D modelled in the CAD program Solidworks, the modelling of the product also included making decisions about the way it will be manufactured. After altering the shape according to the correct manufacturing method, there has been a study into the possible material choices. First, the study was mainly focusing on plastics, but after some feedback, the decision to go for metal had been made instead. After studying several metals using GRANTA EduPack the decision to use 5182 H19 aluminium has been made. This material can be recycled, shaped by press forming, is resistant to the stress that our structure will have to endure and is sold at a reasonable cost for our use. To protect the aluminium from moisture, dirt and rust it will be coated in epoxy. This epoxy layer will form a protective layer for the aluminium.

To estimate the stress the product will have to endure, two separate stress simulations have been made. The first one simulates a heavy storm applying

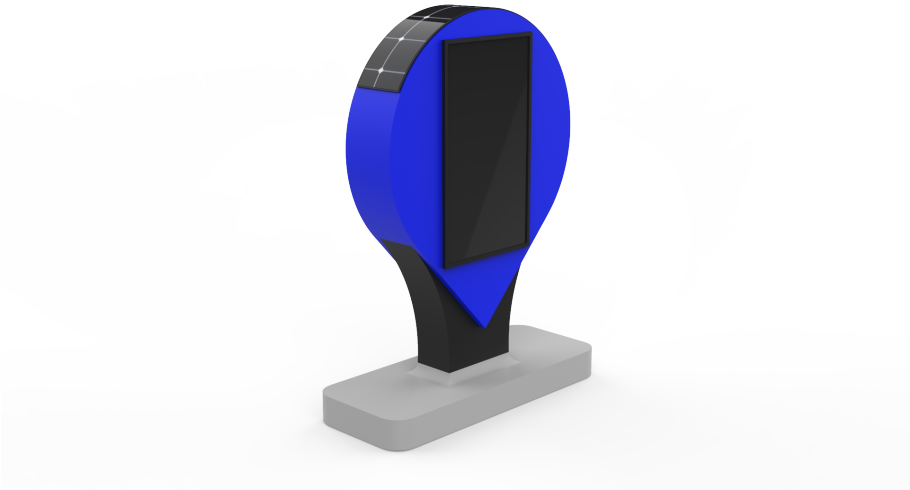

Fig. 1. Public Kiosk

pressure on the front of the product. The simulation has been made exclusively for the casing of the product and left out the screen. The second simulation simulated the impact of a beer bottle at the back of the screen. The goal of the second simulation was to recreate a situation in which a drunk individual would throw it's drink against the back of our product, a situation which could occur in real life. Both simulations concluded that our aluminium casing is resistant to heavy wind and a thrown beer bottle.

To properly visualise the structure and its shape, a cardboard model has been made. The creation of the cardboard model was to research the look and feel of the product. The cardboard model has been made in two different sizes, a smaller model to test the shape and a bigger model to get a feel for the dimensions. The bigger model is about 30 per cent the size of the real product. The shape works well with the screen and will fit well into a public environment.

Technical Assets To increase the appeal of the product, the team decided to equip it with a proximity sensor and a speaker to attract the attention of people when they pass by the kiosk. To do this, the team used an ultrasonic proximity sensor with a transmitter and a receiver, an Uno R3 micro-controller, a speaker, an SD card for storing sounds, and an MP3 shield that is superimposed on the Uno R3. Currently, this assembly of components is made separately from the product, it is part of the prototype but it is intended to be integrated into the product. These electronic components will be powered by the solar panel on top of the structure. Seeing as the production of the kiosk is meant to be outsourced the components will most likely change but the functionality should stay the same.

Web Application As for the design of the mobile web application, key functionalities were set and a flowchart was created to visualise the application's logic. Table 2 shows an overview about the required functionalities of the the web application. Later in chapter XY, the implementation of these requirements for the Web App will be discussed further.

For the front end mockups were created, all in line with our overall design and colour scheme. The application is mobile first designed, seeing as it will be played while walking but will be implemented responsively, so it could adapt to bigger screens like tablets. Figure 2 shows an example of the mockup, the startpage of the web application on a mobile phone.

Table 2. Key Functions of the Web App

Number	Functionality
1	Giving information about how the game works
2	Ability to start the game (with team name)
3	Start tour at randomised point
4	Giving information about tasks
5	Check if people are at specific places / Scan QR code
6	Tasks can be skipped
7	Counting points
8	Measuring time
9	Store points and team name in data base
10	Show ranking and vouchers in the end
11	Keep game progress even when closing the browser
12	Game can be stopped at all times

4 Prototype Development

Like the whole project the prototype has also two main parts. Firstly the public kiosk part, consisting of a technical setup for the by-passer detection and an application to give initial information, let the user choose a tour theme and lead them to the game. Secondly the web application as the main part, the game/tour, to be used on the tourist's phone.

4.1 Assembly

Kiosk The prototype of the kiosk is kept rather simple. An I-pad stands in for the bigger display on which an application runs, made with AppGyver[1].

The technical setup consist of an Arduino micro-controller (Uno R3) on top of which sits the MP3 VS1053 shield which makes it possible to play audio files

[1] https://www.appgyver.com

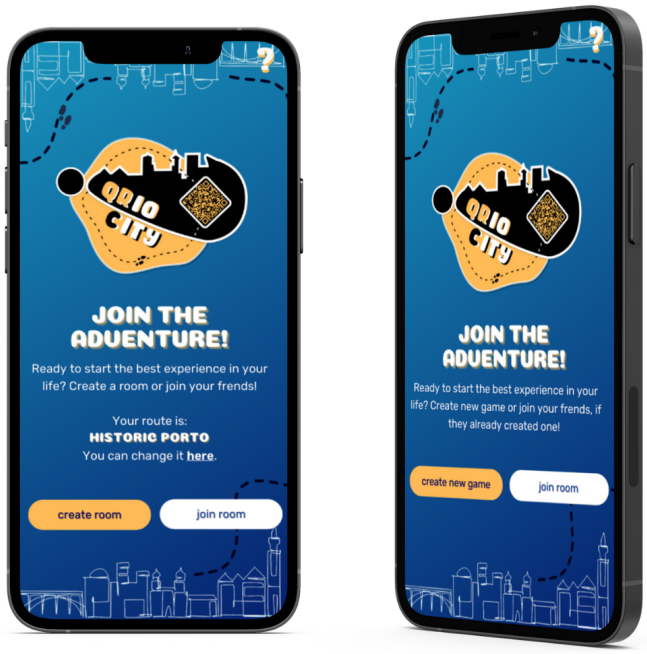

Fig. 2. Web Application Startpage Mockup

(mp3) which are stored on a SD card inserted into the shield. Connected to the shield is a speaker and also the ultrasonic sensor HC-SR04, which sends out ultrasonic waves that bounce off of objects and then come back to the sensor which makes it possible to measure distances. Figure 3 shows the setup sketch.

This setup allows the program running on the micro-controller to check the area around the setup for by-passing objects and then play a sound over the speakers to get a potential users attention. In the prototype, it was determined that one randomly selected sound of five would be played when a person was within one to two meters. After that the program waits a set number of minutes before scanning again, to avoid constantly making noise. When a person is closer than one meter to the setup will not make a sound seeing as in this case the user is probably already standing in front of the display. The range of meters and minutes can be adapted to any use case, this was just the configuration for the testing of the prototype.

Web Application The following presents the implementation of the required functionalities of the web app (Table 2). First of all, two use cases have to be distinguished: Main use case, when tourists access the web app via the public display. In this case, the tour is already selected and only a team name has to be entered

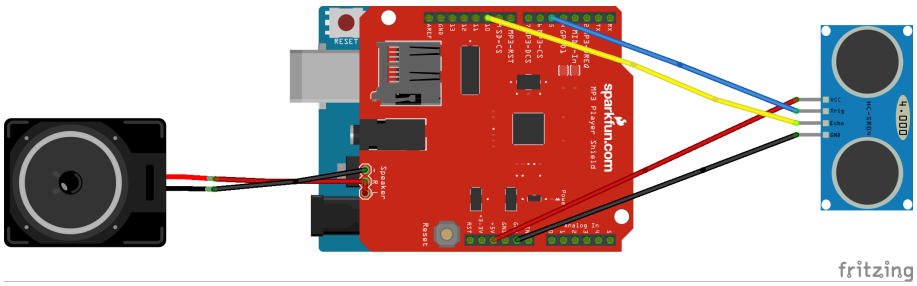

Fig. 3. Technical Setup

before the game can be started. Use case two, when tourists reach the web app without having been to the kiosk before. In this case, the web app needs to give the user background information about the game and how to play it. There must also be the possibility to select a tour category. Accordingly, the processes and functions of the public kiosk must also be available in the web app. After the game has been started, the following functionalities and steps in the web app are the same for both usage scenarios. For the prototype, a tour consisting of 4 tasks was developed, which are always completed in the same order. In order to ensure a different first task for each team, this is selected at random. For each task, there is just enough information to make the task solvable, but not trivial. If the task is successfully solved, the team receives a certain amount of points. If the given information is not sufficient to solve the task, it is possible to acquire one or two hints. These must be "bought" with the points acquired. The tasks are also intended to ensure that the team can only solve them in the right place. This is either guaranteed by the fact that a QR code must be scanned at a certain location, or that the tasks can only be solved with specific knowledge on site. There is also the option of skipping each task. Of course, no points are awarded for this. In addition, the duration of the game is measured. For the final score, the duration of the game is weighted negatively (weakly weighted). After completing all tasks successfully, the final score is shown in comparison to the other teams. Depending on the score achieved, the team receives a voucher to a local restaurant or shop of varying value. In general, it is guaranteed that even if the browser is closed or the internet connection is lost, the score, the measured time, the name of the team, the currently opened page and all other game data is retained.

4.2 Tests & Results

The first prototype was developed to test our concept, no elaborate tour was created, just the basic application with a few test tasks to simulate a simple game. The display setup was tested by walking by the prototype around 10 times and in all cases a sound was produced. The application also fulfills all its use cases, for example giving information, letting the user choose the tour and

presenting the first QR code leading to the web app. Team members not included in the programming, tested the application for usability and if every function was included. In case of the web application, tests concerning the functionalities and the performance were carried out. All the required functions (Table 2) were successfully implemented in the web app. You can find an example in Figure 4 including buttons to start the game, to exit the game, skip the task, get a hint or to open the camera to scan an QR code. In addition, the tests on the functioning of the web app logic were also passed. For example, it can be ensured that the game can only be started after a team name has been entered. For the performance test, each page of the web app was sent ten requests and both the time of the requests and their size were evaluated. This resulted in a range of an average request time of 168 ms - 182 ms and an average request size of 2.23 KB.

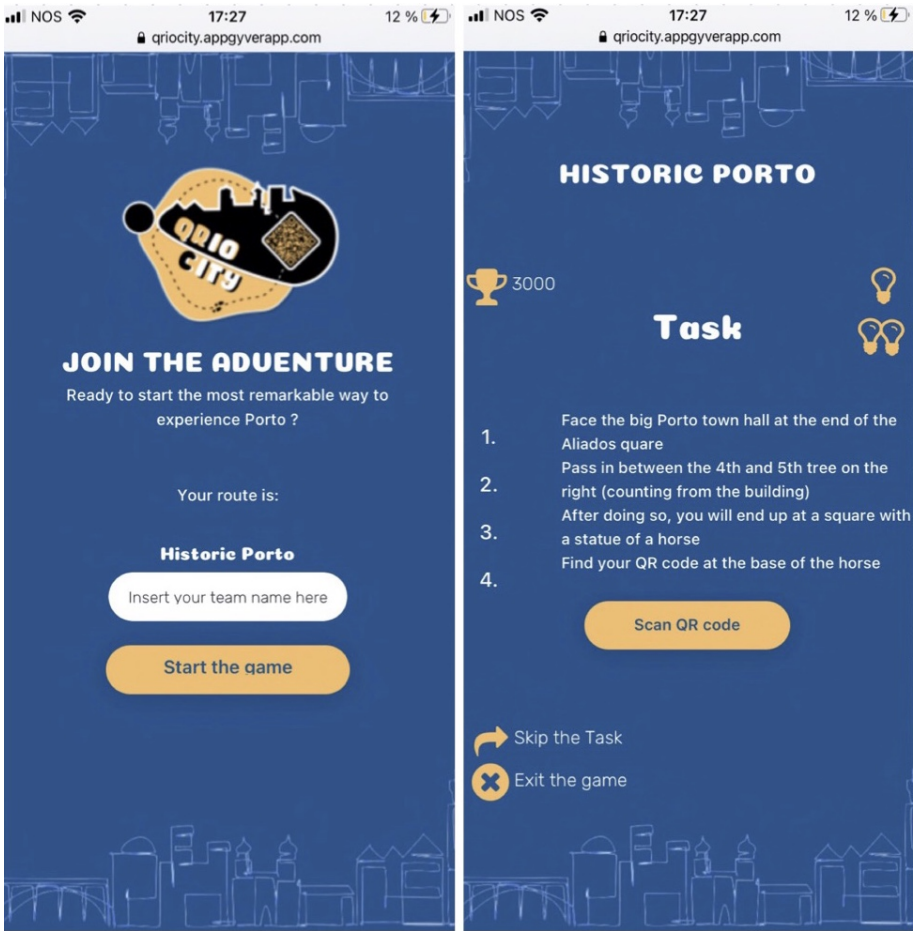

Fig. 4. Functionality test of the Web App - Example

4.3 Discussion

The initial tests succeeded, giving green light to developing a first tour and testing it on the market to see if users react the anticipated way. For the tour development a wide spread survey to Porto locals would help figuring out some hidden treasures and the most popular spots, making sure to provide the tourists the most outstanding and special experience. Another crucial point to the development of the product would be the acquiring of partners, probably best handled by a local representative. After the application is finished and market tested in can be deployed and the production of the display can be put in motion. Even though the kiosk is a crucial part to the concept it should be produced last to avoid the risk of unnecessary spending due to unforeseen changes.

5 Conclusion

5.1 Project Outcomes

This project aimed to design and develop a new environmentally friendly product that could sustain itself in the market and would not conflict with ethical, deontological, and sustainable principles. The team focused on finding a solution for young tourists who are looking for innovative ways to explore a city. They are looking to explore in an interesting and engaging way that will keep them entertained. Simultaneously meeting the needs of city authorities who are looking for innovative ways to attract tourists. After extensive research and many discussions, the team proposed a solution that meets all the needs of the target audience and the customer (city authorities). QRioCity is a solution that combines a web application game with a public kiosk that grabs attention and encourages interaction. Users can take on the challenge of exploring the city on their own, but also with a group of friends, competing against each other. Thanks to cooperation with local companies we can offer all players vouchers to local restaurants, stores, et cetera after completing the game. QRioCity benefits not only the company itself, but the entire community - users who can visit the city for free and receive vouchers, local businesses who gain new customers, and city authorities who become known as innovative.

After analysing the solution, there are a few things that could be improved. These will be discussed in more detail in the section "Future Development".

5.2 Future Development

QRioCity is a solution that was specifically targeted at the city of Porto. After implementing the service in Porto, the team intends to expand to other cities. The success in Porto can be used to promote the service in other cities while building a community on social media. During the expansion, it is important to continue to service all existing screens, so if the expansion gets too big, the company could consider to split in two parts. One part should focus on serving existing screens, improving the user experience as well as keeping city authorities

satisfied. The other part will focus on expanding to other cities and building a community, which can also contribute to a improved user experience.

As for the product itself, the choice of materials can be optimised. The epoxy coating makes it difficult to recycle aluminium, so it is recommended to find a solution to this problem. This can be done by choosing a different type of coating, material or way to protect the enclosure.

5.3 Personal Outcomes

Anita - "By participating in the European Project Semester, I have gained valuable skills that will definitely help me in the future. The project helped me increase my self-confidence, improve my language and communication skills with people from different countries and with various personalities. I think that my teamwork skills have definitely improved. As a member of the group I had the opportunity to observe the importance of good relations between team members and mutual support when working together, overcoming obstacles together and facing new challenges. The activities accompanying the project allowed me to gain new and additional knowledge that went beyond my area of expertise."

Bram - "This semester has been very insightful and taught me a lot about different cultures. Working in an international team from different backgrounds has been a privilege and I've enjoyed every minute of it. The project was interesting, the supporting courses educational and the supervision was adequate. Furthermore the teamwork was splendid since each team member played into each others strengths and weaknesses very well. In conclusion my European Project Semester experience has been very enjoyable and I recommend it to anyone who's thinking about doing an EPS semester!"

Chloé - "This semester has allowed me to grow and learn new things. At the beginning I didn't expect this, I thought we would have a defined project with a real demand. The fact that we had to create everything was quite disturbing for me but thanks to my team I managed to adapt. Working in a multicultural and multidisciplinary team was very enriching for me. Indeed, we did not always have the same concerns about the project due to our field of study, but we managed to overcome all the obstacles as a team. I think I managed to improve my English and to some extent my communication skills. It was a good experience for me."

Jakob - "The European Project Semester was a very educational and valuable experience for me. I learned a lot about different cultures and working in a multinational and multidisciplinary team. It shows that effective teamwork can only, but also primarily, come from everyone being able to contribute their different strengths and interests. Improving my language and communication skills is definitely something that I achieved. I find it particularly exciting to see how an idea develops and evolves, influenced by different perspectives and scientific topics. Especially because these largely influence each other. I also truly enjoyed working on the development of a specific product for an entire semester."

Lina - "It was a challenging semester but worth it. It was my first time working with people from different disciplines and it showed me that we can work together nevertheless and use our expertise even if it is not in our speciality. I

was able to deepen my technical skills but more than that, my soft skills. Being part of a bigger scaled project gave me insight in many different sections of project management and development I did not know before. By times, it was hard to incorporate every members opinions or work efficiently but in the end we overcame every obstacle and became stronger as a team."

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