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Engaging Sustainability: The Role of Gamification in Promoting Eco-Friendly Practices Within the Hospitality Domain

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Abstract

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Nowadays hotels are looking for new ways to encourage sustainable practices among their guests. This thesis examines the use of game-like features to achieve this goal. Many hotels today are committed to being responsible towards society and the environment. Therefore, there is a growing interest in finding creative methods to encourage sustainable practices.

This research will investigate the concept of gamification—a strategy that borrows elements from games to make activities more engaging. The study aims to design a digital platform in the form of either a web or mobile application that would encourage and track various eco-friendly practices.

The hotel industry is focusing on resource conservation. The goal is therefore, to research and determine which practices can have the most impact on improving the social and environmental impact of hotels. To achieve this, the existing literature and use cases will be reviewed, helping to provide valuable insights to hotels looking to improve.

As a result, this thesis presents a successfully implemented prototype web application – which showcases gamification as a potential solution to promoting sustainability within the hospitality industry.

Keywords: Hospitality, gamification, sustainability, web-based application.

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List of Abbreviations

ENT: Ericsson Nikola Tesla. Croatian affiliate of the Swedish telecommunications equipment manufacturer Ericsson.

ESG: Environmental, Social, Governance. A set of standards that is used to measure and examine the social and environmental impact of a company.

CO2: Carbon Dioxide. Chemical compound.

HVAC: Heating, Ventilation, and Air Conditioning.

1 Introduction

In the present day, where environmental sustainability is an important aspect and need in this rapidly growing society, industries all around are developing new strategies to integrate their operations with sustainability principles. One of the industries that stands at the forefront of such changes is the hospitality industry. This thesis suggests using gamification as a fresh and innovative approach to deal with the negative environmental impact of tourism and hospitality. This thesis is also of important value to Ericsson Nikola Tesla, the case company, providing ideas and potential ways of implementing gamification in the aspect of promoting eco-friendliness in the hospitality domain.

Considering the current environmental situation in the world, seeing the growing environmental challenges that include global warming from fossil fuels, food waste, biodiversity loss, plastic pollution, and resource depletion, the need for sustainable practices has never been more necessary. Currently, the public, businesses, industries, and governments recognize the importance of acting upon sustainable practices, and within this context, the concept of Environmental, Social, and Governance (ESG) has evolved. ESG was developed as a sort of guidebook for businesses, guiding them in how to operate responsibly. In the lines of the hospital industry, which has significant impacts on the environment through both, its consumption of resources and its production of waste, the principles of ESG and their implementations are crucial.

Taking all this into consideration, the purpose of the research topic, suggested by the case company, Ericsson Nikola Tesla, is to investigate and explore a creative, and innovative method to enhance sustainability and eco-friendliness within hospitality. This is where gamification comes into play – the concept where traditional game boundaries are taken down by applying game-like features and principles in a non-gaming context. This thesis suggests using gamification as not only a strategy but as an approach to encourage the adoption of sustainable practices in an engaging, motivating, and rewarding way. This thesis intends to

introduce and propose the possible use cases of gamification within the domain, aiming to highlight the project's potential for the case company, ENT.

2 Research Framework

In this section, the research problem, research question and the aims and objectives of this thesis will be introduced.

2.1 Research Problem

When thinking about sustainability in various industries, the hospitality industry stands out as one of the most impactful. Some of the impacts are through water usage, consumption of energy, waste generation, etc. According to Dr. Kim, it is common for restaurants and hotels to use excessive amounts of energy for heating, ventilation, air conditioning (HVAC), lighting, and fuel consumption [1]. Therefore, like various other industries, hospitality is under pressure to become more sustainable. With previous efforts, involving traditional methods like informational campaigns or policy changes, not being enough to make a large impact, there is still a challenge in getting guests and staff to get used to and consistently engage in eco-friendly activities.

This thesis will explore gamification as a new approach to the challenge. By implementing game mechanics in non-game settings, gamification offers an approach to try and engage as well as inform individuals about participating in eco-friendly activities. The whole point and idea behind it are to get individuals to change their habits and develop new skills [2]. Through gamification, would it be possible to promote, highlight, and make users contribute to sustainability? This question leads to the investigation of the potential of gamification to aid in sustainability efforts in hotels, leading directly to the formation of the research question.

2.2 Research Question

The primary research question this thesis aims to address is: “How can gamification be effectively incorporated in the hospitality industry to enhance engagement in environmental sustainability practices among hotel guests and

staff?” This question seeks to investigate the potential of game-like aspects to motivate eco-friendly behaviours, therefore providing a new approach to achieving Environmental, Social, and Governance goals within the hospitality sector.

Since there is limited research exploring the relationship between gamification and sustainability in the hospitality industry, this research aims to close that gap. By exploring this, the thesis will contribute to the larger conversation about sustainable hospitality management and provide practical suggestions to not only Ericsson Nikola Tesla but to their clients who aim to improve their social and environmental impact.

2.3 Aim and Objectives

Based on the information gathered in the previous subsections, this thesis aims to explore and gain insight into the ways gamification becomes the turning point in helping the hospitality industry turn to sustainability. This will investigate how game-like features can be applied within a non-gaming context to try to motivate and interest guests of the hotel to adopt and participate in eco-friendly activities.

To achieve this aim, throughout the research process, various objectives must be pursued. To begin with, the research will start with a review of existing literature on sustainability, gamification, on sustainability within the hospitality sector, and on the use of gamification within that context. Following up on this review, the focus shifts to analyzing gamification strategies and elements that have previously been successful in promoting engagement and motivation within non-gaming contexts.

In the next steps, the research will explore the possible operational areas within the hospitality industry, such as energy usage, water usage, and waste management, to establish the potential use cases for gamification strategies. Considering these use cases, the subsequent actions involve designing wireframes and conceptual prototypes for a web application. This prototype is

used to detail the structure of the application and the user journey and showcase how the use cases are integrated into it.

Consequently, the conceptual prototypes are developed into a functional web application through coding. Throughout the process, it is ensured that the application is user-friendly and engaging and that the use cases are properly functional.

Finally, the outcome of this thesis will offer a set of recommendations and evaluations for ENT. These recommendations will be completely based on what was learned throughout the research and the thesis. Improvements and suggestions on what the possible use cases are, and how to effectively implement gamification with those use cases will also be included.

3 Literature Review

This section offers a comprehensive review of the existing literature, focusing on the key areas that highlight this thesis. It will focus on the current situation in sustainability within the hospitality industry, as well as examine what ESG is and how its principles align with environmental sustainability. Additionally, this review will go through the concept of gamification, its advantages and disadvantages, and existing literature on its potential power in enhancing sustainability. Through this, the aim is to identify where and how gamification can be successfully implemented to promote sustainability within hospitality.

3.1 Sustainability in the Hospitality Industry

In this subsection, the thesis will discuss the early roots of the term 'sustainability' and its definition, as well as its modern application in terms of hospitality. This section will conduct a literature review of various existing resources to help define and outline the necessary information.

3.1.1 Origins and Definition of Sustainability

Due to global issues like climate change and sustainable development, sustainability has gained importance in recent years. The concept of 'sustainability' was introduced by Hans Carl von Carlowitz in the 18th century. In his work, 'Sylviculture Oeconomica,' published in 1713, Carlowitz aimed for the 'sustainable use' of forest resources and called for maintaining a balance between harvesting mature trees (consumption) and making sure that enough young trees would grow to replace them (preservation) — the source of today's understanding of sustainability. Over the years, this concept has evolved and expanded into a broad idea that now applies across various sectors of our society, including social, economic, human, and environmental. Today, sustainability is the ability to exist and grow without wasting and destroying natural resources during the existence period [3].

3.1.2 Sustainability Practices in Hospitality

Further expanding on sustainability, the hospitality and tourism industries are prominent for their impacts on eco-friendliness. As one of the world's most popular and rapidly expanding financial industries, hospitality is also one of the largest consumers of resources. The tourism and hospitality industries contribute significantly to environmental deterioration and significant greenhouse gas emissions. Naturally, the hospitality sector acknowledges sustainability as a major priority for future growth and is one of the significant sectors actively incorporating it. Many hotels are driven to implement sustainable practices due to heightened awareness, government regulations, and customer demand [4].

Furthermore, current data underscores the mentioned impacts: according to Sloan, Legrand, and Chen, an average hotel can emit between 160 and 200 kilograms of CO₂ per square meter of the room floor area per annum. That is one of many concerns; water consumption levels are equally concerning. A hotel guest in a five-star hotel could use anywhere between 170 and 440 liters per day; comparing that to an average of 145 liters per day at home raises apprehension [5, 6]. Furthermore, hotels produce around 1 kilogram of waste per guest daily. Nevertheless, based on a study by Salam MA, the average amount of residential household waste generation was 0.28 kilograms per person daily, raising concern about the high volume of hotel waste [7]. These numbers show the significant environmental impact of hospitality and highlight the need for sustainable hotel practices. Implementing such practices is essential to address the environmental issues covered in this section and improve hotel operations.

The hospitality sector, having acknowledged these concerns alongside others, has realized the urgent need for various sustainability initiatives. As a result, the International Business Leaders Forum (IBLF) program established the International Hotels Environment Initiative (IHEI) organisation in 1992. The role of the IHEI organization was to create useful, free tools and information for the hospitality sector, and the first thing that was published was the Environmental Management for Hotels manual. The manual looks at the main

concerns surrounding hotel operations and offers tools and valuable advice to manage the influence of properties on the locations and communities where they are located. The manual's chapters cover critical issues related to hotel operations, such as supply chains, social sustainability, energy consumption, waste management, and water and energy conservation. Nowadays known as the Sustainable Hospitality Alliance (<https://sustainablehospitalityalliance.org/>), the International Hotels Environment Initiative became the International Tourism Partnership in 2004, highlighting the organization's efforts and successes in providing tools to develop and implement solutions to significant sustainability challenges [8].

Continuing the topic of sustainability initiatives by hotels, a more current example is Scandic Hotels, a leading hotel chain in the Nordic region, which has implemented various sustainability practices to reduce its ecological footprint. Based on their annual sustainability report in 2022, Scandic Hotels took essential steps in reducing energy consumption by using energy-efficient solutions and sourcing 100% renewable energy from hydroelectric sources for its operations. Furthermore, water-efficient fixtures and toilets have helped reduce water consumption levels. Another step towards a more sustainable future that Scandic Hotels implemented was using environmentally certified or recycled materials for room décor and interiors. Moreover, Scandic Hotels Group continuously works towards reducing food waste and has achieved a 14% reduction between 2019 and 2022, demonstrating its active and promising approach to environmental sustainability [9]. This data also highlights the effectiveness of integrating sustainable practices in hotel operations underscoring a key argument of this thesis.

3.1.3 Critical Analysis of Sustainability Practices in Hospitality

Following this research and utilizing Scandic Hotels Group's sustainability reports from 2019 and 2022, this section examines sustainable practices to highlight progress and areas for further enhancement.

Waste management is one of the biggest challenges for hotels due to the high amount of waste generated by such operations. Scandic Hotels Group regularly tracks the amount of trash produced during their activities and looks for ways to reduce it. Scandic tries to reduce the amount of packaging and unnecessary materials used, like single-use disposables. Additionally, they make an effort to recycle and reuse materials and products. To reduce its damaging environmental effects, Scandic Hotels Group sends waste from operations to recycling centers or contemporary waste management facilities. Additionally, Scandic wants to reduce food waste from their hotels; therefore, any unavoidable waste becomes composted or used as much as possible to create biogas [10]. Such strategies towards eco-efficiency in waste management have been proven efficient, according to Figure 1 below.

Total weight per method of disposal, tonnes	2022		2021		2020		2019	
	Hazardous waste	Non-hazardous waste	Hazardous waste	Non-hazardous waste	Hazardous waste	Non-hazardous waste	Hazardous waste	Non-hazardous waste
Reuse	-	-	-	-	-	-	-	-
Recycling	9.9	8,733.1	3.1	5,705.3	4.9	5,357.7	14.0	11,301.2
Energy recovery ¹⁾	33.0	7,357.4	18.9	5,580.0	17.6	4,723.0	29.8	8,494.5
Combustion	44.8	0.0	26.5	0.0	24.0	0.0	38.6	0.0
Landfill	5.9	57.6	3.4	18.2	3.2	18.2	5.1	41.1
Total	93.6	16,148.1	52.1	11,303.5	49.7	10,098.9	87.5	19,836.8

Figure 1. Environmental data showing the total weight of disposal (waste) depending on method, in tonnes [9].

Figure 1 shows the disposal methods and corresponding waste tonnage. From 2019 to 2022, the data in the figure clearly shows an overall decrease in the total non-hazardous waste production, from 19,836.8 tonnes in 2019 to 16,148.1 tonnes in 2022. This figure highlights the shift and commitment towards more responsible waste management. However, the 2019 to 2022 period also hosts the COVID-19 pandemic, which significantly impacted the hospitality industry. With travel restrictions in place, hotels saw shortages in occupancies. According to Coyne, in 2020, at the peak of COVID-19, the hospitality industry had to shorten its workforce by more than 18%, and based on experts' examinations, profits from the industry were dropping by billions of dollars [11]. Therefore, the years 2020 and 2021 are notable anomalies, and as can be seen from the graph,

the waste outputs had a drastic drop. For such reasons, it is crucial to consider the uncertainty of how much of the decreased waste output is due to sustainability efforts and how much is a consequence of the pandemic. As a result, though the overall waste reduction is encouraging, a more thorough analysis considering the hospitality industry's post-pandemic recovery would be necessary to ensure the impact of Scandic Hotels Group's waste management efforts.

Moving on from the figure, it is evident that the hotel group's active approach is shown through waste management improvements and a 29% decrease in CO₂ emissions per square meter. Scandic Hotels Group achieves that by systematically measuring emissions and setting targets to reduce them. Scandic Hotels Group also makes educated choices when purchasing energy, and the fossil fuels utilized by Scandic are gradually replaced with energy derived from renewable resources. These sustainable practices show a fundamental shift towards energy efficiency and a reduced carbon footprint. Furthermore, there has been a 7% decrease in water consumption between 2019 and 2022 by using water-efficient dishwashers and implementing water-efficient fixtures and toilets [9, 10].

Scandic Hotels Group's progress looks promising regarding the impact of sustainability efforts within the hospitality industry. It is a perfect case study for how environmental sustainability can lead to success for hotels, considering the numerous awards, like the Hotel Innovation Awards' special sustainability prize and winning five out of seven Danish Climate Awards, which honor Denmark's most sustainable hotels, won by the Scandic Group hotels [9].

Nevertheless, sustainability is not staying in place; it continuously evolves. Environmental expectations continuously increase, and the hospitality sector must continue to find and adopt innovative technologies and ways to address sustainability challenges. More hotels must start being more mindful of their building materials or integrate smart technologies for energy, water, and waste management. Being environmentally responsible highly benefits hotels. Hotels that practice environmental responsibility can minimize operational costs and

improve cost control, increasing revenue by cutting expenses. Furthermore, they can improve financial stability over the long run, increase customer satisfaction levels, improve their image, increase brand recognition, and reduce adverse consequences while protecting the environment [12].

This section, along with all the information and analysis of use cases, highlights, and further enhances the point made by this thesis – sustainability in hospitality is mandatory, popular, and effective.

3.2 Environmental, Social, and Governance (ESG) in Hospitality

Now more than ever, discussions on sustainability are growing. Because both sustainability and hospitality have a significant effect on the economic and social sectors of the world, it was essential to consider the implementation of a set of principles to deal with possible challenges [13]. That is where hospitality's environmental, social, and governance (ESG) concept was born. Environmental, social, and governance (ESG) is a set of standards that is used to measure and examine the social and environmental impact of a company [14].

According to Henisz et al., ESG principles present financial gain in five ways. For example, companies with strong ESG propositions, like Finland's petroleum-refining company, Neste, generate more than two-thirds of their revenue from its sustainable products and renewable fuels. Similarly, by introducing the 3Ps program (pollution, prevention, pays) in 1975, 3M, the American multinational corporation, has cut costs by 2.2 billion dollars through repurposing and recycling production waste, refining machinery, enhancing manufacturing procedures, and reformulating products [15].

Moreover, a well-thought-through ESG framework can lead to fewer legal and regulatory interventions, allowing businesses more strategic flexibility. Additionally, it can help businesses recruit and keep skilled employees, boost morale by giving them a feeling of direction, and increase productivity. Lastly, ESG may increase investment returns by directing funds toward more

sustainable and promising opportunities; China's dedication to reducing air pollution has been estimated to bring in more than 3 billion dollars through investment opportunities in 2030. Therefore, it is beneficial and advisable for businesses all around to adopt ESG principles [15].

Returning to the hospitality sector, the importance of environmental, social, and governance (ESG) principles is highly in demand by hotel guests, employees, investors, and owners; they have started paying more attention to how hotels run their operations and their impact on the environment and society. With growing expectations, customers and employees motivate the hospitality sector to prioritize reducing carbon emissions and responsible practices [16].

An article by the United Nations World Tourism Organisation (UNWTO) says that the ESG principles relevant to the hospitality industry are meant to battle climate change, diversity (racial, ethnic, and gender) and inclusion, waste management, and governance [17]. Therefore, with an increased awareness of such principles and the sustainable challenges at stake, people have started prioritizing sustainable living. In fact, according to the 2022 Sustainable Travel Report by Booking.com, 71% of travellers from the UK emphasize the importance of sustainable travel. Furthermore, 33% have mentioned their stays in sustainable accommodations throughout the year, and 62% have said that that is what they intend to do in the next year. Moreover, an impressive 55% expressed their wish to leave the locations they visited better than when they arrived, with 26% preferring to travel during off-peak seasons to mitigate overcrowding [18].

Below, the three dimensions of ESG in hospitality are presented. Even though they are explained separately, it is important to comprehend that they are linked. Social responsibilities will be impacted by environmental activities. As a result, the business needs socially responsible governance. When these three factors are combined, management techniques may be strengthened, and business performance may be improved [19].

The environmental matters of ESG represent the environmental impacts of companies. As previously explored in this thesis, it is known that hotels tend to have significant environmental impacts. Therefore, it is essential that the business employs the most effective management techniques to reduce waste, hazardous waste, water usage, energy consumptions, air emissions, and their effects on biodiversity. ESG principles promote the adoption of sustainable practices by hotels, which will benefit the hotel's reputation [19].

The social responsibility aspect of ESG represents the social practices of companies. In hotels, according to Hubbard et al., the social features of ESG consist of moral work ethics, involvement in the community, and a strong dedication to the welfare of society. ESG urges hotels to support fair labor practices, guarantee employee well-being, encourage diversity and inclusion, and make good contributions to the communities in which they operate. These actions lead to an increase in the productivity of the hotel's employees, benefiting the brand's image and reputation [20].

The governance practices of ESG represent the ethics of companies. Being transparent, ethical, and honest in their operations is a must for any business, including hotels. Ethical governance factors of ESG encourage hotels to put in place solid managerial frameworks, fair corporate conduct, and responsibility for decision-making. According to Dimitriou et al., several studies showcase that businesses that prioritize social responsibility and ethics typically have higher profitability than other types of businesses, clearly showing that hotels stand to gain from operating more morally and responsibly [21].

Figure 2 below showcases a summary of the above discussed ESG practices, alongside their definitions and impacts, provided by UNWTO [17].

Environmental	Social	Governance
Environmental matters that consider a company's impact on the natural world and its position to deal with climate change.	Social matters that consider a company's social impact, both in and outside its organizational chart.	Governance matters that consider leadership's commitment to positive change.
<ul style="list-style-type: none"> • Climate change and carbon emissions • Impacts on biodiversity • Water usage • Waste and recycling • Energy consumption • Air quality • Land clearing 	<ul style="list-style-type: none"> • Workforce freedom of association • Child labor • Forced and compulsory labor • Workplace health and safety • Discrimination, diversity and equal opportunity 	<ul style="list-style-type: none"> • Reporting requirements • Risk management • Codes of conduct and business principles • Transparency and disclosure • Bribery and corruption • Shareholders rights

Figure 2. The three pillars of ESG: definitions and impacts [17].

In summary, ESG represents an approach to conducting business safely and sustainably. It helps to make sure that businesses, including hotels, operate ethically and responsibly. By focusing on and abiding by ESG principles, hotels align with ethical standards and global sustainability, positioning themselves for growth and success. This section highlights the importance and need for sustainable and ethical work within the hospitality industry.

3.3 Introduction to Gamification

Gamification has been around for decades but only as a concept. The term was only formed in 2002 by a British consultant, Nick Pelling [22]. Although there was now a term for the concept, it was still not widely used. The word only started to see widespread adoption during the second half of 2010 [23]. Unsurprisingly, a concept like gamification has a lot of different viewpoints and opinions about it, so naturally, it also has a few definitions. A study by Deterding et al. claims that until 2012, efforts to define "gamification" gained little attention. Alongside the study came the following widely accepted definition: "Gamification is the use of game design elements in non-game contexts." [24].

Gamification principles include game design features such as leaderboards, competition, clearly defined progression paths with attainable goals, levels, offering feedback, promoting player cooperation, rewards, and various combinations of such principles [25].

According to Ahmadi MM, motivation has always been an issue in any business organization, and businesses have always been looking for ways to motivate and persuade their employees to be closer to the organization and its culture and goals [26]. In order to combat this, organizations across different sectors are now adopting gamification strategies and principles to improve employee engagement in the workplace and, as a result, boost job satisfaction [27]. Moreover, gamification has become increasingly popular as a means of changing attitudes and behaviours [28]. As previously mentioned, organizations are already beginning to use gamification to motivate employees. Top performers at insurance company Ansay & Associates get the chance to spin the "Wheel of Wow," and each employee receives a special reward. Moreover, in the 2019 Gamification at Work Survey, 89% of employees claimed that they would be more productive if their jobs were more gamified [29].

Furthermore, gamification has also transformed itself into a strategy to grow user engagement and loyalty in various businesses. In marketing, for example, gamification was used to persuade people to spend more time browsing the products, therefore increasing the probability of purchasing. In fact, in a survey from 2013, over 70% of the Forbes Global 2000 companies said they intended to employ gamification for client retention and marketing, highlighting the excitement around gamification [30].

While gamification in marketing has increased customer interactions and potential sales, and its impact on employee motivation has been significant, the gamification approach also has its drawbacks. According to Algashami et al., some companies want to use gamification without setting clear goals and plans, which poses potential issues to the effectiveness of gamification. A concern with

gamification is the potential issues that arise with competition. Although such competition, like leaderboards, is meant to be fun, it can affect people differently, potentially creating tension and rivalry [31]. Therefore, when it comes to workplace motivation, gamified solutions must be well-planned to avoid adverse effects. Careful evaluation of employee behaviors and attitudes toward gamified processes must be assessed to avoid such issues [27].

3.4 The Application of Gamification in Promoting Sustainability

During the last few decades, the interest in gamification and the urgency of sustainability practices have grown. As environmental concerns became pressing, gamification has been adopted as a convincing way to make people more conscious of the effects of their actions by educating them about how their consumption influences their environmental decisions [32]. According to Stevens, digital sustainability engagement programs will become essential to any company committed to responsible and innovative practices [33]. Furthermore, sustainability is essential to any successful organization's strategy. A company's profitability, growth, and employee retention are all negatively impacted when sustainability risks are ignored [34].

In 2012, according to Makower and GreenBiz Group's 'State of Green Business Report 2012', gamification became one of the top sustainable trends, considering multiple companies increasingly used game-like features to reward people for making greener choices [35, 36]. A recent McKinsey & Company survey shows that many companies have started incorporating sustainability efforts into their operations. The focus is on saving energy, developing eco-friendly products, and enhancing employee retention and motivation [37]. Based on the article on businesses using gamification to save the world by Bates, gamification is used by German software company SAP to cut down on vehicle emissions. SAP developed the TwoGo app, which companies can use to motivate staff members to carpool. Car poolers can accumulate points, monitor their friends' advancement, and give the money they save by participating in the program to the charity of their choice. Since introducing the app internally, twenty thousand

employees, the company as a whole, and the environment have benefited from the project [38]. To further highlight this point, according to Perryer, companies incorporating sustainability efforts could benefit from gamification as a valuable tool to encourage staff involvement in such efforts [39].

Nowadays, there are many apps available, and a few of them are all about sustainable living. Moreover, gamification is used in these apps to motivate and encourage people to start living a sustainable lifestyle. The 'JouleBug' app does that. It is a mobile application established in 2007 and designed to gamify the process of adopting sustainability in everyday life. In a 2021 review of 5 different environmental apps by Shoutem, JouleBug was "an absolute winner" according to its design, quality of information, and usability [40]. It uses various game-like elements; for instance, there are hundreds of actions that users 'buzz' when they get done in real life, earning bonuses for it. Another example is the implementation of friendly competition. With a social aspect present to enhance motivation, users can share every 'buzz' after completing an activity on the social activity page. This creates a positive feedback loop when users are motivated to act after seeing what their friends are doing, therefore, performing better due to friendly competition. According to Williard, it was clear from the beginning that this version of competitive gamification could be an effective behaviour-changer [41]. People can change their attitudes and behaviours, therefore performing at better levels due to competition; individuals tend to become inspired and fulfilled when they align and assess themselves against others [42]. Figure 3 below showcases four screen images from the JouleBug application. The four screens represent the actions, competition, social, and impact pages of the app.

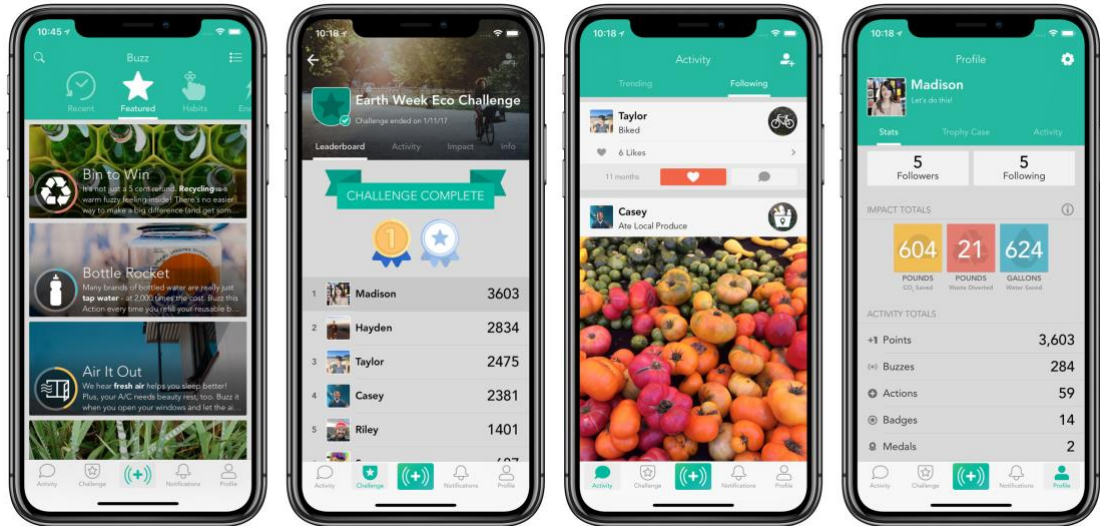


Figure 3. Actions, Competition, Social, and Impact pages from the JouleBug app [41].

The effectiveness of the JouleBug app is highlighted by its impressive performance numbers from 2022-2023. Throughout 2022, the JouleBug community significantly contributed to environmental sustainability by increasing the year-over-year CO₂ savings by 24.7%, totalling 2,195,779 kilograms. Furthermore, the amount of water saved increased by 32.5%, totalling 27,868,535 litres, and 118,966 kilograms of waste were diverted from landfills, resulting in a 15.5% rise in year-over-year savings. These statistics highlight not only the success of JouleBug but also the potential of gamification in promoting sustainability [43].

Considering the future, gamification is a good strategy that can be adapted across industries and businesses, as well as individual needs as an approach to address environmental challenges. However, there are drawbacks. Maintaining the desired positive behavior and interest over an extended period is challenging since users' enthusiasm may gradually fade as the service becomes routine or monotonous, according to a study by Kawachi. This point is further supported by previous research made by Hamari et al., where it was suggested that the benefits of gamification tend to lose their effectiveness with time. This might be viewed as both a benefit and a disadvantage because the positive effects do exist, but they do not provide a long-term fix [44, 45]. It is therefore essential to

think through the implementation of various gamification principles to meet engagement goals and always keep the interest on.

The subsequent chapters will examine gamification specifically in a hospitality setting and as a way to promote sustainability in hospitality.

3.5 Gamification in Hospitality

Hospitality and tourism, like the other industries, are not falling behind and have also turned to innovative strategies. According to Campione, the hospitality industry is well-suited for gamification. The most important thing for service-oriented businesses is to engage customer loyalty. By incorporating gamification into the hotel industry, it is possible to motivate guests to stay engaged with the hotel's services [46]. Furthermore, the hospitality industry shows a growing need to implement sustainable practices in its services, considering its significant contribution to environmental deterioration, discussed previously in this thesis [5]. As a result, gamification offers an innovative approach to meet these urges [32].

Using gamification, hotels can encourage guests and employees to enjoy their stay sustainably in a fun and motivational way by introducing eco-challenges like reducing water usage and food waste or promoting energy-saving activities. Participants can also be rewarded for their actions while benefiting the hotels [47].

3.5.1 Case Studies of Gamification in Hospitality

Utilizing case studies, this section explores real-world applications of gamification in the hospitality industry, expanding on the foundation that was provided in the previous section. These examples highlight how some hotels have successfully integrated gamification strategies to enhance the guests' stays.

In 2011, Intercontinental Hotels Group improved its loyalty program with a daily online quiz game "Win It in a Minute". Participants in the quiz game receive bonus miles for quick and accurate answers about various travel destinations.

Researchers found that younger consumers — a demographic not often associated with brand loyalty — were attracted by this initiative. In the first two weeks, the data seemed impressive, with 100,000 users participating and more than 100 million Priority Club points up for grabs. Over time, however, user engagement started to fade little by little [48, 49].

Similarly, Voco Hotels, in an attempt to improve their customer service experience, introduced an innovative gamified initiative. The company developed an inter-hotel competition that is set on achieving perfect guest review scores. The rewards program for employees was made to engage and motivate staff across all positions. At the end of every month, the employees with the best reviews take part in a 'spin the wheel' game to win prizes. As a result of this gamified initiative, Voco Hotels noticed a rise in staff motivation levels and performance scores, which were up by 10% across all their properties, highlighting the ability of gamification to improve employee engagement [50].

When it comes to effectively used gamification techniques to encourage sustainability in hotels, an example is the Make a Green Choice program curated by Starwood Hotels & Resorts. This allows guests to decline full housekeeping services. According to the Global Citizenship at Starwood 2013 Update Report, for every night that the guests choose to decline room cleaning, 49.2 gallons of water, 25,000 British thermal units (Btu.) of natural gas, 7 ounces (oz.) of chemicals from cleaning goods, and up to 0.19 kWh of electricity are saved. When declining such services for up to three nights in a row, guests will receive recognition for their eco-friendly decisions, which results in a \$5 food and beverage voucher or 250–500 Starwood Preferred Guest points [51].

These case studies demonstrate the potential, limit, and use of gamification within hospitality. However, there is little information about how gamification can be adapted to improve sustainable practices in the hospitality industry. Therefore, this thesis aims to address the gaps in existing research and use cases. To bridge the gap, this thesis will aim to present possible use cases that show the potential implementations of gamification to promote sustainability in hospitality.

4 Methodology of Web Application Design and Implementation

This section aims to show an approach to the question of how the hospitality industry might combine gamification and environmentally friendly practices alongside ESG considerations. Furthermore, it aims to ensure that the research method is transparent and objective, therefore strengthening the research's credibility [52].

This section is going to cover the following topics: planning the project, selecting potential use cases, applying design principles to the user interface, and selecting the technology to be used.

4.1 Project Planning for Web Application Development

Project planning is a crucial factor in ensuring the success of a project. The project planning phase aims to set up the structure for project execution [53].

This project explores the interaction of sustainability and gamification within the hospitality industry, showcasing a prototype web application of how the three can interact. The task includes developing a prototype application, designing an interface, and determining how and which environmentally friendly efforts are appropriate for gamification. Before the project began, a timeline was developed to ensure a well flowing progress and compliance with deadlines and the requirements set by the case company Ericsson Nikola Tesla (ENT). The whole process of this project is documented meticulously to provide a deeper understanding of the subject and ensure that anyone can understand what is being done.

The requirements were well thought through to ensure the project's success. The first step involved thoroughly understanding the requirements being set by the case company. Online meetings with the supervisor from ENT provided a deeper understanding and insight into the company's expectations of this thesis. The

expected results include a functioning web application prototype showcasing how gamification can be used to promote sustainability in hotels, a comprehensive set of potential use cases, and further suggestions for potential implementation in a real-case scenario.

In order to fulfill the expectations of ENT, a detailed analysis was conducted on the existing use cases of gamification in the hospitality industry. This analysis helped identify the fundamental features necessary to develop a successful web application. The fundamental features discovered include a comprehensive point system and a dashboard that enables progress monitoring. The features mentioned were considered to ensure that users are interested in the web application. Naturally, the 'must have' features were being implemented while other features might be implemented later.

Regarding other features, the following subsection will discuss the identified and selected use cases for gamification.

4.2 Selection of Eco-Friendly Use Cases for Gamification

Considering the project's objective to promote environmental sustainability through gamification in hotels and the requirements set by the case company, several use cases have been formed to help with the issue. These use cases were developed based on studies and research discussed in the literature review.

The first use case focuses on water levels and aims to encourage guests to minimize water usage. By establishing a daily water usage benchmark, the system rewards guests with points when their consumption is below the set target.

Similarly, the use case for energy conservation works by establishing a daily energy benchmark and awarding points based on energy usage.

Transportation is a widely discussed topic because of its contributions to approximately 25% of worldwide carbon dioxide emissions [54]. Therefore, it was appropriate to include a sustainable transportation use case. The feature encourages guests to log their transportation choices in the web application, and the points are then rewarded for choosing eco-friendly transportation options.

Furthermore, hotel housekeeping is known to be harmful to the environment through measures such as water and energy consumption, waste generation, and the use of cleaning agents [55]. It was therefore logical to introduce an Eco-Friendly Housekeeping use case. Using a toggle in the web application, guests can choose not to have housekeeping services on a particular day. Every day that guests select to opt out of housekeeping services. Therefore, by reducing water, energy and chemical usage, they receive points.

The ultimate use case is recycling. The idea is to have marked recycling bins in guest rooms, common areas and other locations throughout the hotel. Each bin is equipped with a QR code specific to its type of recyclable material and a web application's feature allows guests to scan the QR code on the recycling bin after they dispose of their items, logging their recycling activity and awarding points to their account.

Points are used as a factor of motivation in the system. The point system is a significant indicator of a user's performance, offering constant feedback [56]. In the web application, when guests sign up, they join a sustainability program where eco-friendly actions earn them points. These points are rewarded based on how well guests meet environmental goals like the ones from the use cases. This approach aims to raise awareness among guests regarding their environmental impact and encourage self-motivation while providing feedback [57].

Each of these use cases address serious aspects of sustainability in today's world, and will hopefully contribute to a more rewarding and engaging guest experience while incorporating environmental responsibility.

4.3 User-centered Design Principles Implemented

User-centered designs are fundamental when it comes to websites and web applications. User-centered design (UCD) has appeared through human-computer interaction (HCI) and is an approach to software design that helps developers and designers create applications that satisfy user needs. The most common misunderstanding of user-centered design is the belief that it is all about the user interface of an application. However, even though the aesthetic aspect of an application is very important, user-centered design ensures that the web application is practical in achieving its purpose as well [58].

This project uses several important UCD concepts to guarantee the web application's effectiveness and user-friendliness. First and foremost, when developing the user interface prototype and, later, the web application, the most important thing to consider is the user's point of view. Therefore, researching about common issues users would have with user interfaces was essential. This action helped shape an idea of what should be considered to meet the needs of an average potential user.

When beginning, the user interface design process involved multiple stages of prototypes, comparing each with the usual feedback similar tools would receive. The final interface of the prototype was designed to be simplistic in all senses, use, and aesthetics. By employing a clean yet exciting and intuitive layout and clear and straightforward navigation, the web application ensures that users with even the most minor technical proficiency can easily use it.

During the phase of coming up with the look of the web application, Figma played a crucial role for the user interface design. Figma is a user interface design tool used to create designs for products such as mobile apps, websites, and other. At first it was used to develop simple wireframes to ensure that the case company likes the layout and functionality of the application. Consequently, detailed prototypes were being designed to further gain approval from the case company on the visuals of the web application.

Figure 4 below showcases the final version of the user interface design made in Figma. Specifically the homepage of the web application because that is the very first section that a user will see, therefore getting it to look and perform right was extremely important.

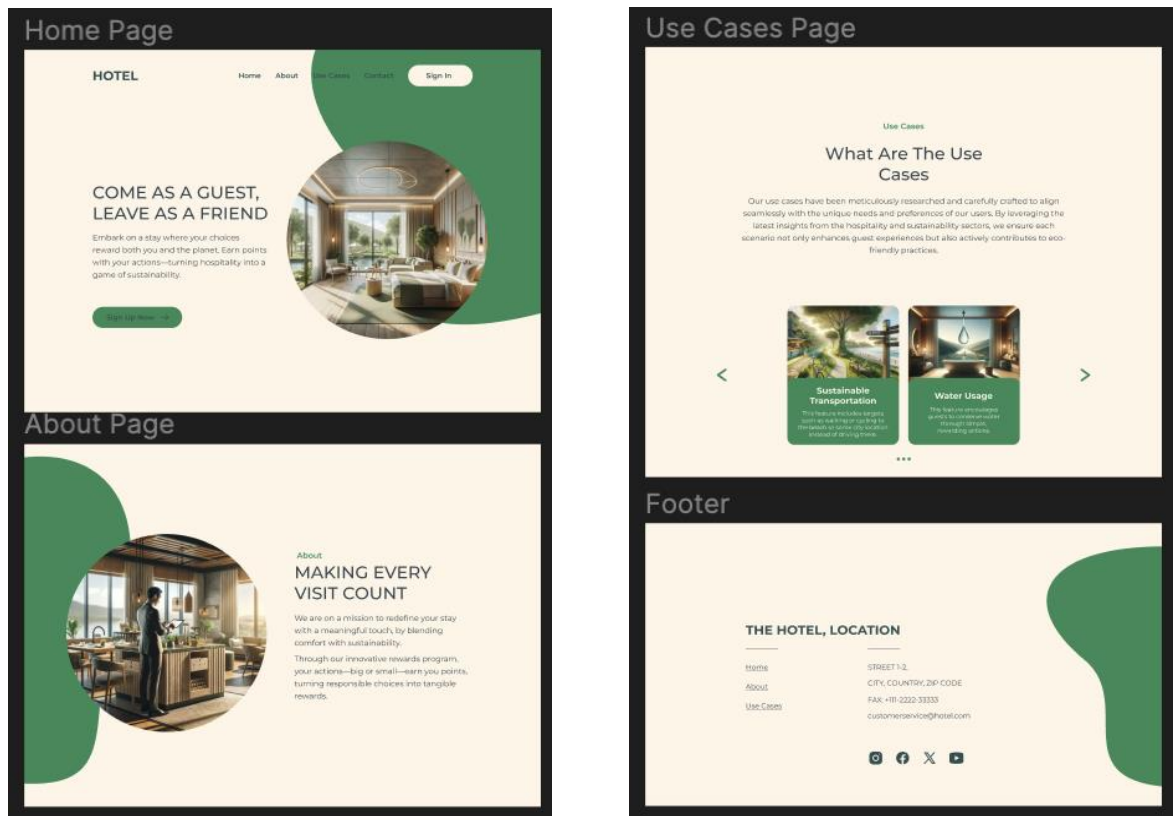


Figure 4. Final version of the landing page in the web application designed in Figma.

4.4 Technology Stack and Development Tools

Selecting the correct and most effective technology stack and development tools is mandatory to ensure the success of any web application. The chosen technology stack for this project was based on several factors. These included the ability to support a user-friendly, scalable, and robust application while

aligning with the principles of user-centered design—moreover, the stack needed to meet the specific requirements of gamification in promoting sustainability.

4.4.1 Frontend Technologies

HTML5 (HyperText Markup Language), CSS3 (Cascading Style Sheets), and React.js were chosen for the front-end technologies. HTML5 and CSS3 were used to structure and style the web application's front-end. Semantic elements in HTML5 enhance accessibility, and multiple programmers say it streamlines tasks, coordinates access to various devices and apps, and provides new and incredible capabilities [59]. CSS3 is a style sheet language that allows developers to correctly display and style HTML elements. The responsive and flexible design layouts in CSS3 enable a smooth user experience across various devices. Considering this information, the two were selected to develop the web application. React.js was selected as the JavaScript library for building the user interface of this web application. It aims to simplify the development process and promote a more comfortable user experience, and enables developers to make dynamic and responsive web pages.

Furthermore, its component-based architecture makes it perfect for creating user interfaces that render and update quickly. Multiple react packages were used to create this project. However, they will be discussed later on in the implementation section of the thesis. It is one of the most widely used JavaScript front-end frameworks at the moment, and considering all of the aspects, it was deemed perfect to use when developing the gamified web application [60].

4.4.2 Backend Technologies

The backend section of the application is everything that happens behind the curtains. However, it is an essential part of a well-functioning web application. It is responsible for keeping data stored in an organized way and ensuring that everything functions properly on the client's end [61]. Backend technologies were

chosen for this project based on their effectiveness and compatibility with the overall architecture.

Backed by Google, Firebase was selected as a backend platform because of its many features that help quickly develop and manage mobile and web applications. Firebase Authentication is one of the key features used in the web application. It ensures secure user authentication procedures and provides methods to create and manage users. Moreover, Firebase Authentication enables sending password reset emails [62]. Firebase's integration capabilities and ease of use make it an ideal platform for fast application development without compromising functionality and user experience.

The database used for this project is Firestore. Its real-time data synchronization capability makes it an ideal choice for applications that need instant updates and interactive features, which, in the case of this web application, is the points system for gamification. Furthermore, its flexibility in structuring data is also a key benefit for projects that require data changes based on user feedback or scalability needs [63].

Firestore works with Firebase to ensure that the website is safe and runs smoothly.

4.4.3 Development Tools

In order to meet the technical requirements of the web application and streamline the development process, the appropriate development tools for this project were chosen carefully.

During the project, three main tools were used: Figma, GitHub, and Visual Studio Code. Figma was particularly important in designing the front-end of the project. It was used to create detailed prototypes and wireframes which were presented to Ericsson Nikola Tesla. Furthermore, GitHub was essential for version control. It is a platform for developers to create, store, organize, and share code. In this

project it was the code's central repository, keeping track of every developmental change. Using GitHub led to a smoother coding and development experience, making sure that the project was well-organized and accessible for future reference. Ultimately, Visual Studio Code (VSCode) was chosen as the development environment. Its seamless integration with React.js and extensive support for web development languages like HTML, CSS, and JavaScript led to the decision. Visual Studio Code is very straightforward when it comes to use and offers developers flexibility. Therefore, selecting VSCode as the IDE offered a flexible and user-friendly platform for the development process.

5 Development and Implementation of the Web Application

As part of this thesis, a web application was developed to provide a prototype and showcase the functions of possible use cases in promoting sustainability within hotels for Ericsson Nikola Tesla. This section describes the development and implementation process of this project, including an overview of development stages, the integration of gamification elements, the refinement process, and the challenges encountered and solutions that were deployed to overcome them.

5.1 Overview of Development Stages

The development process of a web application can take a long time. However, once the process is divided into stages, it does not seem as daunting anymore by breaking the process down into smaller parts. In the case of this project, there are five critical stages to building the web application:

1. **Review of Requirements and Expectations:** This initial stage involves understanding the case company's needs and expected application outcomes.
2. **Project Planning and Wireframes:** This is where the project is planned in detail, and the initial wireframes are created to help visualize the application's structure.
3. **Web Application Design and Prototypes:** The focus shifts to designing the user interface and user experience at this stage.
4. **Web Application Development:** The actual application is fully developed during this stage.
5. **Testing and Refinements:** The final development stage involves trying out the application and implementing refinements where needed to ensure that it meets the initially set expectations.

These five stages help ensure a proactive and manageable approach to achieving project success.

5.2 Implementation of the Web Application

This web application proposes a sustainable approach for the hospitality industry through gamification. The project planning section of this thesis discusses the prioritization of the essential features while keeping in mind that additional features could be incorporated later. Thus, the following features and functionalities have been successfully implemented as of writing this document:

- Homepage. The very first implemented section. It consists of 4 sections that can be accessed by scrolling or using the navigation bar: the home page, an about page, a page about the use cases, and a footer page.
- Authentication system. It is essential to enable users to create accounts (sign up) and access them by signing in. Further, it is crucial to have a section where users can retrieve passwords in case of forgetting. Data security and protection are considered for all the data that users enter.
- Dashboard. Once logged in, users access the dashboard page with various features specifically developed with gamification principles in mind:
 - Progress bars track water and energy usage with a view of how much water and energy out of the set threshold has been used in watts and liters.
 - Toggle button that users can turn on when they want to have their room cleaned. By default, it is off, aiming to minimize water, energy, and chemical usage.
 - A section to select users' way of transportation for the day. Each choice (e.g., walk, cycle, public transport, etc.) is followed by checkboxes to make it easy for users to select their choices.
 - "Your Progress" section, where a graph is displayed to present the users' progress in adopting greener choices. It is a line graph with data points representing the points earned daily. Furthermore, on two sides of the graph, representations of "Today's Points" and "Overall Amount of Points."

- Sidebar. Considering that multiple pages follow the dashboard, a sidebar was implemented as a navigation method for users' comfort.
- Recycling page. On this page, the users are introduced to the Recycling Rewards Program. There is information on how the program works and what needs to be done to earn points. Furthermore, a "Start Scanning" button opens a pop-up window with the camera for users to scan the recycling QR codes. Once opened, the "Start Scanning" button turns into a "Stop Scanning" button that, when pressed, will close the camera window.
- Events page. This page offers an overview of the hotels' eco-friendly activities and events. It is currently a static page with made-up activities, as there is no access to an actual hotel that offers such activities. This can be enhanced into a schedule/blog page to update guests on available and new activities.
- Travel tips page. This page aims to inform users and is also static, offering sustainable travel tips to practice during the guests' stay.

As can be seen from the list of features and functionalities, essentially there are three main parts of the web application: Homepage, Authentication system, and Dashboard section.

5.3 Project Setup

The web application was initially being developed on macOS Monterey Version 12.2.1, however, later the development process migrated to a setup running the Windows 10 Pro operating system version 22H2.

5.3.1 Installation of Node.js

The first step of the development initiation was to install the necessary software program. The following software was installed:

Node.js - a runtime environment for JavaScript that is free, open-source, and cross-platform. Developers can use it to create servers, web apps, command line

tools, and scripts. Node Package Manager (npm) is an essential tool to handle JavaScript packages, and it comes along with Node.js. It can be downloaded directly from the Node.js website (<https://nodejs.org/en>).

It is worth noting that the current project has been developed using Node.js version v18.16.0 and npm version 9.5.1.

5.3.2 Creation of React Application

The technology stack and development tools section mentioned that the project was developed in Visual Studio Code using React.js. The subsequent step of the project was to create and initiate the React app. Listing 2 below shows the necessary console commands that must be run to create the react app.

```
npx create-react-app my-app  
cd my-app  
npm start
```

Listing 1. Console commands that need to be run in to create a project.

The first command, 'npx create-react-app my-app,' tells npm to use npx (a package runner tool that comes with npm 5.2+) to run the 'create-react-app' package. 'my-app' is the name of the project folder. The 'cd my-app' command moves into the project directory. Finally, the 'npm start' command starts the React development server and opens the app in a web browser, usually under the <http://localhost:3000> address.

5.3.3 Project Structure

When developing the web application, the project structure plays a big role in ensuring that the everything is organized and can be easily navigated through. Figure 5 below showcases the structure of the thesis React project – my-app.

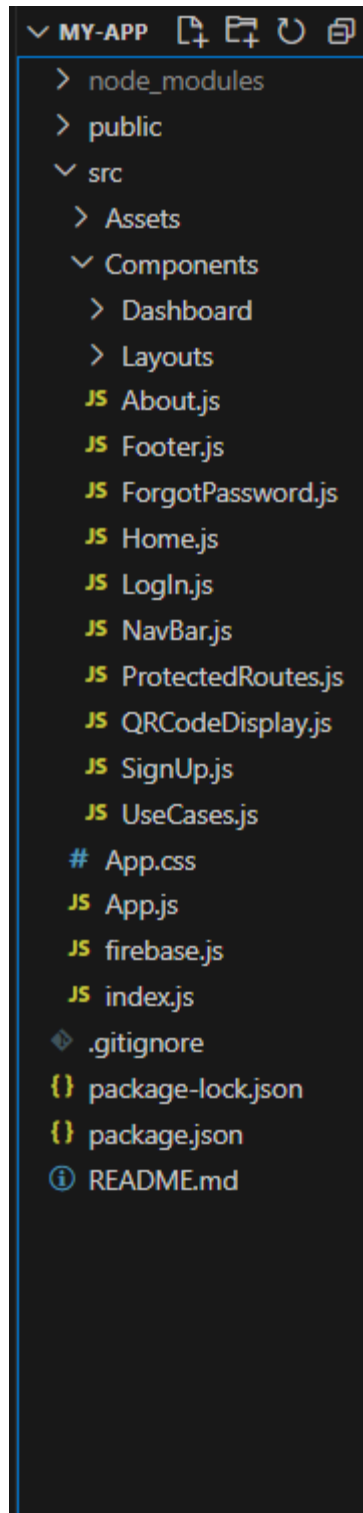


Figure 5. Project structure overview

As seen in Figure 5, the React application, is designed to keep things organized and manageable. It contains:

- The `node_modules` directory which holds all the Node.js packages that are installed for the project. When opened, there are multiple other folders that each contain its own code and `package.json` files.
- The `public` folder which hosts static files from the React application. In the case of a newly created project, this directory includes the `'index.html'` file – main HTML file for the app, and various icons and images provided by React.
- The `assets` folder where all the images used throughout the web application are stored.
- The `components` directory, dedicated to all the React components of the web application, it is further divided into two folders:
 - The `Dashboard` directory contains all the components dedicated to the Dashboard section of the web application.
 - The `layout` folder is dedicated to the layouts of the sidebar, dashboard, recycling page, events page, and travel tips page.
- Furthermore, the separate pages are also within the `components` directory:
 - The `About.js` file includes the About page component.
 - `Footer.js` contains the Footer component that is displayed at the bottom of the web application's homepage.
 - `ForgotPassword.js` is responsible for password recovery functionality and serves as a component for it.
 - `Home.js` represents the Home page component of the application.
 - `Login.js` includes the Login form component.
 - `NavBar.js` has the Navigation Bar component that provides links to navigate through different parts of the application.
 - `ProtectedRoutes.js` handles routing for authenticated users and ensures that certain routes are accessible only after logging in.
 - `QRCodeDisplay.js` is a component that generates and displays QR codes.
 - `SignUp.js` is the sign-up/register form component.
 - `UseCases.js` contains components and content related to the application's use cases.

- Additionally, the src folder contains:
 - The App.css file which is the main stylesheet for the entire web application.
 - The App.js file which is the root component and acts as the entry point for the application.
 - Firebase.js where Firebase services are configured and initialized, including authentication and database.
 - The index.js file which is used as the JavaScript entry point to render the React application to the DOM.
- A .gitignore file used by Git, a version control system, that specifies which files or directories to ignore and not keep track of.
- A package-lock.json file that ensures that the same versions of the installed packages are used on every machine running the project. The file is created automatically and should not be altered manually.
- A package.json file that contains essential information about the project and its dependencies, as well as lists the packages the project relies on and defines project properties and scripts.
- A README.md markdown file. It generally includes details about the project, such as instructions for installation, operation, and utilization of the application, as well as information regarding the app's objectives and capabilities.

This project structure divides the files based on their purpose, providing a clean looking working section.

5.3.4 Installation of Additional Packages and Components

The reasons to install additional packages and components within the web application are to guarantee consistency and quality as well as be efficient with time. Existing packages are well-tested and therefore can guarantee consistency and quality throughout the web application. Furthermore, using pre-built components can speed up the development process, considering that ready-made packages often provide a high level of optimization that can take a very

long time to achieve if trying to do it from scratch. Some of the additional packages and components that were installed for this project are listed below:

- Material UI (MUI) - is a popular React UI framework. `@mui/material` is the primary library of MUI. It provides a wide range of ready to use and high-quality components like buttons, cards, and more. `@emotion/react` is a library created to write CSS styles with JavaScript files and it is specifically made for React applications. `@emotion/styled` is another package from the Emotion library. It allows the creation of React components with attached styles.
- Material UI Icons - `@mui/icons-material` is a package that contains a collection of components (icons). Each icon is pre-made and can be imported to be used in a project.
- Chart.js - Chart.js is an open-source JavaScript library that can be used to visualize data. It supports eight different types of charts, including bar, line, area, pie, bubble, radar, polar, and scatter.
- Date-fns adapter for Chart.js - This acts as an adapter and allows the use of date-fns with Chart.js. date-fns offers an extensive yet simple set of tools for managing JavaScript dates in both Node.js and the browser.
- Firebase - Firebase SDK package files can be installed to the local machine to easily integrate Firebase services, such as Firebase Authentication for handling user authentication, Firebase Firestore for a NoSQL database, and more.
- Html5Qrcode - Html5Qrcode is a powerful collection of APIs to build the user interface without having to worry about camera configuration, managing authorizations, scanning codes, and more.
- Qrcode.react - Qrcode.react exports three components, supporting rendering as SVG or Canvas.
- React-chartjs-2 - React-chartjs-2 is a set of React components for Chart.js
- React-router-dom - This package contains bindings for using React Router in web applications.
- Styled-components - Styled-components is a React library that enables developers to create custom components while writing CSS in JavaScript.

5.4 Application of Packages and Components in the Development Process

This section will showcase how the most essential packages or components were utilized within the codes of the project and how they contribute to the features and functionalities of the web application.

5.4.1 Firebase Authentication

Managing user authentication in this web application is very important, and Firebase Authentication plays a crucial role. It is employed consistently on the pages and is responsible for user login (Login.js), registration (SignUp.js), and password recovery (ForgotPassword.js).

To start, the code snippet below represents the core configuration of Firebase.

```
import { initializeApp } from "firebase/app";
import { getAuth } from "firebase/auth";
import { getFirestore } from "firebase/firestore";

const firebaseConfig = {
  apiKey: "XXXXXXXXXXXX",
  authDomain: "thesis-aizh.firebaseio.com",
  projectId: "thesis-aizh",
  storageBucket: "thesis-aizh.appspot.com",
  messagingSenderId: "1234567890",
  appId: "X:XXXXXXX:XXXXXXXXXX",
  measurementId: "X-XXXXXXX "
};

const app = initializeApp(firebaseConfig);
export const auth = getAuth(app);
export const db = getFirestore(app);
```

Listing 2. The central configuration of firebase.js, used across the web application.

The firebase.js module is very important for web applications that want to use Firebase services. It simplifies the process of setting up Firebase features like Authentication and Firestore, making them easily accessible throughout the application.

The SignUp.js component helps new users sign up for an account. To sign up,

users need to provide their room number, email address, and password. The component uses React's `useState` hook to manage the form inputs and error messages. When the user submits the form, the `handleSignUp` function is executed. This function uses Firebase's `createUserWithEmailAndPassword` method to create the user account. After the account is created, the room number and email address are saved in Firestore using the `db` module's `setDoc` function. If there are any errors during this process, they will be displayed to the user straight away. Once the user has successfully registered, they will be redirected to the login page. This process is intended to improve the security of the application's authentication process.

The `Login.js` component of the web application allows users to log in by entering their email and password. To handle user inputs and any error messages that may occur during the login process, the code uses React's `useState` hook. When users press the login button, the `handleLogin` function runs. This function checks if the email and password that were entered, match the user's credentials. That is performed by using Firebase's `signInWithEmailAndPassword` method. If the authentication fails, an error message appears. However, if it is successful, users are redirected to the dashboard page using React Router's `useNavigate` hook. The interface of the login page has input fields for email and password, a login button, and an error message section. This makes the login experience simple and efficient.

The last component to use the Firebase Authentication system is the `ForgotPassword.js` component. It allows users to reset their passwords if they have forgotten them. This component uses React's `useState` to manage the email input and to track whether a password reset email has been sent. The main function used for resetting passwords is `handleResetPassword`. It uses Firebase's `sendPasswordResetEmail` method to send an email to the user's email address, allowing them to reset their password. Once the email is sent, the user is notified by message to confirm it. Any errors during the process are displayed

to the user. This setup ensures that users can securely attempt to reset their passwords and regain access to their accounts.

The figure below showcases the authentication page of the Firebase system. There are multiple testing accounts registered already.

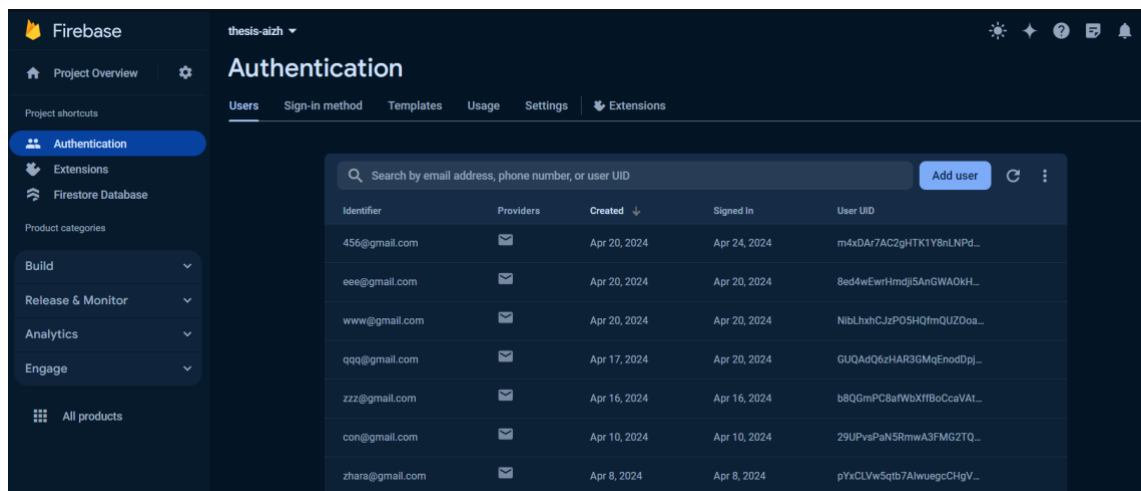


Figure 6. Firebase Authentication overview.

The dashboard, recycling, events and travel tips pages are all wrapped inside 'ProtectedRoutes' in order to ensure that they cannot be accessed without signing in.

5.4.2 QR Code Scanning

The Recycle.js component aims to suggest a way to run a recycling rewards program to hotels. Guests can scan QR codes on recycling bins and earn points for recycling. This feature uses Firebase services and the html5-qrcode library to process user interaction and real-time data. Figure 7 below offers a look at what the recycling page from the web application looks like.

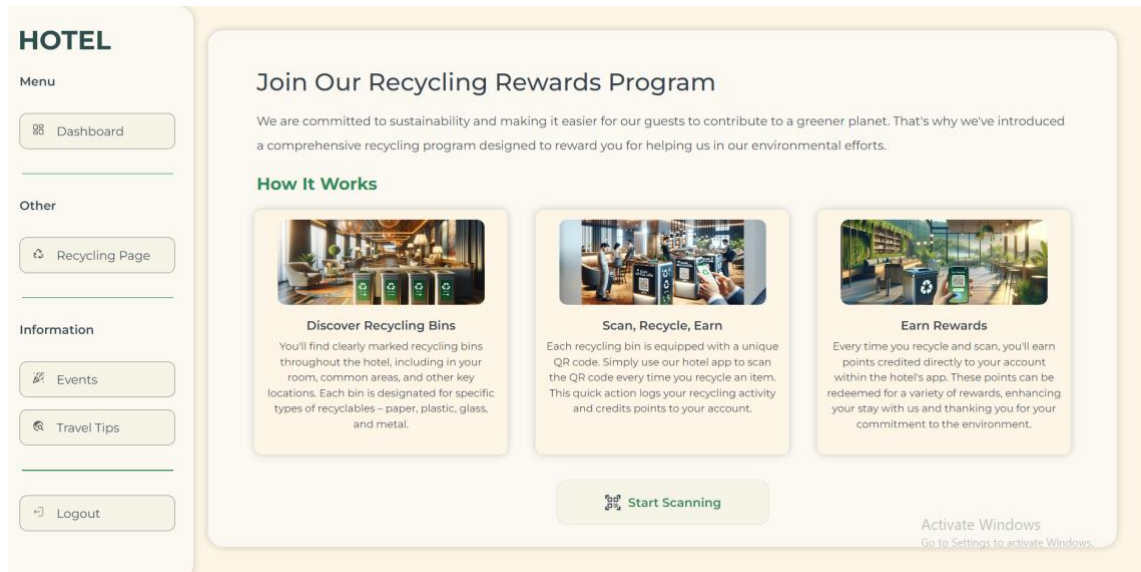


Figure 7. Recycling Page of web application.

The layout of the page is user-friendly and straightforward. There is a sidebar to the left with buttons to the dashboard, this page (recycling page), events, travel tips, and to logout and return to the homepage. The recycling program is explained in the following three sections, “Discover Recycling Bins”, “Scan, Recycle, Earn”, and “Earn Rewards”. Below the content is a button with the text “Start Scanning”, which when pressed, initiates the QR code scanning feature. The `Html5Qrcode` is used to handle the scanner, and the `isScanning` state determines whether to start or stop scanning. When a QR code is successfully scanned, the `handleScanSuccess` function is triggered. This function calculates the amount of points based on the materials that are being recycled and updates the user’s points in Firebase Firestore by using the `setDoc` and `increment` methods from Firestone’s API. When the “Start Scanning” button is pressed, it opens the camera and turn into a “Stop Scanning” button to close the scanner when done. This information represents what is happening in the code snippet below. The code snippet was taken from the ‘Recycle.js’ component in the web application.

```

import { useRef, useState } from "react";
import { Html5Qrcode } from 'html5-qrcode';
import { auth, db } from "../../firebase";
import { doc, setDoc, increment } from "firebase/firestore";

const Recycle = () => {
  const scannerRef = useRef(null);
  const [isScanning, setIsScanning] = useState(false);

  const handleScanSuccess = async qrCodeMessage => {
    if (!auth.currentUser) return; // Ensure user is authenticated
    const pointsToAdd = calculatePoints(qrCodeMessage);
    const userRef = doc(db, "users", auth.currentUser.uid);
    const pointsRef = doc(userRef, "PointsLog", new
Date().toISOString().split('T')[0]);

    await setDoc(pointsRef, { points: increment(pointsToAdd) }, { merge: true
});
    setIsScanning(false);
  };

  const startScanning = () => {
    const config = { fps: 10, qrbox: { width: 250, height: 250 } };
    scannerRef.current.start({ facingMode: "environment" }, config,
handleScanSuccess)
      .then(() => setIsScanning(true))
      .catch(err => console.error(`Error starting scanner: ${err}`));
  };

  return (
    <button onClick={isScanning ? () => scannerRef.current.stop() :
startScanning}>
      {isScanning ? 'Stop Scanning' : 'Start Scanning'}
    </button>
  );
};

export default Recycle;

```

Listing 3. Code snippet from 'Recycle.js' component, showcasing the QR code scanning process.

Figures 8 and 9 below offer a view of how the page looks before starting the scanning process and during it.

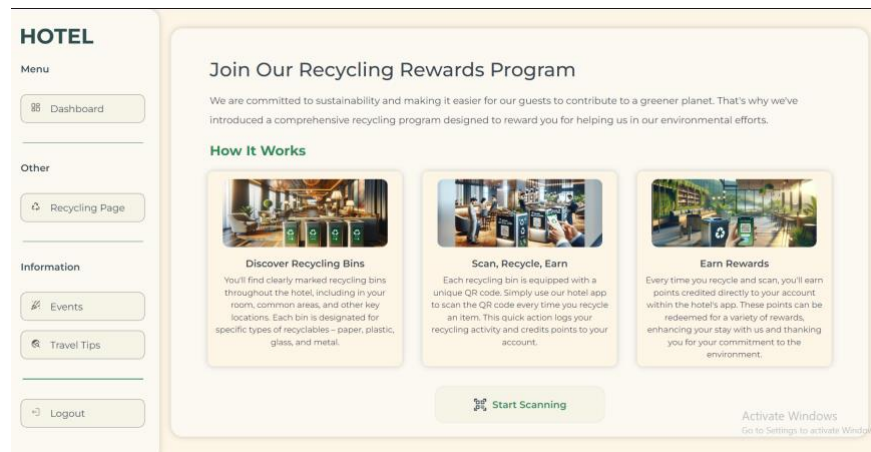


Figure 8. Display of the recycling program page before initiating the scanner.

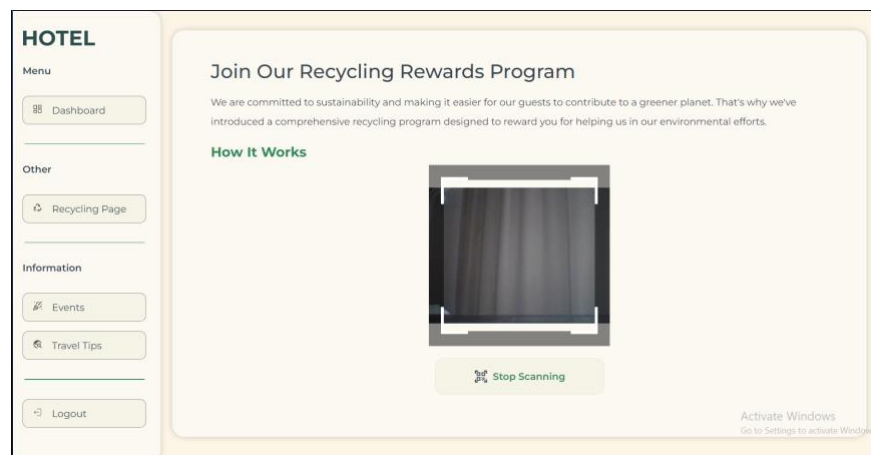


Figure 9. Display of the recycling page while the scanner program is running.

5.4.3 Dashboard Page

The dashboard page can be considered as the highlight of the web application. This is where a lot of gamification principles are implemented into various features. These gamified features mainly revolve around a points system.

The features implemented in the dashboard are:

- Energy Usage Progress Bar – This feature was implemented in the form of a progress bar to serve as a visual tool designed to encourage guests to reduce energy usage levels generated by them. The progress bar was implemented using the 'LinearProgress' component from Material-UI. The

feature has a threshold value (16,000 watts) that acts as the maximum number of watts that a guest can use and receive points. By using less than 50% of the threshold value, guests receive 10 points. When using more than 50% but less than 16,000W, guests receive 5 points. When guests go above the threshold value no points are awarded. The progress bar is dynamically updated based on the data that is being fetched from the Firebase Firestore.

- Water Usage Progress Bar – This is very similar to the energy usage monitoring feature, also using a progress bar to encourage guests to conserve water. The implementation process uses the same 'LinearProgress' component from Material-UI and with data being fetched in the same way. Just like in the energy usage feature, there is a threshold value (200 Litres). The same points allocation system applies to this progress bar as well.
- Room Cleaning Toggle Button – This feature was implemented in form of a toggle button that allows users to opt-in or out of daily room cleaning services. By opting out of the cleaning services, guests conserve water and cleaning chemicals use, choosing a sustainable action and therefore receiving 5 points. The feature was implemented with a 'Switch' component from React-Switch and whatever the choice is, the toggle button updates the user's choices in real-time to the backend Firebase system, therefore gaining or losing points.
- Transportation Mode Selector - Users can easily choose how they want to travel each day. They can pick from various options such as walking, cycling, or using eco-friendly vehicles, receiving 1 point for each choice. Each mode of transportation is represented by an icon and a checkbox, and once a user selects a mode, it updates their profile right away on Firebase. This affects their overall sustainability points.
- Line Chart - The chart feature provides instant feedback and keeps users informed about their sustainability efforts. Users can also see how their daily activities impact their overall progress by viewing how many points they have received during the day and in total. The chart was implemented using Chart.js with React through react-chartjs-2. This method of

implementation allows for dynamic updates and interactions within the React ecosystem. Daily points are stored in Firebase Firestore and can be viewed under each user's profile. The chart updates in real-time as users earn new points or when the data is edited.

Figure 10 below showcases what the dashboard looks like for an existing and active user account.

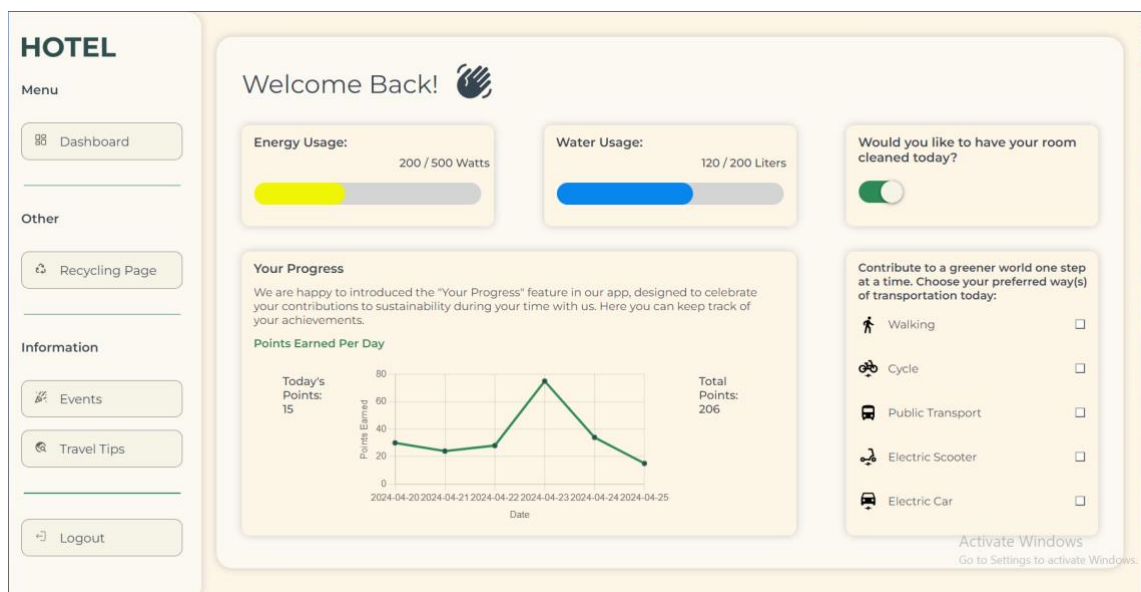


Figure 10. The dashboard page of an existing user account.

In the figure, the implemented features can be clearly seen.

5.5 Challenges Encountered

Although all these features currently work as they should, there were a lot of technical challenges during the development period, specifically the process of making sure that the updates were appearing in real-time, and the data was accurate. To make everything work to the best of its abilities, a combination of Firestore document snapshots and reactive state management in React were used.

When implementing Firebase Authentication, there was another major issue encountered. Keeping user data synchronized between Firebase and the client application has been challenging, especially after actions requiring authentication can result in discrepancies. The problem was later solved by connecting real-time listeners to user IDs and updating the user interface reactively whenever changes were made to the user data on the server.

Considering these challenges, it was necessary to perform some performance testing. The first test conducted was 'load testing' where multiple users were logging in at the same time to observe what effect this would have on the performance of the login process. This test did not have a noticeable effect on the performance. Furthermore, there was a test with the response timing of the chart. By continuously creating and updating data in Firestore, it was observed that the response time stayed consistent. Another test conducted was to test the user input validation. The main objective was to make sure that the signup form properly validates the user inputs according to pre-defined criteria. There were many validation rules being tested, such as:

1. Validating that the email address entered by the user contains the '@' symbol.
2. Verifying that the 'password' and 'confirm password' fields match.
3. Verifying that the account being created does not exist already.

These tests were crucial to ensure a user-friendly signup process, and the results were successful.

6 Results, Evaluation, and Future Work

As this research project comes to an end, it is important to summarize and expand on the results, what was learned from it and what was achieved. The result of this thesis is a fully functioning web application with various features and use cases of gamification used to promote sustainability in hotels. This is not a finished product, and its aim is to serve as a prototype to showcase how gamification principles can be implemented in such a case. Therefore, even though the web application is functional, more features can be added to enhance it.

The following snapshots offer a view of several parts of the web application.

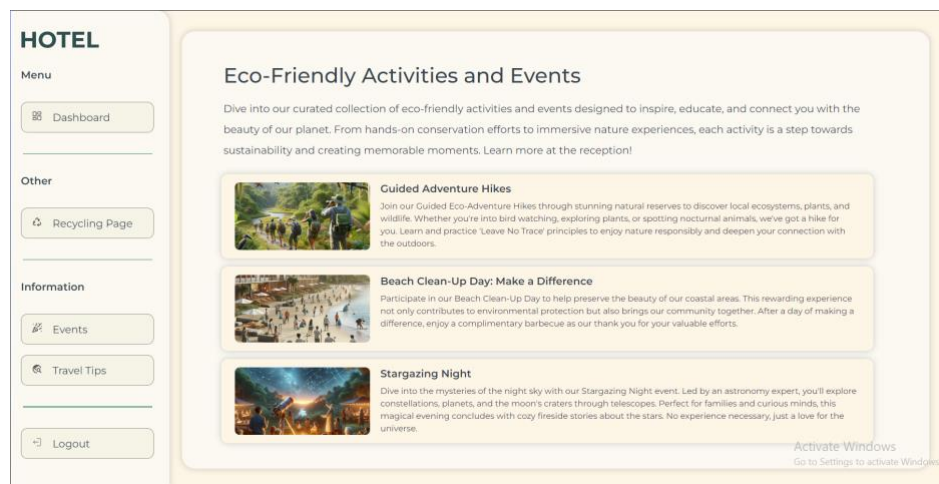


Figure 11. The events page of the web application.

This webpage provides a summary of the eco-friendly activities and events that hotels are offering. Currently, the page is static and contains made-up activities, given the lack of access to a real hotel that provides such activities.

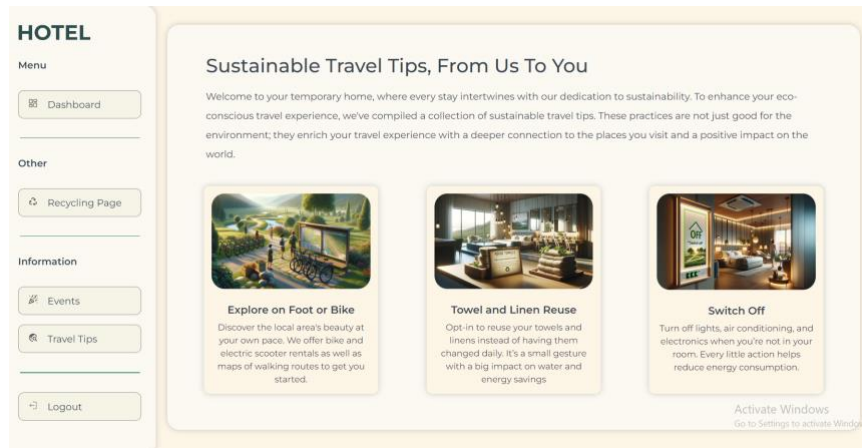


Figure 12. The page offering sustainable tips to guests.



Figure 13. The homepage of the web application.

Figure 12 shows the travel tips page which aims to suggest what actions guests can make to have a more sustainable stay. And finally, figure 13 offers an overview of the homepage of the web application, that welcomes users to join the rewards program. It consists of a 'home', 'about', 'use cases', and 'footer' sections.

The main objective of this thesis to discover how gamification can become the turning point in helping the hospitality industry become more sustainable was successfully reached. The web application was successfully created and can serve as a prototype model to showcase how gamification principles can be incorporated with sustainable practices.

The user interface of the web application was developed using a simplistic approach with a few interesting design features to capture the user's attention. The supervisor from the case company, Ericsson Nikola Tesla was given the initial design prototypes and only positive feedback was received. The web application itself was developed using React.js, JavaScript, Firebase, HTML, and CSS. The coding was separated into specific components to keep the code clean and manageable.

While the application was fully developed and is working as it should, it is not ideal. It has not been implemented and used in a real-world setting by actual users, and even though it has been tested during the development period, there is no way to directly evaluate its effectiveness in a practical context. However, there are suggestions for potential improvements and recommendations for future deployments. These include conducting a testing session with a small group of people who can use the application and provide some feedback. This would be beneficial as it would test the web application with different users and provide important feedback on user interface design, functionality, and the engagement levels of the developed gamification elements. Later, when deployed within an actual hotel, more use cases can be developed. As requested by the case company, a file with various potential use cases was created,

however due to time constraints and lack of real-world application, not all were included.

A suggestion for further enhancement of the sustainable transportation would be to reward guests who come in electric vehicles by either awarding them points upon confirmation of their vehicle or offering free charging times for their cars. Moreover, a reservation system for electric vehicles charging slots can be developed, allowing guests to book specific times for charging their vehicles. An alert system would be set up to notify guests when their charging session is complete, encouraging them to move their vehicle promptly. An overstay penalty must be introduced if someone leaves their car at the charging station beyond their allocated time.

Furthermore, a sustainable dining feature can be developed to promote a selection of dishes that are made with local, organic, or plant-based ingredients in the menu. When guests order these eco-friendly menu items, their choices are automatically tracked via the hotel's ordering system.

Moreover, a separate but similar system can be developed for the staff of the hotel to use. The use cases could be a program that would reward staff for walking, biking, carpooling, or using public transport instead of driving alone and they would be able to log their daily commute method in a similar way as guests. Furthermore, a program aimed at saving resources could be introduced where the hotel would need to figure out how much water, electricity, etc., each department is currently using and set goals like, "Use 10% less electricity this month" or "Reduce water usage by 5%." Then by implementing sensors and meters it will be possible keep track of how much each department is using. A same-way functioning recycling program can also be introduced with clearly labelled recycling bins for different materials being in staff areas. Additionally, training modules can be introduced with series of short and engaging modules/daily quizzes on topics such as energy conservation, waste reduction, and more. Staff members would be rewarded for each module completion with points or rewards like a gift cards.

Overall, the case company was satisfied with the suggested use cases and the prototype web application. In the future, they could use this prototype to develop a full-fledged web application in cooperation with a hotel.

7 Conclusion

Throughout this thesis, the impact of sustainability on the hospitality industry and the effectiveness of gamification in promoting sustainability were explored. According to numerous studies, many hotels are required to implement sustainable practices due to heightened awareness, government regulations, and customer demand. As further discovered, the most crucial thing for service-oriented businesses is to capture their customers' attention. This can be done by incorporating gamification into the hotel industry, which can motivate guests to stay engaged with the hotel's services [4, 45].

It was, therefore, decided to implement a web application that would present how these gamified elements can perform in hospitality. This approach has shown both promise and limitations. Although this web application was successful in theory and development, its practical effectiveness in a real-world situation still needs to be tested. This makes it hard to fully evaluate the overall impact of the application.

However, it is still clear that the web application does hold significant potential in promoting sustainable practices with gamification. This study's and the web application's aim to be an assertive foundation for further development and practical applications within hotels was hopefully achieved by driving technology integration and sustainability.

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