

CLOUD GAMING CONSUMER EXPERIENCE

Nikolay Efimov

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Aalto University
School of Business
Bachelor's Program in International Business
Mikkeli Campus

Author: Nikolay Efimov
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Objectives

The main objectives of this study were to review the technological specifications, economic viability, and user experience of cloud gaming. The study also sought to assess the existing level of player uptake of cloud gaming and pinpoint the key problems. Finally, the study focused on latency, input lag, and visual quality to assess how cloud gaming affects user experience.

Summary

This thesis focuses on consumer experience by interviewing experienced gamers and also has autoethnography to fill in some details. The literature review mainly summarizes current information on cloud gaming and the current providers. It also covers relevant topics and factors.

Conclusions

The research mainly confirmed what was already known in the literature review but also uncovered some factors that were not talked about. Bandwidth and latency is still the priority when it comes to a users experience with cloud gaming but they're not necessarily the only things that guarantee prolonged usage.

Key words: *video games industry, internet, games, interview, interviewing, technology*

Language: English

Grade:

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1. INTRODUCTION

1.1 Background

Cloud gaming is rising as a potential game-changer that might change how games are created, distributed, and played in the gaming business, which is always growing. Cloud gaming enables players to access games hosted on distant servers, doing away with the need for expensive hardware upgrades and lowering entrance requirements for new players. The adoption of cloud gaming is still very low, despite its potential to change the game industry, and the reasons for this are not well understood. As a result, this undergraduate thesis seeks to explore the potential of cloud gaming and pinpoint the obstacles standing in the way of player adoption.

The adoption of cloud gaming will be looked at from a technological, economical, and user experience perspective in this thesis, and solutions to these problems will be suggested in order to increase the acceptance of cloud gaming. The study topics will center on the current status of cloud gaming, the technological requirements for cloud gaming, the important user experience factors that influence cloud gaming use, and the challenges associated with using cloud gaming services. The goals of the study will be to explore the information that is currently available on cloud gaming, assess its uptake, and look at how it impacts user experience.

Ultimately, this bachelor's thesis's conclusions will help people better understand cloud gaming, how it might transform the gaming business, and what tactics can be used to encourage its widespread use. The thesis will offer suggestions for service providers, politicians, and game creators to enable cloud gaming's potential as a game-changer in the gaming industry.

1.2 Research Problem

Cloud gaming has the ability to completely change the game business, but its uptake and user base are still quite small. Cloud gaming's current state and its potential to revolutionize the gaming industry are not fully recognized. The goal of this bachelor's thesis is to study the possibilities of cloud gaming and pinpoint the barriers preventing

players from adopting it. The thesis will examine the technical, financial, and user experience aspects of cloud gaming adoption and suggest ways to get through these obstacles so that cloud gaming can be more widely adopted.

1.3 Research Questions

Some of the questions are:

- How has cloud gaming evolved over the past few years, and what is its current state?
- What are the technical requirements for cloud gaming, and how do they impact the user experience?
- What are the key aspects of the user experience, such as input lag, latency, and visual quality, that affect the usage of cloud gaming?
- What are some the obstacles to using cloud gaming services, and how may they be overcome?

1.4 Research Objectives

This undergraduate thesis looks at the current state of cloud gaming, analyzes the technical, financial, and user experience issues influencing its adoption, and suggests solutions for getting beyond these obstacles so that cloud gaming can be adopted more widely. The thesis specifically seeks to:

- Review the information that is available about cloud gaming, including its technological specifications, viability from an economic standpoint, and user experience.
- Evaluate the adoption of cloud gaming as it stands today and pinpoint the major issues preventing player uptake.
- Examine how cloud gaming affects the user experience, taking into account elements like latency, input lag, and image quality.

2. LITERATURE REVIEW

2.1 Cloud Gaming definition

Cloud Gaming is a streaming service that allows consumers to stream video games on almost any device with a screen and without having to download or install it on the said device (Shea et al., 2013). It works as follows:

- A player launches a game through the services application or in some cases just through their webpage. The game is launched through a remote server via the internet.
- Any inputs made afterwards by the player get sent to the remote server and are streamed back to the player in video format in real-time with delay depending on the player's internet connection and server processing.
- This allows players to play video games without their devices requiring any computational power.

Before cloud technology has only mainly been used in gaming relating to uploading your save data to the cloud so you don't have to store it on your computer or transfer it. Now cloud gaming instead goes all the way and doesn't make your device interact with the game in any sort of way besides sending signals via the internet.

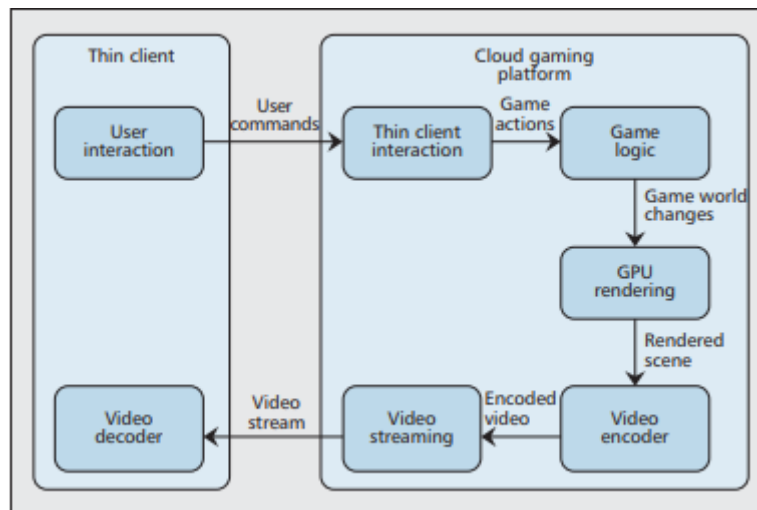


Figure 1. Framework of a cloud gaming platform (Shea et al., 2013)

2.2 History

The first application of cloud gaming technology was announced by the startup G-cluster (Game Cluster) during the 2000 Electronic Entertainment Expo (E3). Approximately three years later, this technology was made available to the general public. To make their service available to network operators, G-cluster devised a paradigm where PC games were hosted on their servers in collaboration with video-on-demand providers, set-top box makers, and middleware software suppliers. Finally, portals were used to make these games available to users (Ojala & Tyrväinen 2011).

Later, companies such as OnLive and Gaikai were formed. OnLive's founder believed that cloud gaming was ready to replace normal gaming in 2010 when the company was launched. OnLive offered the full experience of streaming entire video games to any device with an internet connection. Around the same time, Gaikai was also formed, however, they didn't offer whole games to stream and instead focused on game demos. The purpose of streaming game demos was to market the full games. Gaikai found great success in this and was later acquired by Sony for 340 million dollars (Shea et al., 2013). Meanwhile, OnLive was never even profitable from the start and was acquired by Sony in 2015 only to be shut down soon after (Hollister, 2012).

G-cluster, OnLive and Gaikai were essentially pioneers in the cloud gaming industry. While G-Cluster and Gaikai managed to find success in the industry Gaikai turned out to be the embodiment of everything that is holding back the industry which we will later dive into.

A more recent and perhaps the most successful cloud gaming attempt is Nvidia's GeForce Now. It was released originally in 2015 as a beta service and just like OnLive allowed people to stream video games in their entirety (Suznjevic et al., 2016). Since the service's debut, it has grown to offer support for several operating systems, including Windows, Mac, Android, and iOS. The NVIDIA Shield TV set-top box also provides access to the service. Additionally, the Chrome or Edge browser can be used to access the service. The service initially started with only a couple of dozen games, however, it currently supports over 1500 games on its service (Nvidia. 2023).

Other companies decided to join in as well in the upcoming years. Now there are several recognizable brands with their offering of cloud gaming such as Microsoft's xCloud, Google Stadia, Amazon Luna and PlayStation Now. Another popular one that

isn't recognizable by its name is Boosteroid, which partnered up with Intel and Asus. We will look at these companies, their requirements, payment models and more in the next section.

2.3 Current competitors and their requirements.

Note that in the following Internet requirements for all these companies, compatible monitors need to be used in order to experience the desired frame rates and resolutions. Resolutions for apple devices may also vary.

2.3.1 Nvidia GeForce Now

Required internet speed	Resolution and framerate
15Mbps	720p 60 FPS
25Mbps	1080p 60 FPS
35 MBPS	3840x1440/2560x1440p 120 FPS
45Mbps	3840x2160/3456x2160p 120 FPS

NVIDIA GeForce now is perhaps the current leading cloud gaming service. It has over 1500 games and offers the highest resolutions and frame rates. They use the highest-end computers since the company also manufactures graphics cards and is leading the development and cloud gaming technology. The way the model works is that you either purchase a game that is available on their service or just play a game that you have owned beforehand. You also need to pay a monthly subscription of 10 euro's or if you want to access the higher resolutions and frame rates you must pay 20€ a month. They also offer a free membership though you can only play for one hour at a time and must wait in a queue. This model is especially good for people who already own a lot of games and perhaps have outdated gaming computers (Nvidia, 2023).

2.3.2 Boosteroid

Boosteroid mentions only a 15Mbps requirement for 1080p 60 FPS streaming. Boosteroid works in a similar way to NVIDIA GeForce Now in the sense that you need to buy the game first and then you can play the game with the service. It also uses computers as servers through which you play video games however it does not offer higher resolutions or frame rates than 1080P and 60FPS. Boosteroid charge is 9.89€ a month and has no other tier of subscription. (Boosteroid, 2023).

Both Boosteroid and Nvidia GeForce now are well-suited for players who already have a large catalogue of video games and are perhaps looking to upgrade their old gaming computers. Of course, new gamers are also interested in the service but perhaps they might find the next options more enticing.

2.3.3 Xbox Cloud Gaming

Xbox only recommends that you have at least a connection of 20Mbps. It uses Xbox consoles as servers with which you play the games. The subscription for the service costs 15 dollars a month and lets you play over a hundred games through their cloud service without any additional cost. The cloud gaming service is still in beta as well. You don't only get to play games through their cloud gaming service, however. You also gain access to over 300 games (some of which are in the cloud gaming service) which you can download and play on your computer or Xbox console. The service is available in 28 countries which are mostly located in North and South America, Europe, and Southeast Asia. (Microsoft, 2023).

2.3.4 PlayStation Now

PlayStation Now requires a minimum of 5mbps and recommends 15Mbps for 1080p streaming. Like Xbox, PlayStation Now uses PlayStation consoles as servers through which you play games. It is not specified how many games are accessible, but it is likely similar to the number of games it offers to download on PlayStation consoles if you have PlayStation Now, which is in the hundreds. It also allows you to access online multiplayer, store discounts and many other perks on the PlayStation consoles. Also similar to Xbox cloud gaming is the fact that PlayStation cloud gaming service is available in around 30 countries which are also based in North and South America Europe and Southeast Asia (PlayStation, 2023).

Both the PlayStation Now and Xbox Cloud Gaming are great ways for new players to get into video games since you're not required to separately purchase the video games because they are included in the subscription. Xbox cloud gaming seems to offer a better variety of games since Microsoft tends to make games on all platforms. PlayStation Now mostly offers PlayStation exclusives which can be good for both new video gamers and for people who perhaps play on another gaming platform and want to play a PlayStation exclusive but don't want to buy a PlayStation console. It is also

worth mentioning that both services require a controller and cannot be played on a mouse and keyboard.

2.3.5 Amazon Luna

The minimum Internet speed required for Amazon Luna is 10 Mbps. Luna is a bit unique in their payment model. Some games you can access just by having an Amazon prime gaming subscription which includes other perks besides cloud gaming. Then they have different packages with each package having different games in them. The main package out of these is Luna plus which offers around 300 games for \$10 a month. Other packages are Jackbox Games and Ubisoft plus. Jackbox Games includes party games and cost \$5 a month. Ubisoft plus costs \$18 a month and includes games from the gaming company Ubisoft. Amazon Luna is only available in the United States. It is more niche than the other services but serves as a great way to market their other services such as Amazon prime gaming (Amazon, 2023).

2.3.6 Google Stadia

Internet Requirement	Resolution and framerate
10 Mbps	720p and 60 FPS
20 Mbps	1080p and 60 FPS
35 Mbps	4k and 60 FPS

Last and in some way least is Google Stadia. The reason for that is that Google Stadia shut down on January 18th, 2023. The reason for this is likely due to their payment model and video game collection. The service offered around 300 video games. While Nvidia GeForce now allows you to play games that you have previously owned, Google stadia did no such thing. Instead, you had to buy the game specifically for their platform kind of like on a console and you'd have to play it on Google stadia exclusively. There was no way to download the game you bought on any device.

The games were sold for full retail price. You didn't need a subscription to play the games you bought but to access 4K resolution you would have to pay \$10 a month. In that subscription, you would also get free monthly games that you would get to keep so long as you had a subscription similar to PlayStation Now.

2.3.7 Nintendo

Another implementation of cloud gaming worth mentioning is Nintendo's. While the Nintendo's console Nintendo switch mostly runs games on its own it has a few graphically demanding titles that can be played with cloud gaming. Nintendo doesn't Provide the minimum or recommended bandwidth requirements but instead offers you to play a trial of the game for you to find out whether you're capable of running it or not. The service is certainly not the selling point of the console, and many have not even heard of it but it is a nice addition (Nintendo, 2023).

2.4 Challenges to accepting cloud computing

2.4.1 Bandwith Limitations

One of the key aspects of cloud gaming is a consumer's bandwidth. It determines how much data you can send and receive to and from the device you're playing on in a second. A sweet spot for cloud gaming seems to be around 25 Mbps for a solid full HD experience on most of the previously mentioned platforms. Although some claim to have a lower requirement than that it's important to remember that that likely does not provide an uninterrupted experience because they're minimum requirements. So, let's take a look at the world's Internet speeds.

According to (Ookla, 2023) 120 out of the world's 195 countries have a median bandwidth of 25Mbps or more. Out of the countries that barely meet the requirement or are below the requirement most are located in Africa and parts of Asia. This likely explains why cloud gaming services are not being offered in those areas. The numbers would also suggest that there is a big enough audience for cloud gaming to be a viable business option. This was not however the case back when OnLive launched which was likely to be one of the reasons why they had such a low user base right from the start.

There is however a caveat to this which is even mentioned in some of the requirement's webpages of cloud gaming platforms. The fact that you can't do anything else that is demanding on your bandwidth. So, for example the kids want to play some games through the cloud and the parents want to stream a show on Netflix. If your bandwidth is not too far from the recommended requirement it won't be a good experience for anyone since both the game and the show on Netflix would be constantly buffering. This could be a potential deal breaker for family households.

The previously mentioned median bandwidth was for countries' fixed broadband which is mostly Wi-Fi you have in your house. In terms of mobile performance, only 80 out of 195 countries in the world have the required median bandwidth. This is important because one of the key selling features of cloud gaming is the fact that you can play demanding games anytime and anywhere on your mobile devices. It is also important to remember that mobile bandwidth fluctuates constantly, especially when you're on the move.

2.4.2 Ping/Latency

Besides the internet, another key issue is ping or the more technically correct term latency. It is basically how fast data moves from one server to another and is measured in milliseconds (Briscoe et al., 2014). It is mainly affected by the distance between the servers and how much network traffic is going through the network. The tricky part is that when you play a multiplayer game your device first needs to send a signal to the remote device you're playing on, then that remote device needs to send the signal to the multiplayer server you're playing on and then that data needs to come back to you the same way. The solution to this problem? Have the video game multiplayer servers in the same place as cloud gaming servers. This makes it so that there is almost no latency between the cloud gaming servers and the multiplayer games. So, the only latency you need to worry about is that between the player and the cloud gaming server.

Keeping cloud gaming servers and multiplayer game servers close to each other applies to players' devices as well. Of course, you can't have the server in the house of the player as that would defeat the whole purpose of cloud gaming. But servers need to be at least in the same or one of the neighbouring countries for latency to be at an acceptable level for cloud gaming. This is another reason why some countries don't have cloud gaming since not only is their bandwidth too low but also there are no servers nearby and setting up servers in countries with low bandwidth would be a waste.

Setting up cloud gaming servers next to multiplayer servers is something that Xbox cloud gaming is already doing. They are doing this with their platform called Azure which Microsoft owns (Azure, 2023). They essentially have huge data centres in many countries around the world. Companies can use their service for hosting multiplayer

game servers or cloud gaming servers which is exactly what Xbox cloud gaming is already doing (Microsoft 2019).

In essence, even if you have very high bandwidth, you will not have a pleasant experience if your latency is too high. The only thing that can help your latency is being close to the source of the Internet or being connected through a cable though that would not be possible on a mobile device. For example, my bandwidth is more than enough for cloud gaming, but I still find my experience having significant delays since my latency is above recommended. Most cloud gaming providers recommend a latency of 20 ms or below.

2.4.3 Infrastructure deficiencies

Perhaps the biggest issue with cloud gaming is infrastructure. We've already gone through how the servers need to be close to multiplayer servers and the users. What we've not covered is the sheer size of them. Media streaming services such as Netflix can use Open Connect appliances that can stream movies and series for thousands of people at the same time (Techquickie, 2017).



Figure 2 Open Connect appliance (Abdel-Hafez, 2017)

Cloud gaming instead requires a graphics card for each user because video games require a lot of processing power and for many games, the whole card is required. This would mean that you would need millions of graphics cards to have millions of users and the plan is for this technology to one day replace normal gaming completely that number would go up to hundreds of millions if not billions. Keep in mind that users would also be constantly fluctuating as people would use the service at different times

of the day and there would likely be usage increases during holiday seasons and dips during busy times of the year (Techquickie, 2015).



Figure 3 GeForce RTX 3080 graphics card used in Nvidia's ultimate subscription tier (Nvidia, 2023)

As games developed so too with the graphics cards and regular replacement of the graphics cards would be needed. These do not come cheap and are susceptible to shortages like there were during covid because of not enough crucial chips being produced. The amount of electricity required to run such an operation and the cost of it would be astronomical as well (Huang et al., 2013).

2.4.4 Interaction Delay Tolerance

What it all comes down to is interaction delay tolerance. This is a concept that is covered well by Shea and other writers in 2013. Interaction delay tolerance is essentially how much of a delay you can tolerate in a specific video game. Some games are more competitive than others and players may tolerate action delays more than some games. For example, in a competitive first-person shooter, even the slightest delay could severely impact your experience. In other games such as MMORPGs, precise inputs are oftentimes not necessary and larger delays can be tolerated.

The article also covers some of the issues related to cloud gaming but doesn't dive too deep into them and doesn't cover all of them which is what this thesis plans to expand on. A lot of the information is also outdated, and the riders use OnLive as an example which as previously mentioned is no longer around. Updating what's been going on in the cloud gaming industry is another key objective of this thesis.

2.5 Technology acceptance model

The last part of this literature review is the technology acceptance model. The technology acceptance model (TAM) is a theoretical framework that explains the elements that affect people's attitudes towards technology and its use. It was originally introduced by Davis in 1989 and has been extensively used in research relating to technology ever since, including cloud gaming (Davis, 1989).

The model suggests that two key factors are always involved in an individual's usage and acceptance of technology. One of the key factors is perceived usefulness (PU). It refers to the degree to which a user perceives a certain technology to be an improvement or satisfaction for performing a particular task. Perceived usefulness in the context of cloud gaming would refer to how much a person thinks that cloud gaming will improve their gaming experience in terms of functionality, convenience, and quality. Other factors such as how many games the service has or whether you need to buy games separately for the service also affect the PU. Perceived usefulness is an important factor in cloud gaming and will likely continue to grow as cloud gaming advances.

The other key factor is perceived ease of use (PEOU). PEOU is about how much effort a person perceives is required to use specific technology. In the context of cloud gaming, it just means how easy a person finds it to use cloud gaming technology. Factors of PEOU in cloud gaming would be things such as compatibility with devices, user interface, internet connection and ping, some of which we've previously covered. In the methodology section, we'll go into more detail as to how the technology acceptance model will be applied in this thesis.

3. Methodology

This study used a qualitative methodology and focused on the thoughts and experiences of four active gamers who have used various levels of cloud gaming services, as well as the author's own experience with the service. Semi-structured interviews were employed as the data collecting technique since they allowed for an open-ended conversation and gave the freedom to thoroughly examine the participants' experiences. Each interview lasted around 30 minutes and was conducted in person with some of the interviewees and online with others.

So why has qualitative methodology been chosen instead of quantitative? The reason is that cloud gaming is still a relatively new phenomenon. Not much research has been done on the topic. So, to find the variables for quantitative data about cloud gaming, qualitative research must be done first. In this case the interviews will provide all the necessary information without omitting any details which might be missed in quantitative research such as context or unexpected findings.

The other method of research that was used was the writer's autoethnography. The reason for this was to confirm some of the finding from the interviewees, capture imagery and test out some of the parts of cloud gaming that the interviewees had not, such as playing on a mobile device.

The research was carried out in a methodical and exacting way to guarantee the authenticity and dependability of the data that was gathered. A sample of active gamers who were chosen for the study based on their interest in gaming and willingness to take part was used. The participants were acquired through personal acquaintances. Based on their level of experience using cloud gaming services, the players were chosen. Two of the participants had prior experience using cloud gaming services, while the other two had little to no prior experience. This method made it possible to portray a variety of viewpoints in the study.

The Technology Acceptance Model (TAM), a commonly used theoretical framework for comprehending user adoption of technology, was utilized to evaluate the interview results. TAM was chosen because it offers a thorough framework for assessing the elements that affect user acceptance, such as subjective norm, perceived usefulness, and perceived ease of use. In order to identify important themes and patterns in the data, the replies were coded and subjected to a thematic analysis method.

The interview questions were made to extract details regarding the participants' experiences with cloud gaming services. For context interviewees were asked about their internet speed, location, gaming experience, device they used, etc. Some of the main questions was asked were the following:

- Why do you use the service?
- How noticeable is the input delay?
- How is the image quality?

- Does the game selection satisfy you?
- What improvements would you like to be made?
- How easy to use is it?
- What is its usefulness for you?

Due to the open-ended nature of the questions, participants were able to elaborate on their answers. To make sure they were clear and relevant to the research goals, the interview questions were also pilot tested with the first participant in person.

This study used a qualitative approach using the TAM framework to investigate the perceptions and experiences of four active gamers who have utilized cloud gaming services to various degrees, as well as the writer's own experiences. Semi-structured interviewing techniques were used, and theme analysis was used to examine the data. The results of this study will shed light on the elements that affect users' acceptance of cloud gaming services and guide the development of plans for increasing their uptake.

The results of the interviews were summarized and analysed in the findings section using technology acceptance model's perceived ease of use and perceived usefulness factors.

Interviewee profiles:

Interviewee	Location	Age	Gender	Gaming Experience	Education	Cloud Gaming Service Used
1	Finland	late 20s	Male	10+ years	University student	Boosteroid
2	Finland	early 20s	Male	10+ years	University student	GeForce Now
3	Turkey	early 20s	Male	10+ years	University student	GeForce Now
4	Turkey	early 20s	Male	10+ years	University student	GeForce Now

As previously mentioned, the interviewees were all personally acquainted with the writer. Although gender and age were not specifically targeted, they can naturally affect the results. The most important demographic for this study was gaming experience in order to have the most accurate comparison between cloud gaming and non-cloud gaming. The writer's gaming experience was also similar to that of the interviewees, which is why autoethnography was also a good fit for this study.

4. Findings

4.1 Perceived Ease of Use

First, let's discuss the perceived ease of use, as negative ease of use can also impact perceived usefulness. When it comes to playing games as they are, there seem to be no issues. The process is quite straightforward, and if using the supported browser, there's no need to install anything on the computer. None of the interviewees had any trouble starting or using the service long-term, finding it to be affordable, with GeForce Now even having a free version that further lowers the barrier for entry.

For those who already own games on the supported platforms, the experience is easy. For new gamers, creating accounts on other platforms and purchasing games there might be more challenging, but this would require separate research as all interviewees already owned games on the required platforms.

Upgrading one's Wi-Fi contract or connecting a device to an ethernet cable could be another barrier to ease of use, depending on the current bandwidth and Wi-Fi latency to the router. For one interviewee, this made the service unusable since they couldn't access better internet even if they paid more. However, this is a one-time obstacle that wouldn't actively impact the ease of use.

4.2 Perceived Usefulness

The main reason that came up for all interviewees for using the service was either that they couldn't play the game they wanted on their device or they couldn't play it at a satisfying level. Naturally, this reason is also the biggest part of the perceived usefulness of the service. However, whether this reason will be perceived as useful is entirely dependent on your internet speed. Out of the interviewees, only one had above the required internet speed. Out of the rest, one barely met the requirements, one used fluctuating mobile data, and one used below the required internet speed. So how did it affect their experiences? Well, what was discovered was that the interviewee who had the best and most stable internet connection had the best experience. However, even though all the other interviewees had a subpar experience with the service, one of them still decided to keep using the service. The reason? Not having another alternative.

As mentioned in the literature review, we have talked about input delay tolerance. The article concluded that a consumer's input delay tolerance depends on the genre of game they're playing. However, what happens when you don't have the financial means for an alternative? The input delay or your tolerance of the experience would most likely increase. This was the case for one of our interviewees. Due to using a mobile connection, his experience was severely fluctuating, and the input delay was very noticeable. The experience was clearly worse than playing games on his own device that he could play. But when it comes to games that are unplayable on his device, the experience was still perceived as being useful enough to be usable when

left with no other alternative, despite being a subpar experience. Of course, the genre of games matters as well, and the interviewee mainly played strategy games. Had he needed the service for a competitive shooter, he most likely would not have used it at all, even with no other alternative, as the experience would have been downright unplayable.

The other two interviewees did end up dropping the service quite soon after they tried it, but they also had better alternatives. The devices offered by the service were better, but the overall experience on their devices was still better due to the bad connection. The person who had the bare minimum connection seemed to have a bad experience as well. Image quality was fluctuating, and the input delay was very noticeable. He did, however, manage to confirm one of the hypotheses mentioned in the literature review. It was the fact that if you were to use the internet for something else while using a cloud gaming service, it would severely impact your experience if you had a limited amount of bandwidth. In this case, the interviewee tried to voice chat on an online communication platform called Discord while playing on the cloud gaming service. The result was that both the voice chat and the cloud gaming experience were severely impacted, rendering both unusable.

First impressions seem to matter significantly. Out of the ones who dropped the service after trying it, neither has tried it again in the years since. Granted, one of them cannot even acquire a better internet contract due to the poor infrastructure in his area. The other, however, has had multiple changes in location and internet speed but has never given it a try ever since the first trial. Interviewees who had more experience with the service mentioned other factors they perceived to be useful after using the service for an extended period. One was the ability to play a game without downloading or updating it. An interviewee even said that sometimes he had a game downloaded on his computer, but he still used the service because he didn't want to wait for the game to update before playing it. This also meant that none of the storage space on his computer was being used, and one of the interviewees even decided to use the service again after having stopped using it, due to constantly running out of space.

Another factor was the ability to play any game on the highest graphics settings, but this benefit was only possible if the stream was at its best. Lastly, games were guaranteed to work, even when the device met the game's requirements. However, there could still be issues launching the game, especially on computers.

As for the reasons that made the service less useful, the experienced interviewees mentioned two: the service would kick you out of a session due to inactivity after a few minutes, and you couldn't install mods. These reasons led one of the interviewees to acquire another device for gaming, but as mentioned earlier, they still ended up coming back to the service due to running out of space on their device.

Surprisingly, game selection wasn't much of an issue. Even the interviewees who played a large variety of video games found the game selection to be almost completely satisfactory. There is even a surprising amount of niche games with a low player count.

To conclude, the service's perceived usefulness will mainly depend on your internet connection and the availability of alternative ways to play video games. For the interviewee who had a stable and required connection, the experience was seamless, without noticeable input delay or image quality degradation. Therefore, they perceived the service as extremely useful.

4.3 Autoethnography

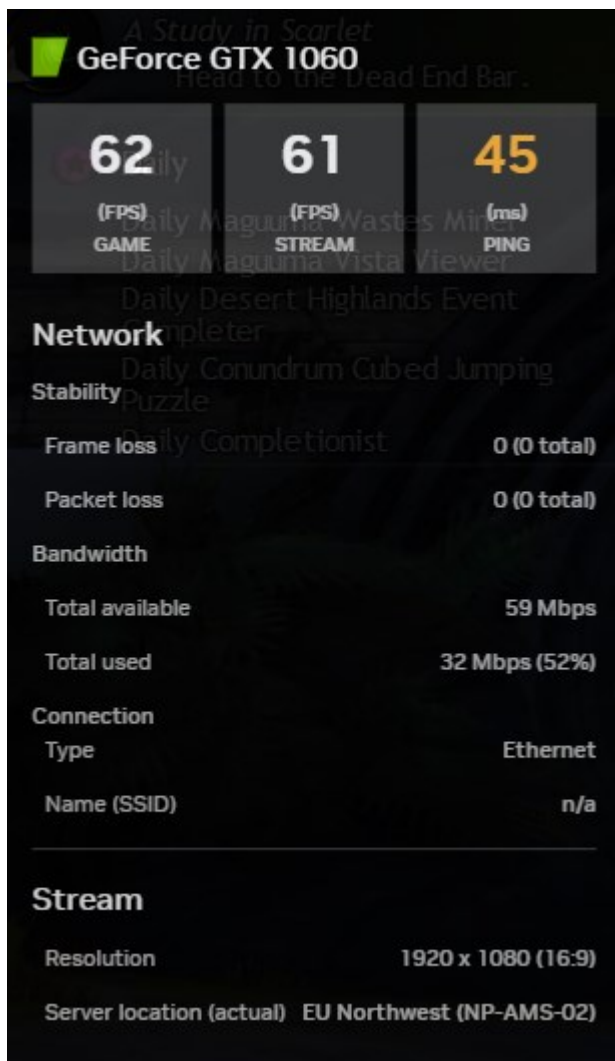
I personally tested a couple of services, namely Xbox Cloud Gaming and GeForce Now. At the time, I had a subscription to Xbox Game Pass Ultimate, which allowed me to use their cloud gaming service that is still in beta. Additionally, I tried the free version of GeForce Now. My internet connection was a stable 50 Mbps, and I connected my computer to the Wi-Fi router through an Ethernet cable. I also tested GeForce Now on my phone and laptop to see if the experience would be affected.

The first service I tested was Xbox Cloud Gaming, and it did not go well. The image quality was noticeably worse, but I couldn't tell if it was due to the stream or the fact that the Xbox was playing it at a lower resolution than my monitor. The user interface did not provide necessary information, such as the server location and my current stream status. I chose a rhythm game that relied on precise inputs, but the delay was noticeable, and I could not get into the rhythm, making the game unplayable. I tried

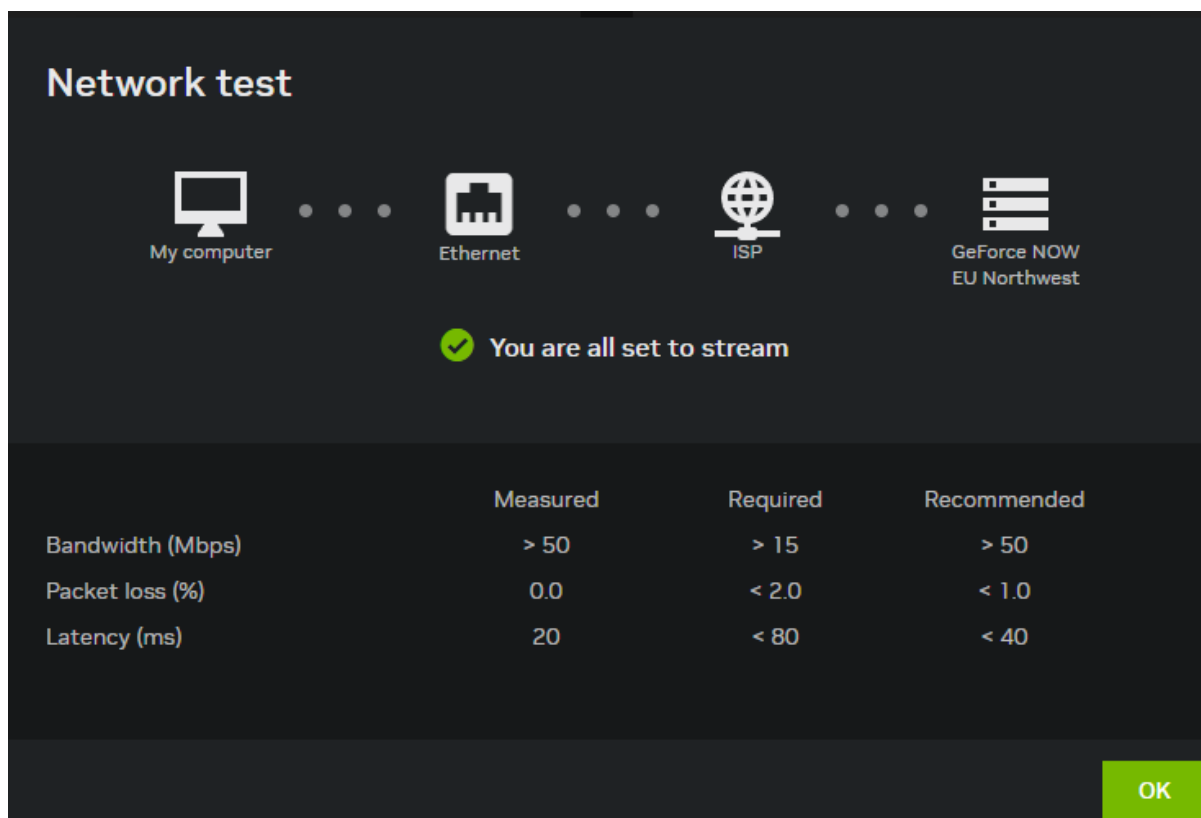
other games later, but the input delay was still too noticeable to have an enjoyable experience. Despite this, the image quality was generally good.

The experience left a bad impression on me, and it reinforced the importance of first impressions with this service. If not for this thesis, I would not have tried another service, thinking that it would be just as bad. However, since GeForce Now offered their service for free, I decided to give it another shot.

I tried a game I had been playing recently called Guild Wars 2, so I could compare the differences. The game is also multiplayer, so I could check the latency to the game's server. The experience was similar to what the interviewee with the most optimal internet connection had described. The image quality was almost like playing on a present computer and was only worsened by the computer the game was being streamed from being worse than mine. The input delay was almost non-existent. I was pleasantly surprised after my experience with Xbox Cloud Gaming. The interface of GeForce Now also provided me with all the necessary details to figure out what was going on with the stream shown in the image below.



It displays the graphics card of the computer you are connected to, the framerate of the stream, your latency to the computer you are playing on, the resolution of the stream, and the total bandwidth being used from your available internet. It also shows the location you are being connected to, which in this case was EU Northwest located in Stockholm, Sweden. Additionally, you can set a limit to how much bandwidth the service uses and choose the server you connect to manually. Before connecting, you can also test your network to each server, as shown in the next image, but the latency doesn't usually match what you get when you actually play the game.



Network test to the Geforce Now server in Stockholm (Screenshot taken by writer)

I also played around with the bandwidth limiter to see how different the stream quality would be if I limited my stream bandwidth to 10 Mbps, similar to the first interviewee's Wi-Fi. Surprisingly, it didn't affect my experience as much as I thought it would. The image was a bit blurrier, but the framerate and resolution remained the same, and the experience was still just as smooth. Below, you can see the comparison.



Image with Bandwith limit set to 10 Mbps



Image with no Bandwith limit

I also tried GeForce Now on my laptop and phone. At first, I tried it with my Wi-Fi in another room. Although the experience was quite good, it did have some hiccups from time to time, likely due to the higher latency I was experiencing because my laptop was using Wi-Fi instead of an ethernet cable. I then tried it on my mobile data, and the stutters were almost constant. Even though my phone's internet connection supposedly goes up to 200 Mbps, this is rarely the case, and even when stationary in my apartment, the experience was subpar.

This leads me to believe that cloud gaming is not a viable option for gaming on the go. Using my mobile data, even when stationary, wasn't a very smooth experience, and while on the move, for example, on a train, the experience would be even worse due to high signal fluctuations. Only in a country with a very large and fast bandwidth coverage would cloud gaming on the go be possible.

Overall, I was very impressed by the experience, but as of right now, I have no need for it. For me to have a potentially better experience than my current gaming computer, I would have to get the more expensive version of the subscription, which costs 20 euros a month, and even then, it wouldn't be much better. For me, the perceived usefulness at the moment is very little, but in the future, it would most likely change with my computer getting older.

5. Discussion and Analysis

5.1 Attitude towards using

It's true that the internet conditions play a major role in cloud gaming, and they can heavily impact a user's experience. Game selection and modding, on the other hand, may not be dealbreakers for everyone but they are still important factors to consider for some users. The availability of games and the ability to modify them can greatly influence a user's decision to subscribe to a cloud gaming service.

In terms of user attitudes, it's also important to note that not everyone may be comfortable with the idea of streaming their games and relying on an internet connection for gaming. Some users may prefer to have their games installed on their own hardware and play offline. Others may be concerned about issues like data privacy and security. So while cloud gaming may have its benefits, it may not be for everyone.

5.2 Discussion

This thesis examined the cloud gaming user experience and discovered that bandwidth and latency concerns significantly impacted service quality. These results are in line with other studies that have stressed the significance of these elements in influencing the success of cloud gaming platforms.

Yet, the research also produced some novel understandings of the cloud gaming user experience. For instance, it was discovered that the inability to take extended breaks and the lack of support for modding were major barriers to user adoption. These aspects, which have not received much attention in prior study, emphasize the significance of taking the full user experience into account in addition to technological aspects.

The research also revealed that users were more inclined to put up with input latency difficulties when there were no other gaming options available. This means that customers in places with little access to gaming hardware may find cloud gaming to be a viable option.

Addressing the research topics, the market for cloud gaming has had tremendous growth in recent years thanks to the entry of well-known companies like Nvidia, Microsoft, and Amazon. The sector is still in a state of change, though, with several platforms still in the testing stage and others struggling with infrastructure and license issues.

High-speed internet connectivity, low-latency servers, and appropriate hardware are needed for cloud gaming. The platform and the user's location can affect these needs, which can affect the overall quality of service.

The main user experience factors that influence the utilization of cloud gaming are input lag, latency, visual quality, and device compatibility. Taking care of these issues is essential for offering a top-notch customer experience.

The cost of subscription services and the requirement for a strong internet connection, are some of the barriers to using cloud gaming services. By enhancing infrastructure and boosting user awareness of the advantages of cloud gaming, these challenges can be overcome. Free trials and rewards for early adopters can also serve to enhance user adoption and promote industry growth.

5.3 Recommendations for cloud gaming service providers

Businesses in the gaming industry should concentrate on upgrading their cloud gaming services to suit customers' requirements and expectations, according to the results of this thesis on the consumer experience of cloud gaming. To guarantee lag-free gameplay and customer satisfaction, businesses should pick locations with good bandwidth and make sure there's cloud gaming server's close enough to connect to. If even further expansion is require companies should consider investin in bandwidth infrastructure in locations with lots of potential consumers. They should also think about supporting modding and allowing users to be inactive for longer periods of time before logging them out.

The effect of initial impressions on user adoption and satisfaction is yet another crucial factor to take into account. Businesses should make an effort to give users a pleasant first impression as this may have a big impact on whether or not they decide to use the service again.

Businesses should also be aware that even if the minimal bandwidth needs are satisfied, customers may still not be able to multitask or use the internet for other things at the same time. To prevent user disappointment and annoyance, they should be transparent about this constraint.

Businesses could also think about providing trial periods or demos to let consumers try the service before committing to a subscription in order to enhance the overall user experience and increase the adoption of cloud gaming services. Also, they must regularly ask customers for their opinions and modify the service accordingly.

To satisfy customer demands and expectations, companies in the gaming sector should give top priority to enhancing the quality and usability of their cloud gaming services. By doing this, companies can enhance client adoption and loyalty.

6. Conclusions

6.1 Main Findings

The user experience of cloud gaming has been examined in this thesis, along with the major variables that affect its uptake and utilization. It has been determined that bandwidth and latency are the main determinants of perceived utility as well as the

significance of initial impressions in influencing user perceptions of the service using a mix of literature review and empirical research.

Also, it was discovered that being automatically logged out after a short period of inactivity and the absence of modding support are drawbacks that can reduce the perceived value of cloud gaming. To increase customer engagement and retention, it is crucial for businesses in this sector to address these problems and provide a more flexible and individualized service.

In general, the development of cloud gaming over the past few years has resulted in a rise in demand for premium streaming services that provide flexible features and personalized content. Companies may continue to foster growth and innovation in this quickly changing sector by making investments in technical infrastructure, providing specialized content, and placing a high priority on the user experience.

In summary, this thesis emphasizes the significance of ongoing innovation and adaptation in the cloud gaming sector and offers suggestions for how businesses might offer their customers a more useful and engaging experience.

6.2 Implications in International Business

First, businesses in this sector must be aware of how different nations and areas differ in terms of the sophistication of their technology infrastructure and adjust their business plans accordingly. This could entail giving some areas more attention than others or spending more money in some places in order to develop the infrastructure and boost customer acceptance.

Second, businesses need to be ready to manage intricate regulatory frameworks in several nations. For instance, tighter data protection legislation or rules regarding the usage of cloud services may exist in different countries, which may have an effect on how cloud gaming companies conduct business in those markets.

Finally, businesses must be prepared to modify their marketing and promotional plans in order to take into account local tastes and cultural peculiarities. This can entail collaborating with local celebrities or influencers, or moulding marketing messages to better appeal to regional consumers.

Ultimately, there are both opportunities and difficulties for global company in the cloud gaming sector. Companies may successfully extend their operations and offer

customers a top-notch gaming experience by comprehending and managing the distinctive peculiarities of other marketplaces.

6.3 Limitations

Besides the conclusions drawn from this thesis on the user experience of cloud gaming, there are a number of limitations that must be noted.

First off, the empirical research's sample size was really small—only four seasoned gamers from Finland and Turkey were interviewed. This restricts the capacity to gather a wider range of experiences and viewpoints on cloud gaming as well as the generalizability of our findings to different locations and groups.

Second, the fact that only seasoned players were questioned might have caused the findings to be biased in favour of a more or less favourable assessment of cloud gaming because the interviewees may be more or less tolerant of problems like input lag and latency. The addition of new or casual players would have given a more impartial and varied viewpoint on the drawbacks and advantages of cloud gaming.

Thirdly, because the interviews were only conducted in Turkey and Finland, they may not have adequately captured the experiences and difficulties associated with cloud gaming in other areas that have distinct technological availability and infrastructure.

Finally, although the thesis identified crucial elements like bandwidth and latency as essential to the perceived usefulness of cloud gaming, more research is required to delve into the intricate interactions between these technical requirements and other contextual elements like player preferences, game genre, and platform compatibility.

Despite these drawbacks, this thesis provides insightful analysis of the user experience of cloud gaming and lays the groundwork for further study.

6.4 Suggestions for further research

By resolving the noted limitations and pursuing alternative areas of investigation, other research can build upon this concept. Future study can, for instance, try to increase the sample size to comprise more varied demographics, such as new or casual gamers, and to broaden the research to various locations with distinct technological infrastructure and cultural norms.

Further investigation might look into the effects of particular game genres and platform compatibility on the user experience of cloud gaming as well as explore the potential for integrating cutting-edge technology like virtual reality and augmented reality into cloud gaming.

Future research should focus on how to boost the adoption and acceptance of cloud gaming by addressing its perceived negative utility characteristics, such as the lack of support for modding and the logging out after a short period of inactivity. In order to raise user awareness, this may entail creating new products or services that solve these problems. It may also entail communicating existing solutions more effectively.

Overall, the results of this thesis indicate that further research is required to fully realize the promise of this cutting-edge technology and that there is still much that needs to be learned and explored regarding the user experience of cloud gaming.

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