Game Development at Games 4 Life

By

Mridul Roy

Student ID: **1720263**

Spring, 2022

Supervisor:

Md. Ahasanul Haque

Lead Unity Game Developer

Department of Computer Science & Engineering

Independent University, Bangladesh

May 12, 2022

Dissertation submitted in partial fulfillment for the degree of Bachelor of Science in Computer Science

Department of Computer Science & Engineering

Independent University, Bangladesh

Attestation

This is to certify that this report is completed by me, Mridul Roy (1720263), submitted in partial fulfillment of the requirement for the degree of Computer Science and Engineering from Independent University, Bangladesh (IUB). It has been completed under the guidance of Md. Asif Bin Khaled (Supervisor). I also certify that all of my work is original which I have learned during my internship. All the sources of information used in this project and report.

Signature	Date

Write Your Name Here

Name

Acknowledgement

Firstly, I would like to thank God, for his grace in accomplishing my internship report timely. I would like to express my gratitude to the Faculty of Computer Science and Engineering department for keeping this course and to keep the students an opportunity to learn about the practical application of their studies. I would like to thank specially and heartily to my supervisor, Mr. Md. Asif Bin Khaled, Department of Computer Science and Engineering, Independent University, Bangladesh, who encouraged and directed me with his continuous guidance, invaluable instructions, stimulating suggestions and thoughtful advice during pursuing this internship and preparation of this report. I am also thankful to my supervisor Md. Ahsanul Haque from the core of my heart for his kind support, guidance, constructive, supervision, instructions and advice as well as for motivating me to do the internship smoothly at Games4Life. I feel proud and gratified that I was always held the under supervision of the Game Development team and got advice directly from my boss, Md. Redwan Alam Reyadh. Here, with daily reporting along with mental and professional support enhances my experience in the internship life. I am also indebted to the employees of the Game development team and also my colleagues who gave me immense support while working. Moreover, to prepare this report and other documentation regarding Internship Report and else I would show appreciation to all the members of Games4Life team, who always advised me and helped me through hands and pens. Moreover, I must mention the wonderful working environment and group commitment of this organization that has enabled me to deal with a lot of things.

Last but not the least, I would like to thank my parents and other family members for their eternal support given to me.

Letter of Transmittal

Md. Asif Bin Khaled
Lecturer
Department of Computer Science and Engineering
School of Engineering and Computer Science
Independent University, Bangladesh
Subject: Submission of Internship Report for the completion of Graduation.
Dear Sir,
I am submitting my Internship Report, which is a part of the Bachelor Program in Computer Science and Engineering curriculum. It is a great learning opportunity to work under your active supervision. This report is on, "Internship at Games 4 life". I have got the opportunity to work at Games4Life for four months, under the supervision of Md. Ahsanul Haque, Lead Unity Developer, Games4Life. This internship has given me both academic and practical exposures. The internship has given me the opportunity to develop a network with people of similar interests and has inspired me to learn more. I tried to make this report as much informative as possible with the experience I have gained during my internship period. In order to prepare a well-organized internship report, I have followed the guidelines and described the required fields with sufficient details. I sincerely believe that this report will serve the purpose of my internship program.
I would highly appreciate if you would be kind enough to receive this report and provide your valuable feedback. It would be my pleasure if you find this report useful and informative to have an apparent perspective on the issue.
Sincerely Yours,
Mridul Roy
ID- 1720263
Department of Computer Science and Engineering
Independent University, Bangladesh

Evaluation Committee

.....

Signature

.....

Name

.....

Supervisor

.....

Signature

.....

Name

.....

Internal Examiner

.....

Signature

.....

Name

.....

External Examiner

.....

Signature

.....

Name

.....

Convener

Abstract

Internship is defined as obtaining practical experience from various organizations, which helps in the formation of a connection between theoretical and practical knowledge. It is very important because it is the first time for a student to acquire a keen practical knowledge from the different organizations. When I was offered an internship at Games4Life, I got the chance to work and learn with developer team. My first project was a power wash simulator but I did not have much impact in the project. It was a learning experience. Later after a few small projects I was given a project in which I would have a significant impact in. This report covers the whole project that I learned about throughout my internship period.

I had to finish my learning sessions before working on any project, and in this learning session, I was allocated to develop small game mechanics such as camera work, asset generation and asset destruction. Different interface for different parts of the game. It was almost like a skill test before the actual project was assigned. I have detailed the information and experiences I have gained and the work I have done as an intern at Games4Life, in this report.

Later I started working on the game called Idle Light Tycoon Game where I would have a significant impact. In this project I managed some of the core mechanics of the game. A major requirement for this game was that player should be able to continue where they left off another important requirement was to provide a satisfying feeling to the player with the auto-collect system and the little characters walking around the screen.

Contents

List of Figures

List of Tables

Chapter 1

Introduction

1.1 Background of the Work

Being an intern, the main challenge was to translate the theoretical concepts into a working game. I started my Internship as a Junior Game developer at Games4Life in 1st December, 2021. Games4Life gave me the opportunity to work on a game named Idle Light City. It was to be a simulation game of the idle clicker genre. There are many idle genre games in the google and apple play store and it is one of the most popular genre of mobile games in the market. There are hundreds of thousands mobile games being released every year and for that reason there are not really unique games coming out at the moment and in our game ideation period we are required to play multiple popular games and figure out why they are popular and come up with new ideas based on that. Or we play multiple games that are popular in the market and merge their ideas to come up with a new one. The idea of the game was generated following a market research which revealed that the idle clicker genre is dominating at the time in google play store. We decided to look into popular works of the similar genre and we reached out to the publishers in need of guidance. Once the ideation process was done, we laid out the whole idea and I was assigned to the project where I would have a significant contribution.

1.2 Objectives

Project objectives are what we plan to achieve by the end of our project. Objective of a project is specific, measurable and must meet time, budget and most importantly meet the client's requirements. The client for our project was a renowned publisher named Azure games and they gave us certain requirements for the game like upgradability function and room to scale and visual improvements. Our obejective was to make sure that we bring in a large sum of customers and we could do that if we have low tech requirements to play the game. Not everyone runs a high end phone which is why we decided to optimize the

game to the point where it would run on a very low end phone. The reference games we played of idle clicker genre, those game use post processing and other visual mechanisms that slows down the phone. Therefore in our project our goal was to avoid all that and trick the user into thinking there is post-processing using textures.

1.3 Scopes

The game is already live on google play store and apple store and from the initial response data we noticed that the idea was well accepted and we analyzed why some players stopped playing and how long they were playing before quitting the game. From our analysis of the play time we determined that the idea will work in the market and we can expand the game with new updates and features. We will be working on the game again with two new themes and then launch them as an update or a standalone game in the future. We had some plans of expanding the existing game by fixing all bugs in the current version and expanding the playable area into new themes where the player would be able to travel once they are done unlocking and playing the current content.

Chapter 2

Literature Review

2.1 Relationship with Undergraduate Studies

Courses I have taken during my undergraduate have greatly helped me in game development. The courses have given me the fundamental knowledge in programming and completing the project would have been difficult if I had not done those courses. Some of those courses are- Introduction to programming was first when I learned about a programming language and this course taught me about the fundamentals of programming, It taught me how to handle multiple data types, loops, functions and how these are used in real life scenarios. Then I learned about Data Structures in CSE 203 where I was taught how to handle complex arrays, objects, classes,, nested loops and if statements etc. The skills I developed during that course has helped me immensely in developing my projects. In CSE 213-Object oriented programming I first learned about classes and its objects of programming. It also taught me how to write modular programs, which made codes less repetitive and more reusable. It was the first time in this course I used a GUI and wrote modular code. The practice has helped me organize and write scalable and reusable code during my projects. After that I took System Analysis and Design, CSE 307, where I was course introduced to the tools and techniques for the design and analysis of systems. It covered topics such as Systems and models, Project management, Tools for determining system requirements, data flow diagrams, decision table and decision trees, System analysis, system development life cycle models, object oriented analysis, Feasibility analysis, System prototyping. All these lessons helped me complete my projects.

2.2 Related works

There are other games similar to our project that already existed before ours and they have existed for a longer time. However, they were published by the same publishers that

gave us the requirements for our game. There are also other idle clicker games in the market that have similar features to ours.

There is another game named Idle Light and it is of the same genre and idea. Their game was published by the same publishers as ours and that is why both games are almost identical in gameplay. We also looked into some popular names in the idle clicker genre to get more idea of the playstyle and the mechanics of the games, like AFK Arena, Idle Miner Tycoon, Penguin Isle etc. Most of these games had one thing in common is that considering their audience spends a small portion of their time playing these, they will be rewarded with large sums of points/coins to keep the player interested and coming back. This method works as they also give the players option to buy things in-game using those points or coins. We decided to implement the same mechanic in our game, so that when a player comes back to the game after some time, they will be rewarded with huge sums of in-game currency. It lures the player into logging back in and check out how much they have made.

Chapter 3

Project Management & Financing

3.1 Work Breakdown Structure

Work Breakdown Structure (WBS) is a hierarchical structure which demonstrates a project's breakdown into smaller segments. For our project, we have produced a WBS so that we have better team coordination. WBS covers a visual of all the scopes, risks, points of communication, responsibilities, costs and guarantees that it does not skip essential deliverable. For brainstorming and collaboration, it is the ideal tool for the team. In our WBS, we have used the top-down approach.

3.2 Activity wise Time Distribution

The estimated time required to end a project successfully defines process wise time distribution. This helps the developers create a mind map as to how efficiently they need to work in order to meet the deadlines. The most significant challenge in correctly designing an application is time and time management. So, first and foremost, the content must be fixed, and development must be based on this context. The technique of planning and regulating how much time to spend on various tasks is known as time management. Good time management allows an individual to do more in less time, reduces stress, and leads to professional success. Time distribution is greatly needed to complete any project.

3.3 Gantt Chart

I am providing a Gantt chart here to show the timeline of my project dividing it into different aspects of the work throughout the 6 weeks of our project. Most of the time was consumed for the design and development process of development. As shown in the figure-

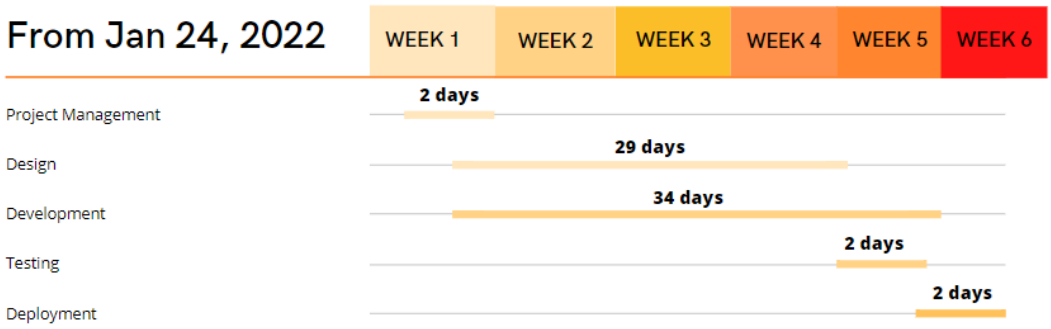

Figure 3.1: Gantt Chart

3.4 Activity wise Resource Allocation

Resource allocation is the process of assigning assets in a manner that supports your team's goals. For this project, the developers are considered as the primary resource followed by the computers used in the office, the servers required for the deployment of the project. Every employee of the company is considered a resource, hence everyone has assigned a particular assignment with certain deadlines, all of which collaborated to the entire production of the project.

• Project Management: This is the first period of the project, where the idea of the project was presented by the CEO of the company. During the first 2 days of the development process, the developers and the CEO engage in hours of discussion of how this project should be built from top to bottom, the approaches to be taken, creating smaller goals and setting deadlines for them and discussed the entire requirements for the completion of the project.

• Design: In this phase the game designers implement the level in their 3D software and design the levels as per the game idea and as per the required mechanics. UI/UX designers were work on the on screen buttons and animations, banners and icon for the store.

• Development/Coding: At this stage, the designs for the games are com- plete and developers started working on writing the scripts of the game, while the management team kept regulating whether all the deadlines were maintained. The whole process is going for 34 days.

• Testing: Testing starts once all the main mechanics of the game are implemented. The game is then exported as an .apk file for android users first to test on their mobile devices and look for bugs or unusual events. Once the bugs are identified by the game testers we then try to recreate the bug in Unity and solve the issue.

• Deployment: We had to extend the deadline to make sure we get the time to remove the major bugs that were faced in testing. After the extension, Once all the major bugs

Table 3.1: Resource Allocation Chart

Activity Wise Resource Allocation		
Activity	Days	Work Percentage
Project Management	2	5%
Design (Parallel with coding)	29	72.5%
Development/Coding	34	85%
Testing	2	5%
Deployment	2	5%
Total	40	100% (Design work was done parallelly with coding)

were fixed we place ads in the game for monetization and prepare the apk file for android play store. Once it is reviewed by google, the game was live in play store.

3.5 Estimated Costing

The cost was calculated on the basis of the features demanded in the Game. It depends on the size, requirements, functionalities and design of the game. This includes pre-designed assets from the unity store, logo design cost, Banner design cost, and many other tools that were used in this game. The cost of developer and resources used were also taken into account. The estimated costs was Tk 1,20,800 (BDT) for the whole project.

Table 3.2: Estimated costing

Featrures	Unit	Cost (bdt)
Rendering Cost	1	2800
Internet Bills	2	4000
Unity Asset Store	2	4000
Senior Developer	1	60,000
Game Designer	1	30,000
UI/UX Designer	1	20,000
Total		1,20,800

Chapter 4

Methodology

The problem that we tackled during our projects is ANR (App Not Responding), Crashes, Compatibility and laggy gameplay on low-end devices and we have succeeded to make a smooth experience for the user. For our projects we used multiple tools such as Unity Engine, Blender, Marmoset, Meshlab, VSCode, Substance Designer, Zbrush, Marvelous Designer, Mixamo, ShoeBox. Firstly we decide the genre, art style, reference and mechanics of the game. Then we decide the gameplay hours, which is to increase retention of the game, which is a measure of how many people are still playing the game after a certain period of time from their first login date. Then we made a GDD which is a Game Design Document. It is a description for the video game that is about to start. It helps to organize the efforts within a development team. Prototyping. At this stage we do not use proper visuals. Box models are used in unity to script the base mechanics of the game such as Player movement, Camera work, setting up collider positions etc. and concept artist is given an overview of what the game will look like. Meanwhile the Level Designer designs assets and then uses the concept art to set up the whole scene. Programmers and Designers then work together on the scene to optimize it and make the scene presentable in Unity. Then we attach the already written scripts to the new Game objects given by the designers and write the remaining ones for the newer models. Once the mechanics are all implemented, Google ads are placed on the game for monetization and then uploaded to Google Play Store for android first. Then we export it for IOS devices in the app market.

Chapter 5

Body of the Project

5.1 Work Description

I have worked on multiple games after joining the company last year and Idle Light Tycoon game was one my biggest project yet. The plan for this game was established in February. I was in charge of making a GDD, which is a Game Design Document. It includes market analysis, core mechanics and requirements of the game. My project manager and supervisor helped me through the process. This game is of the idle clicker genre where the market is people who want to casually play a game for 5-10 minutes and then go about their business and come back later to continue. The core mechanic of our game was that the player is given a certain amount of currency in the beginning and they have a dark city with almost no buildings in the area. The player can then buy animated light bulbs that come out of a structure in the middle of the city area and then it walks to the unlit building and lights the building which then shines brighter and lights the area around it as well. Each building has a UI plane on top of them, which shows a limit. The limit indicates how many light bulb it needs to be completely lit. Once that limit is reached, the light bulbs do not walk to that building anymore. There are roads laid out in the whole scene and a path has been set for the AI to follow according to the road. There scene consists of four blocks, A, B, C, D. The player continues to buy light bulbs until the building is completely lit. The fully lit building then provides the player with more currency and continues to do that periodically. With that currency, the player can then unlock other buildings in the area and buy light bulbs to light the new building. As the player continues to buy newer buildings, the price of the buildings later on keeps getting higher and to manage currency for that, the player needs to upgrade the buildings that they have already lit using light bulbs. Upgrading the buildings require currency as well. After upgrading a building, the amount the building produces periodically is increased and the interval of money generation is decreased as well. While the player progresses through the first block, A, they are given another option after a few building

upgrades, that is auto-collection of currency. The player can purchase this upgrade for certain buildings after they have upgraded that building a certain number of times. This mechanic is what actually puts the game in the idle clicker genre. The player then continues to unlock buildings through Block-A and whilst doing this the other blocks in the city are locked off or just dark to the player and they cannot buy anything there unless first block is cleared. There are hundreds of upgrades available for each building in each block and with visual upgrades for each building at certain levels such as 25, 50, 100 etc. The number varies for different buildings. Once All the buildings are upgraded the player can then move on the next area. In the next blocks the currency required for buying the building is increased progressively and the light bulbs required to light it completely is increased. As the required light bulbs are to increase, we have included a feature that the player can enable auto-buy bulbs. This way, when the player logs back in the game they should be able to see that the amount of currency has increased and any buildings that were not lit before have been lit, given the logout time.

5.2 Requirement Analysis

Rich Picture

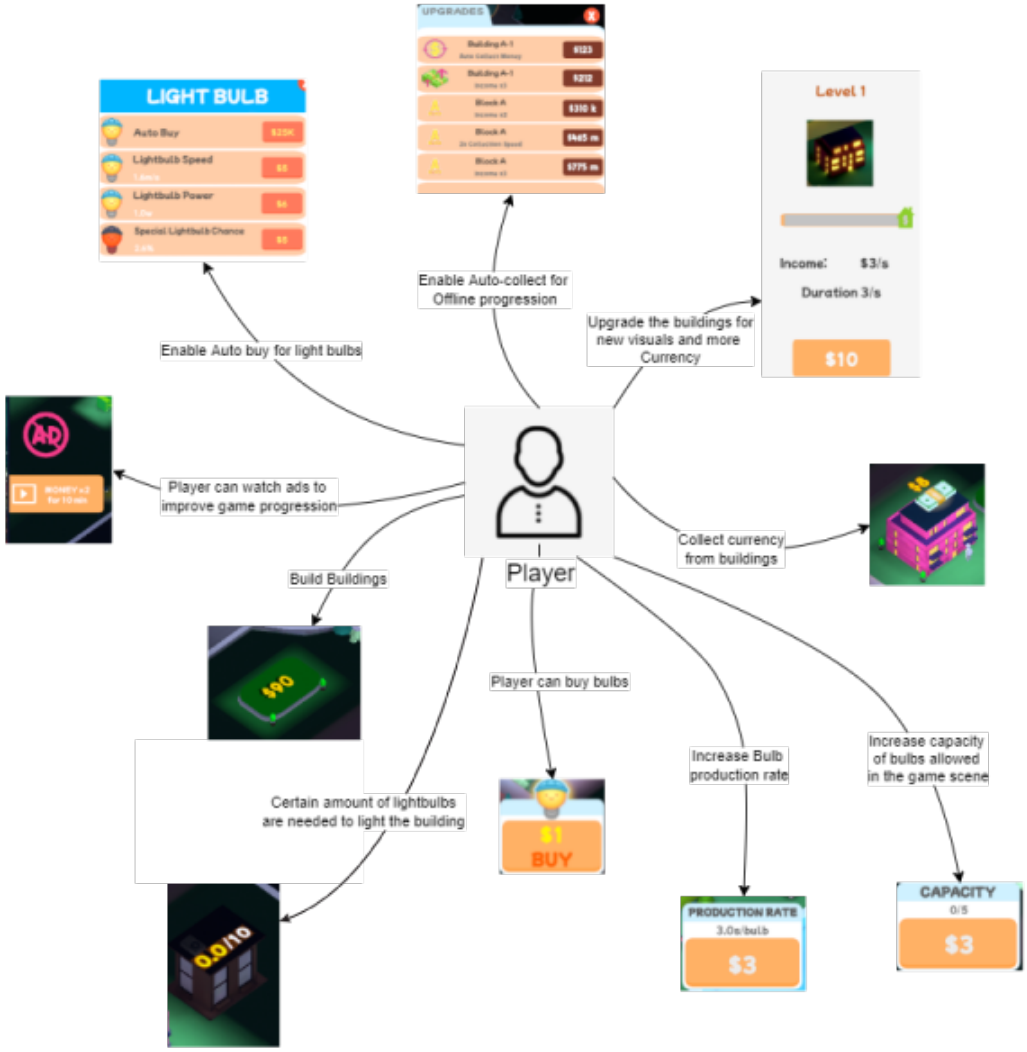

Figure 5.1: Rich Picture

Functional and Non-Functional Requirements

Table 5.1: Functional Requirements

Function: Login		
Input: Username/Password	Process: Google Play Services	Output: User Saved
Precondition: Must have internet connection		
Postcondition: Login is confirmed and player is taken to main menu of the game		

Table 5.2: Functional Requirements

Function: Buy Building		
Input: Press Buy Button UI	Process: Touch Sensitivity	Output: Required currency is used up
Precondition: Must have enough currency		
Postcondition: Instantiates a building in the designated place		

Table 5.3: Functional Requirements

Function: Buy Lightbulbs		
Input: Buy bulbs button UI	Process: Touch sensitivity	Output: Required currecy is used up
Precondition: Must have enough currency and must have enough capacity.		
Postcondition: A light bulb character is spawned in the scene.		

Table 5.4: Functional Requirements

Function: Upgrade Building		
Input: Touch press on Upgrade UI	Process: Touch sensitivity	Output: Building produces more currency and faster
Precondition: Must have enough currency.		
Postcondition: New Visual and building produces more money more frequently.		

Table 5.5: Functional Requirements

Function: Increase bulb production rate		
Input: Touch button UI	Process: Touch sensitivity	Output: Production rate upgrade charge increased
Precondition: Must have enough currency.		
Postcondition: Bulb generation interval time reduced.		

Table 5.6: Functional Requirements

Function: Auto buy bulbs		
Input: Touch button UI	Process: Press Upgrade Button UI	Output: Manual Buy button no longer needed
Precondition: Must have enough currency and need to press buy everytime		
Postcondition: Bulbs will be automatically bought unless the limit is reached.		

Table 5.7: Functional Requirements

Function: Auto collect money		
Input: Touch button UI	Process: Touch sensitivity	Output: No need to click on Money asset again
Precondition: Must have enough currency to unlock feature		
Postcondition: Money is automatically incremented to total currency		

Table 5.8: Functional Requirements

Function: Watch Ad to double money		
Input: Touch button UI	Process: Touch sensitivity	Output: Video ad pops up
Precondition: Ads must be available		
Postcondition: Money is automatically doubled for a certain period of time		

Non-Functional Requirements:

Performance and Scalability: The performance of this game was hard to optimize as the game has a lot of elements on screen at the same time. One of the biggest issue was to make sure it works smoothly when the game is played for a longer period of time. As the game progresses and player approaches the automation upgrades, there are a lot of character moving around the screen and a bunch of buildings as well. The game also has a lot to do with lights and for optimization reason we could not use post-processing effects in unity as that would lag in low-end devices. For scalability we have made sure that the game is expandable where the player will move to new areas with new visuals and more tasks and different theme.

Portability and Compatibility: The game is available in mobile devices on both android and IOS and as for compatibility, we have made it available for android 4.4 and above which is pretty low considering the current versions of android. Reliability,

Availability and Maintainability: We are always trying to make sure that our code is broken into as many components as possible and remove all cases of repeated code. This way we can edit without breaking the entire game. We also have a single source of truth so if we want to make a change that should affect multiple components, we can do it easily without creating any unforeseeable bugs.

Usability: We made sure the player knows what to do and how to do using UI tutorials at the beginning of the game. We make sure that the instructions are clear and buttons are easily visible.

5.3 System Analysis

5.3.1 Six Element Analysis

Process	System Roles				
	Human	Computing Hardware	Software	Database	Comm. & Networks
Main Menu	Player	Smart Phone	Android/IOS	.bin file	WAN
Login/Signup	Player	Smart Phone	Android/IOS	.bin file	WAN
Buy Building	Player	Smart Phone	Android/IOS	.bin file	WAN
Buy bulbs	Player	Smart Phone	Android/IOS	.bin file	WAN
Upgrade bulbs	Player	Smart Phone	Android/IOS	.bin file	WAN
Increase Production rate	Player	Smart Phone	Android/IOS	.bin file	WAN
Upgrade Building	Player	Smart Phone	Android/IOS	.bin file	WAN
Auto-collect money	NULL	Smart Phone	Android/IOS	.bin file	WAN
Auto-buy bulbs	NULL	Smart Phone	Android/IOS	.bin file	WAN
Unlock blocks	Player	Smart Phone	Android/IOS	.bin file	WAN
Increase special bulb production rate	Player	Smart Phone	Android/IOS	.bin file	WAN
Upgrade Visuals	Player	Smart Phone	Android/IOS	.bin file	WAN
Increase Light bulb speed	Player	Smart Phone	Android/IOS	.bin file	WAN
Increase Light bulb power	Player	Smart Phone	Android/IOS	.bin file	WAN
Remove ads	Player	Smart Phone	Android/IOS	.bin file	WAN

Figure 5.2: Six-Element Analysis

5.3.2 Feasibility Analysis

A game feasibility study is a formal project proposal used to secure internal or external funding and resources for a game development project. It is designed to assess the business and technical issues of the project. If the game seems feasible then is goes into development or it is cancelled. There are a few steps to check feasibility of a game. Market Analysis: For the marketing research we tend to 1st verify the target market. The target market is outlined by the genre and also the platform, problems that are already self-addressed within the construct document. we are able to qualify this definition by mentioning specific titles that typify the market. the foremost sure-fire of those titles can

indicate the viability and size of the market. conjointly mention the everyday age vary, gender and the other key characteristics. If this game involves a accredited property or may be a sequel. we tend to conjointly verify the highest performers within the market. Their sales numbers and reviews. we tend to conjointly verify details of World Health Organization developed and printed the sport. Then we tend to compare options and analyses the point of the sport. Technical Analysis: For the technical analysis we tend to analyse the core mechanics of the sport and determine the experimental options, like untried or unproved technologies, techniques, views, or different distinctive concepts. embrace Associate in Nursing estimate of the time that it'll fancy bring the experimental feature to Associate in Nursing analysis state, moreover as Associate in Nursing overall time estimate for finishing the feature. Experimental areas typically want longer within the schedule, that the additional experimental options we tend to list, the longer the schedule are. we tend to conjointly hunt for alternatives, if any, for the risky options and major development tasks. for each development task we tend to write out the execs and cons for it. Legal Analysis: In our legal analysis, before we tend to prepare a GDD, we tend to analyze if the sport involves any copyrights, trademarks, licensing agreements, or alternative contracts that might incur some fees, legal proceeding prices, acknowledgement, or restrictions.

5.3.3 Problem Solution Analysis

During the implementation of the project many issues occurred. There were a bunch of bugs at first and recreating a bug is a bigger issue. If recreating the bug takes time then the process is dragged and it takes longer.

Identification: Giving the game to testers who will record their whole gameplay up to the point of the encounter of the bug and send over the recording for fixing.

Requirements that are affected: We review the video and check if the reported bug is game breaking or it disrupts the players' experience.

Solution: We then recreate the bug step by step and get to the reason of the occurrence and implement a fix.

Test: We then send it back to testers with the new patch applied and they test the game again to look for more bugs.

5.3.4 Effect and Constraints Analysis

Effect: Mobile phones of different variety being available in the market makes things very difficult as we have to make sure we gather the largest customer base for the game. As per data, very few people use the highest end devices to play mobile games. So, for our game we decided to target the mid and low range device users and optimize better

for them to broaden the customer reach and make sure the player gets a smooth and seamless experience.

Constraint: This game was not published by an external publisher. This is an in-house project and company resources were used in production to implement it without any guarantee of monetary returns.

5.4 System Design

UML Diagrams

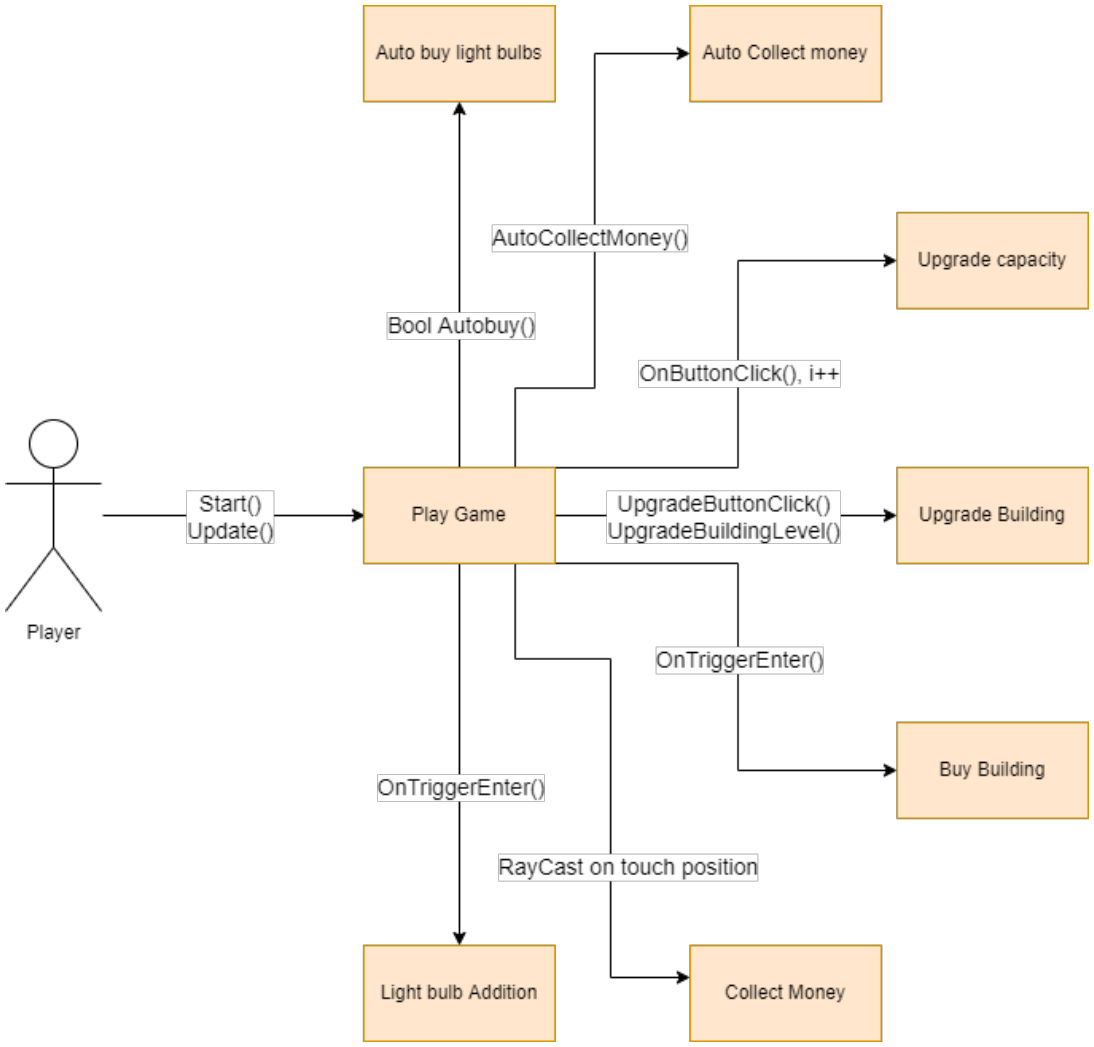

Figure 5.3: UML Diagram

Architecture

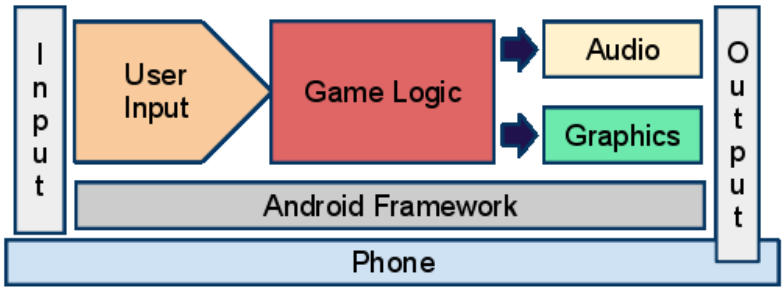

Figure 5.4: Game Architecture

To discuss more in details, This is the general architecture for our game. The users' input is mostly through their phones screens and as per the game logic, we mostly check where the touch input takes place. There are bunch of UI planes on the game scene and if the player were to trigger it the action will take place behind the scene with also a visual update for the player. With every tap, there is something happening on the screen and with that there are other feedbacks as well such as audio and haptic feedback to keep the player interested. Our game is firstly available for android devices and soon it is to be available to IOS as well.

Chapter 6

Results & Analysis

The game "Idle light tycoon game", was released after 5 weeks of development. The market already had a similar game with similar mechanism which caused some issues. As the overall design and UI is different the game passed the review phase in Google Play Store. Once the game passed the review, we looked forward to the first day retention which is basically the percentage of people that play and keep the game rather than uninstalling it. Also the reviews of the users on the first day matter a lot. Firstly the game link is shared with experienced testers who give their opinion and apply their market research on our game and give their feedback and report bugs if they find any. The user reviews are also given priority as we get to fix the game as soon as possible and update it on the store in a day or two. Next is crashes and ANR which is the "App Not Responding" issue. If any of our users were to struggle playing the game on their device it could possibly be and issue with their device configurations or with the game files. So Google prompts the user if they want to send their information over to the developers so the developers can check the issue and figure out a solution. As for our game, I have provided a graph for that below. For market analysis, Google also provides us with data showing where most of our players reside in the world and how many of them are playing regularly.

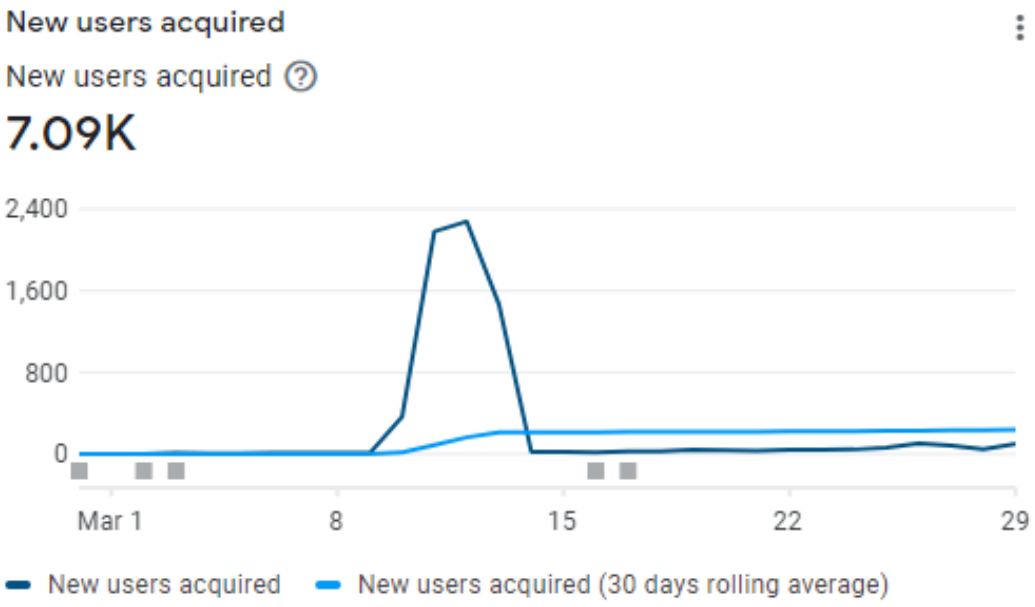

Figure 6.1: New users acquired

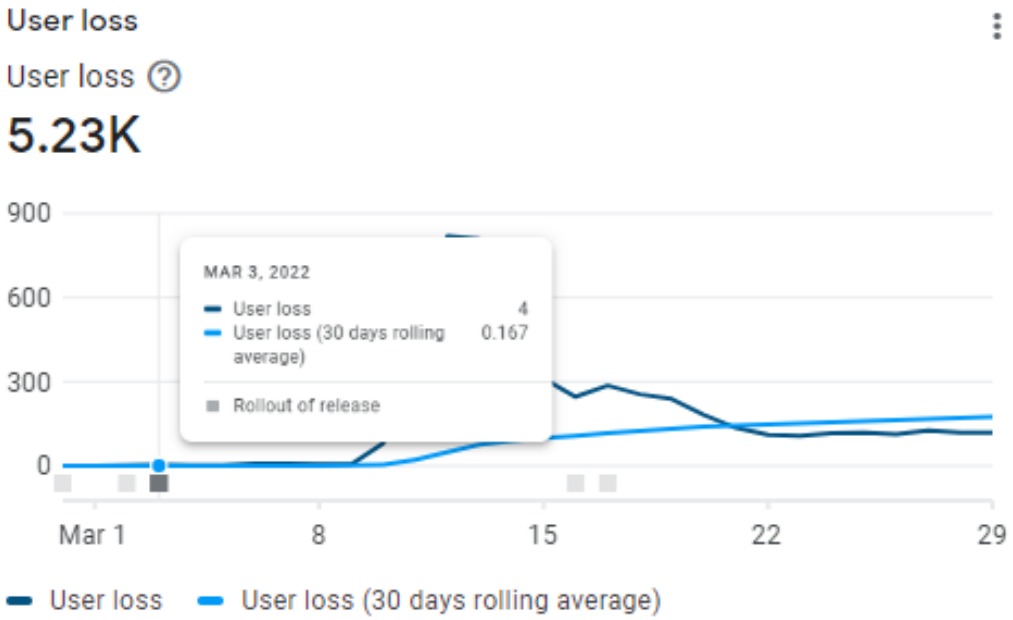

Figure 6.2: Users lost

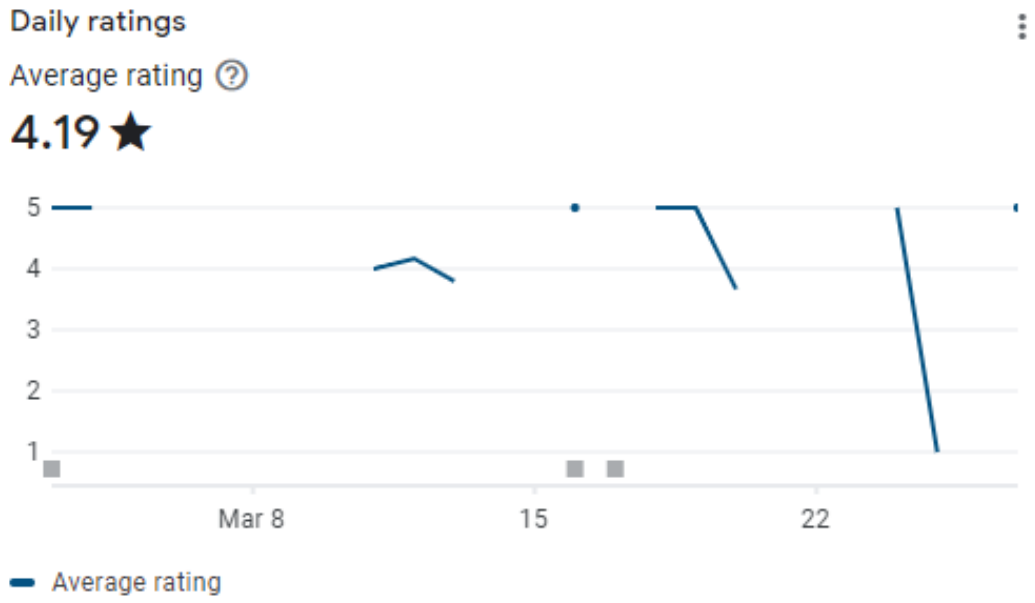

Figure 6.3: Daily Ratings

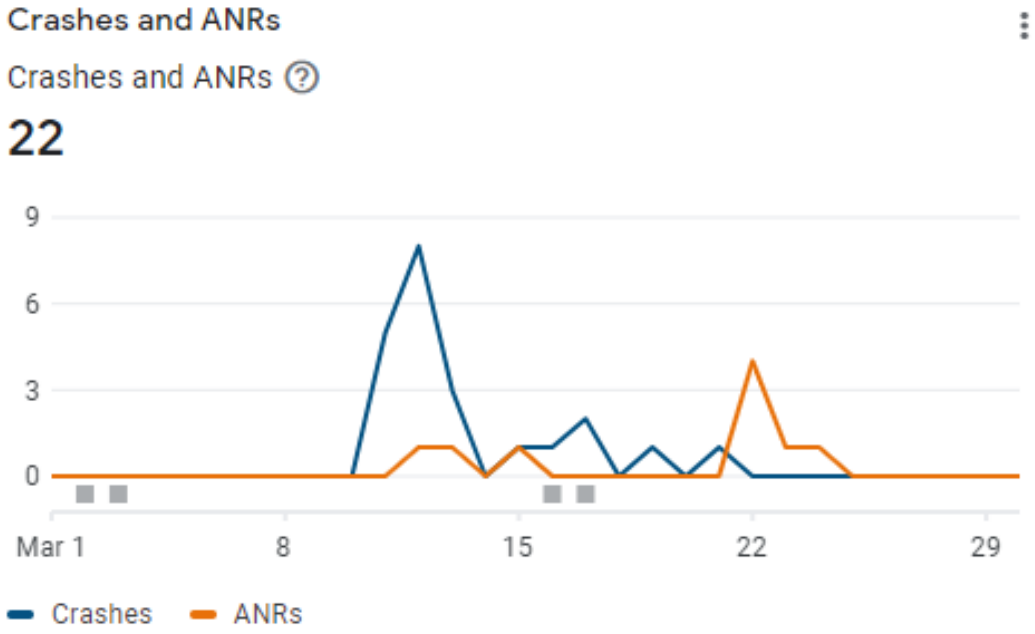

Figure 6.4: Crashes and ANRs

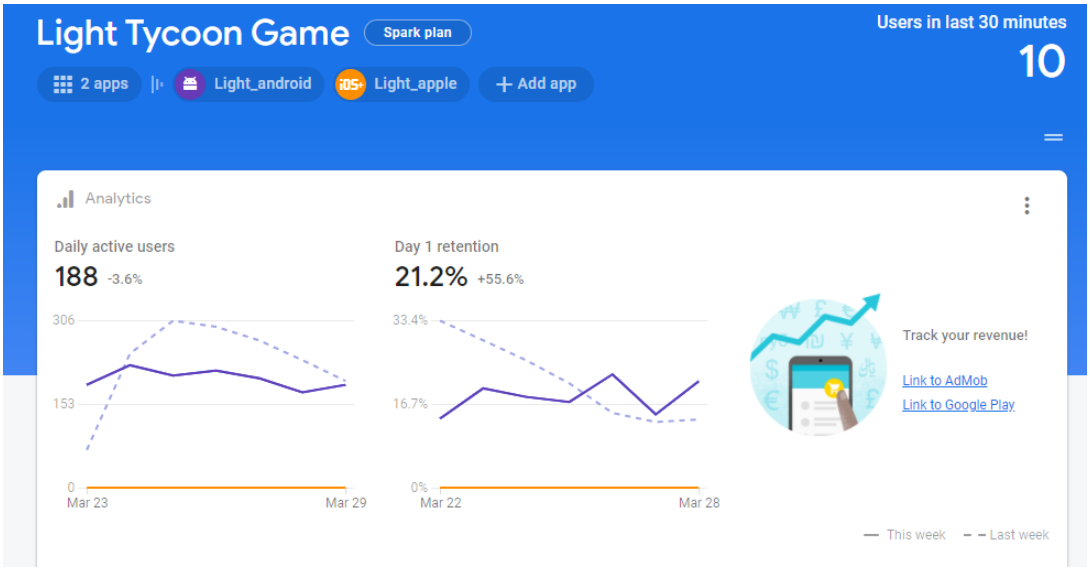

Figure 6.5: Game Overview

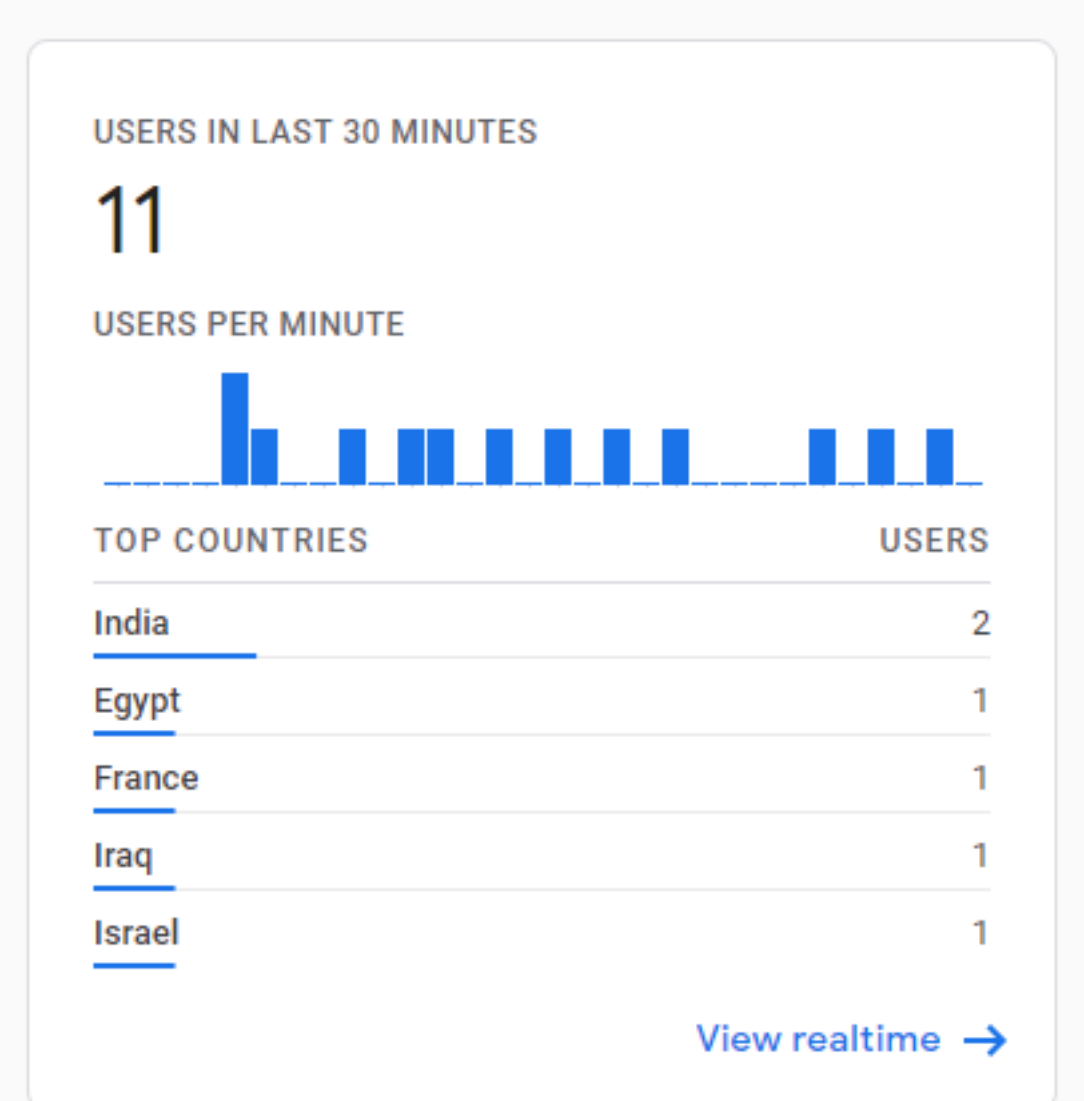

Figure 6.6: Users in last 30 minutes

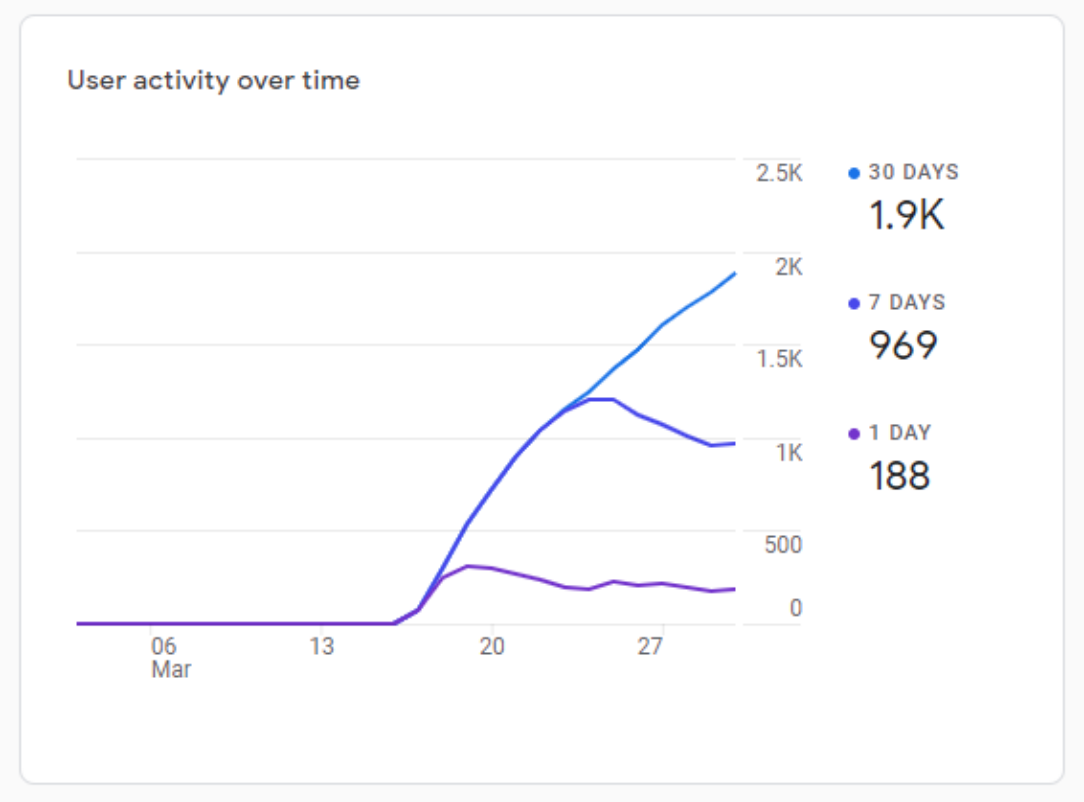

Figure 6.7: User activity over time

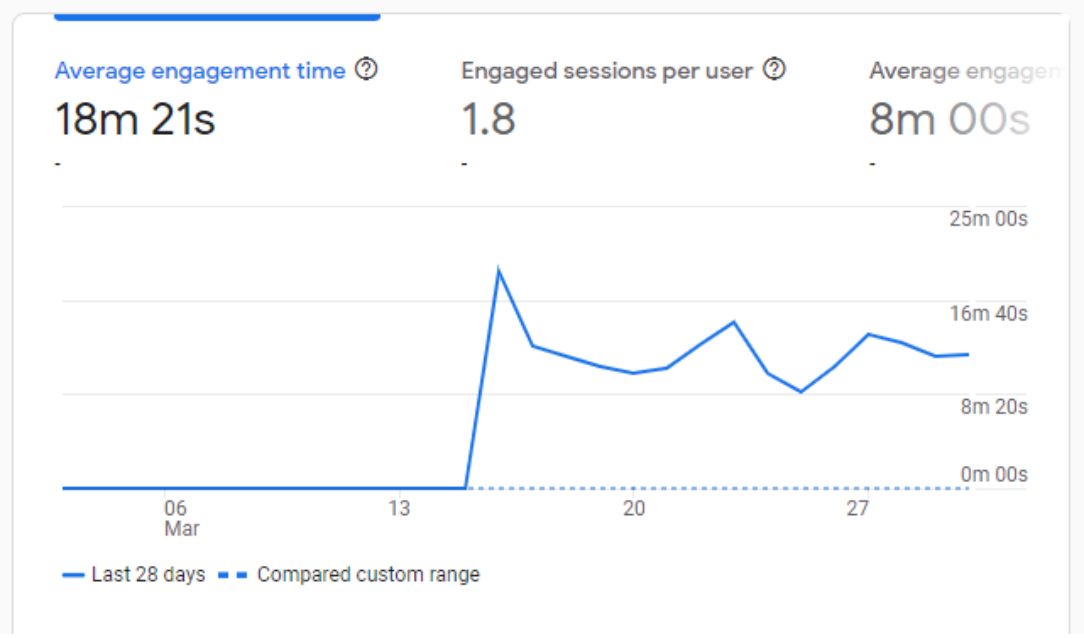

Figure 6.8: Average engagement time

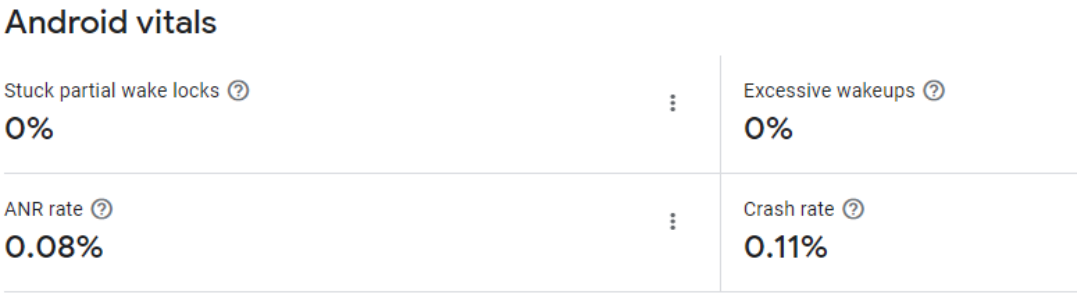

Figure 6.9: Crash and ANR rate

Chapter 7

Project as Engineering Problem Analysis

7.1 Sustainability of the Project

Community Sustainability: After the deployment of the project, "idle light tycoon" game it has reached thousands of people in google play store and is constantly growing in number of players. The game is shown in the top results if searched with its name. There are also many reviews pointing out bugs and issues that we are constantly working on and updating the game to keep the community happy. Financial Sustainability: This means how the game will be maintained and the cost behind the maintenance. The game will be constantly updated with bug fixes and future updates may also include expansions depending on the user reviews. For the bug fixes, visual or in scripts, we need programmers and designers to work on them. Therefore, the main cost would be the salary of the employees working on the project and there is also another cost that comes with marketing of the product. A certain amount of money is paid to have the game ads appear in other products and places.

7.2 Social and Environmental Effects and Analysis

Social Effect: The game is called an idle-clicker type game, which means that it is a game for people who do have enough time to commit to a game. It is for short-term entertainment that the player can stop playing at any time and continue later from the exact point he stopped. It is for people who do not have a lot of free time and they can jump in in between their daily task and it is also aimed at children who are above three years old. The game is very engaging for children due to bright colors and constant clicking that they love. Environmental Effects: This game is played on mobile phones and Ipads which exists in almost every household these days, which means the reach of

mobile games and our game is very high and the player base of our games are mostly children. We analyze the average playtime of the game and it is noticeable that it is not a dangerous amount of time spent in front of the screen. Our game does ask you to sign back in but we made sure that the light bulbs keep doing their job while the player is inactive. That way the player can sign out and come back after a break.

7.3 Addressing Ethics and Ethical Issues

Fraud and Identity Theft: The game does not use any type of third party software that could potentially harm the players. The game does no prompt the player at any time of the play duration to enter any sort of personal information. The player does not have to give their bank account or card information to play the game. Data Security: To download the game the player must have a google account. We do not require the player the sign up on any other place. They will be using the same account to play as the one they regularly use. We take permission from the player to send us their crash report and no other data is taken. No Discrimination: There is no discrimination of any kind based on race, sexuality, gender, religious beliefs, color, language, political or other opinion, national or social origin, property, birth, or other status.

Chapter 8

Lesson Learned

Internship is a completely new experience for me and I faced some issues adapting to the work environment, but I have g2 radually blended in with the team and my communication skills improved as I worked with them. I learned to manage my time and how to meet deadlines. I also learned how to work with a team and organize my project better to avoid any unnecessary mistakes or delays.

8.1 Problems Faced During this Period

Adapting to New Technologies: This was my first time working in a company and one thing that struck me first was that we need to keep learning new things that will help us increase our efficiency and speed. While working in some projects there are always some methods or add-ons that make the implementation easier and we have to stay up to date and keep learning.

Keeping up to speed: When I started working I was clueless and slow compared to the others but my supervisors and co-workers are very patient. They taught me how to manage the workload and how to cooperate with the other employees. We have a weekly update we need to present to the team and I felt like I was not doing much at first.

Identifying and fixing bugs: My first project was short and not very complicated as I was new but when porting the project for mobile devices, it would always have bugs and I did not know how they occurred and why and it would slow down the progress of everyone in the team.

8.2 Solution of those Problems

Adapting to New Technologies: The senior developers and our project manager would always ask if I am struggling with anything or if there is something, they can help me with. My supervisor was very patient and he took time to teach me and I was also given

multiple courses to improve my skills.

Keeping up to speed: As I was not used to working on big projects within a short amount of time, I was given small portions of workload at first and they would offer help whenever I needed.

Identifying and fixing bugs: While working on my first project my supervisor would often fix the bugs, which I was responsible for and then explain, to me why and how it happened and how to avoid it.

Chapter 9

Future Work & Conclusion

9.1 Future Works

There is a bunch of ideas for expansion of the game. Although it depends on the feedback of the playerbase. For future works we are planning on a metaverse and an underwater version of the game. In the current game we have left a boat at one side of the map which is inactive. If we are to expand the game, we will prepare another island with a cyberpunk theme and the core game mechanic will be the same. There will be robots instead of lightbulbs and the next update we might expand to underwater world with an Atlantis theme.

9.2 Conclusion

This internship experience has been an amazing experience for me. I am very lucky to have found the people who are so patient and relentless when it comes to teaching me. I have gotten immense amount of resources and support from the company I work in and they have decided to offer me a permanent position. The people here constantly teach and motivate me in every project I work in and they always offer help when they see me struggling with a task.

Bibliography

Croft, D. W. (1970, January 1). *Game architecture*. SpringerLink. Retrieved April 19, 2022, from https://link.springer.com/chapter/10.1007/978-1-4302-0713-9_7#:~:text=Game%20architecture%2C%20on%20the%20other,Programmers%20create%20the%20game%20architecture.

Architecture, performance, and games. Architecture, Performance, and Games · Introduction · Game Programming Patterns. (n.d.). Retrieved April 19, 2022, from https://gameprogrammingpatterns.com/architecture-performance-and-games.html

Packt subscription. (n.d.). Retrieved April 19, 2022, from https://subscription.packtpub.com/book/game-development/9781783551774/1/ch01lvl1sec10/game-architecture

Technologies, U. (n.d.). *How to architect code as your project scales*. Unity. Retrieved April 19, 2022, from https://unity.com/how-to/how-architect-code-your-project-scales

Costa, E. D. da. (2015, July 30). *Unity with MVC: How to level up your game development*. Toptal Engineering Blog. Retrieved April 19, 2022, from https://www.toptal.com/unity-unity3d/unity-with-mvc-how-to-level-up-your-game-development

Technologies, U. (n.d.). *Camera component*. Unity. Retrieved April 19, 2022, from https://docs.unity3d.com/Manual/class-Camera.html

Introduction to optimization in Unity. Unity Learn. (n.d.). Retrieved April 19, 2022, from https://learn.unity.com/tutorial/introduction-to-optimization-in-unity#:~:text=unity%2D2019%2D3-,Unity's%20optimization%20tools%20allow%20you%20to%20diagnose%20common%20performance%20problems,your%20target%20platforms%20and%20devices.

Performance and Optimization. Unity Learn. (n.d.). Retrieved April 19, 2022, from https://learn.unity.com/course/performance-and-optimisation

Unity game optimization - third edition. Packt. (n.d.). Retrieved April 19, 2022, from https://www.packtpub.com/product/unity-game-optimization-third-edition/9781838556518

Learn how to optimize your unity project. Habrador. (n.d.). Retrieved April 19, 2022, from https://www.habrador.com/tutorials/unity-optimization/

says:, S. for U. A., & says:, L. (2021, September 20). *Unity optimization tips - optimize unity game, tutorial 2022*. Unity Assets & Unity Tutorials. Retrieved April 19, 2022, from https://makaka.org/unity-tutorials/optimization