Steam Games: Factors that Drive Customer Retention

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A Senior Thesis submitted to the Mathematical Methods in the Social Sciences (MMSS) at Northwestern University in the final partial fulfillment of the requirements for a Bachelor’s Degree

Weinberg College of Arts and Sciences
Northwestern University
Evanston, Illinois
June 1, 2019
To Dylan Hsu,
who was proud of me when I first scored points as a Brahma swimmer. I hope you are proud of
all of us graduating this year. Your wit and fearlessness will never be forgotten.

May we swim next to each other again in our next life.
Acknowledgements:

First and foremost, I would like to thank my thesis advisor, Professor Steve Tarzia, for advising me on this MMSS Senior Thesis and also teaching me through EECS 317. Even though he had already been advising other theses, I am especially grateful for his patience, invaluable knowledge, and willingness to help me throughout my thesis and SQL journey.

Thank you to my dear friend Jimmy Hu who immensely helped me with coding the data collection process of this thesis. Thank you for your patience when I had a concussion last year. Through blood, sweat, and tears, we’ve made it and see you at the next BTS concert.

In addition, I would also like to thank Professor Joseph Ferrie, who led the MMSS Thesis Seminar Course and encouraged interdisciplinary collaboration in our coffee chats.

I thank Professor Jeff Ely and Nicole Schneider for giving me unwavering support throughout the brutal MMSS curriculum and nominating me as the SAB Representative for MMSS within the Weinberg College.

Thank you to all my MMSS, Economics, and Kellogg professors as well as teaching assistants for cultivating my learning experience throughout my four years here at Northwestern.

Thank you to all my friends here at Northwestern for the amazing memories. I would like to give a special shoutout to Nat, Henry, Gloria, Matt, and David for being talented and kind-hearted, and letting me explore the diverse world of games. I will miss you all after graduation and good luck on your masters, David. I would also like to thank two wonderful MMSS alumni Tiffany and Sunny for sharing their valuable thesis-writing experience with me last year. I feel your struggle, and let’s listen to BTS’ Born Singer after this.

Finally, I would like to express my highest gratitude to my family -- my father and mother -- for all their love and understanding not only over the past 4 years, but over the past 22 years. 我爱你爸爸妈妈-陈韵熹
**Introduction:**

Inspired by my final project from the MMSS political science course, I originally devoted my thesis to mobile games and wanted to demonstrate how certain apps go viral and retain users. However during my winter quarter milestone meeting with Professor Ferrie, I expressed concerns about collecting sufficient data and its validity. Therefore at his suggestion, I switched to games sold in the Steam store. My thesis looks into Steam games to determine which attributes best help them retain a substantial player base long after its release date. As a proxy for this customer retention, I chose to focus on the number of concurrent players, which I will discuss in detail later.

Despite making up 25% of the gaming industry, PC games brought in $33.4 billion in revenue last year. While the market of browser games decreased 14.8%, downloadable PC games has increased 6.5% from 2017 to 2018 with a $28.2-billion revenue. The gaming population will only continue to expand with the overall trend towards globalized internet connection (Bailey, 2018). With the recent dominance of PC games especially *Fortnite*, a lot of attention has been drawn to Epic Games who recently created their own game store (Sweeney, 2018). Despite this, a large part of the gaming community has bought the majority of their games from Valve. Additionally, the Steam store has been opened since 2008 for any third-party developers who want to publish and sell their games through Steam.
Literature Review:

My research is motivated by a number of studies that examine the use of quantitative data in PC games. Because of the appeal and market share of Valve who owns and runs the Steam store, numerous studies have been published.

In the paper *Condensing Steam: Distilling the Diversity of Gamer Behavior*, O'Neill et al collected a full list of all users, friendships, and games from Steam to pioneer the analysis of the Steam gaming network and examine behavior in terms of social connectivity, playtime, game ownership, genre preference, and expenditure habits. The researchers found that players tend to befriend other players similar in popularity, playtime, money spent, and games owned. Additionally, they note that the top 20% of Steam users account for 73% of the total market value of owned games on the store. Basically, the majority of the Steam gamers behave rather differently from the few who both play and spend significantly more than their peers. Most Steam players spend moderate levels of time and money playing games. In fact, 50% of the account did not play games during the two-week data collection. They found that most play heavily on some days and not so much on other days. Generally, gamers who played the most on the first day tend to play more on subsequent days than their peers. O’Neill et al also found a weak positive relationship between a user’s total playtime and number of game achievements, implying that achievements do encourage more gameplay than if there were none (O’Neill et al, 2016).

The next paper "Playability Heuristics for Mobile Games" was not published in context of PC games, but Korhonen and Kovisto's work into identifying mobile game playability problems based on mobility, usability, and gameplay also applies to PC games. Usability
heuristics include supportive audio-visual representation, efficient and visually pleasing screen layout, understandable terminology, and containing game help. Whereas, mobility heuristics was evaluated by how the game responds in diverse and unexpected environments, and gameplay through clear goals, meaningful rewards, and balance between challenge, strategy, and pace. After analyzing five games, they found 235 playability problems. Some were more severe than others, but all had an effect on the overall game experience. The authors found that usability is the easiest to violate with 151 problems identified: common ones include having navigation issues, terminology-related problems, or unnecessary memorization aspects to the game. There were 10 mobility violations in regards to interruption of SIM cards and ease of launching games in any setting. Finally, the authors found 64 gameplay problems, primarily focused on having understandable goals (a core feature), letting the player be in control, and developing a balanced game. The main risk is that these problems increase as the game becomes more complex (Korhonen and Koivisto, 2006).

In the research paper "The Playtime Principle: Large-Scale Cross-games Interest Modeling", Sifa et al used a dataset (approximately 3000 PC and console games from the Steam platform, five billion hours of playtime, and six million gaming accounts) to also find that very few accounts tend to play more than 30-35 hours on any specific game. In addition, they find that gameplay as a function of time can be modeled using the Weibull distribution, despite differences in the playtime frequency distribution. After fitting the Weibull model to the games in the dataset, the authors utilized kernel archetypal analysis to identify four distinct playtime profiles. The first profile consists of action, indie, and First Person Shooter (FPS) games and represents 44% of their data. This profile experiences a sharp decline in the total playtime with a
cumulative playtime of several hours. The second profile represents 10.2% of the data and comprises of free-to-play strategy and casual games. Games here experience an increasing interest in gameplay until 4 hours and then a sharp decline after this mark. The three group is made up of adventure, and point & click games, approximately 22.4% of the data; these games have a slower decrease in playtime than the previous two profiles. In the last group, major title games consist of FPS, Third Person Shooter, and sports games represent the final 23.3% of the dataset. While these games have the slowest playtime decay, most accounts will quit before reaching 30-35 hours (Sifa et al, 2014).

The final paper "An Empirical Study of Game Reviews on the Steam Platform" deep dives into reviews of 6224 Steam games to see if they are similar to mobile app reviews. The authors Lin et al found that negative Steam reviews are typically posted after 50% of playtime of their positive counterparts. The majority of the reviews for free-to-play games are generally posted after one hour of playing possibly due to shorter gameplay or the player base churn out sooner from the lack of monetary investment. As expected, indie games have a higher community engagement in that they receive more suggestions in the reviews than their non-indie counterparts. Additionally, low-star ratings provide valuable information to the developers about the negative aspects of the game. But surprisingly in negative reviews, players complain more about game design (57%) than bugs that block users from playing (17%), implying that players value a well-designed gameplay over the quality of the software. The paper concludes that game reviews differ from mobile app reviews in several aspects. For one, game reviews tend to be fewer in median than mobile ones, but the length of game reviews are longer. Second, game reviews tend to have a higher percentage of reviews with valuable feedback for developers.
Finally, game reviews tend to include sarcasm and jargon unique to the game. Thus, automated methods could not be used to analyze game review without producing inaccurate results (Lin et al, 2019).

While I will not dive deep into one specific aspect of Steam games such as reviews, account profiles, and/or problematic designs, the previously mentioned research papers are still relevant to my research. I will analyze games at a more aggregate level, using several different game features to assess both game popularity and magnitude of its player base. Thus by comparing my results with specific literature surrounding other proxy variables, I hope to offer evidence in further support or against the current literature, while simultaneously offering my own interpretations of the results to add to the literature.
Data:

With immense coding help from my friend Jimmy, I was able to collect my data through web scraping the Steam store. This method was chosen because there are no publicly available datasets for Steam games along with their corresponding attributes. Additionally, Steam users are constantly downloading and/or gifting new games. One popular way of getting new games is through the Humble Bundle method, which is an online monthly subscription of game keys on a heavily discounted price to support charities. Therefore, it was important to include the most recent data for my analysis. To do this, Jimmy and I primarily relied on BeautifulSoup and Selenium to pull game data on various attributes. I originally had many explanatory variables. In response to our MMSS econometrics and thesis TAs\(^1\), I primarily focused on the price, discounted price, total number of reviews, number of positive ratings, genres, and tags, which I will further discuss in the Methodology (OLS) section.

As of May 2019, there are 30,233 games in the Steam store. After pulling this list of 30,233 games from the store, I used fuzzy matching to look for approximate matches on game titles to find that 10,311 games had corresponding data on the number of concurrent users from SteamDB.

Methodology:

One of the most parsimonious models for measuring effects of any relationship is the ordinary least squares, or OLS model. Such a model is known for its simplicity, clear assumptions, and easily interpretable results. Thus in this section, an OLS linear regression model is conducted to predict the number of concurrent users, as a measure for customer

\(^1\) Thank you Joe and Victoria for your unwavering support during our MMSS data review sessions.
retention. As briefly mentioned earlier, my independent variables are the game’s price (x1), discounted price (x2), total number of reviews (x3), number of positive ratings (x4), genres, and tags. The following lists the specific dummy variables in the latter two “umbrella” predictors:

- **Genre**: The game genre includes Action (x5), Adventure (x6), Casual (x7), Indie (x8), Massively Multiplayer (x9), Racing (x10), RPG (x11), Simulation (x12), Sports (x13), and Strategy (x14) -- 10 dummy variables
- **User-defined tags**: Story Driven (x15) and Open World (x16) -- 2 dummy variables

## Results and Discussion:

The OLS data displays a R-squared value of 0.519 and an adjusted R-squared value of 0.516. While a higher R-squared value generally indicates a model is well-designed, it makes sense that the OLS regression explains slightly over half of the data. As mentioned earlier,

|                | coef | std err | t     | P>|t| | [0.025 | 0.975 |
|----------------|------|---------|-------|------|--------|--------|
| x1             | 0.9999 | 0.060  | 16.689 | 0.000 | 0.879  | 1.121  |
| x2             | 2.8909 | 0.569  | 5.081  | 0.000 | 1.746  | 4.036  |
| x3             | 0.0003 | 0.001  | 0.329  | 0.754 | -0.002 | 0.002  |
| x4             | 0.8354 | 0.014  | 2.590  | 0.016 | 0.007  | 0.064  |
| x5             | 0.2065 | 0.121  | 1.701  | 0.099 | -0.041 | 0.454  |
| x6             | 0.0105 | 0.017  | 0.613  | 0.541 | -0.023 | 0.044  |
| x7             | 0.6087 | 0.292  | 2.091  | 0.046 | 0.013  | 1.204  |
| x8             | 2.1400 | 1.177  | 1.824  | 0.069 | -0.168 | 4.448  |
| x9             | 0.0817 | 0.017  | 4.823  | 0.000 | 0.048  | 0.115  |
| x10            | -0.1503 | 0.205  | -0.738 | 0.470 | -0.569 | 0.269  |
| x11            | 0.0184 | 0.024  | 0.763  | 0.452 | -0.030 | 0.007  |
| x12            | 0.0371 | 0.024  | 1.315  | 0.193 | -0.016 | 0.081  |
| x13            | -3.2332 | 0.927  | -3.477 | 0.001 | -5.089 | -1.357 |
| x14            | -0.0427 | 0.024  | -1.749 | 0.084 | -0.091 | 0.006  |
| x15            | 0.6119 | 0.288  | 2.128  | 0.042 | 0.025  | 1.199  |
| x16            | 0.0108 | 0.004  | 2.705  | 0.011 | 0.003  | 0.019  |
| const          | 10.1031 | 0.310  | 32.573 | 0.000 | 9.479  | 10.727 |

Omnibus: 0.410 Durbin-Watson: 1.998
Prob(Omnibus): 0.731 Jarque-Bera (JB): 0.610
Skew: 0.052 Prob(JB): 0.712
Kurtosis: 2.217 Cond. No. 27.6

The OLS data displays a R-squared value of 0.519 and an adjusted R-squared value of 0.516. While a higher R-squared value generally indicates a model is well-designed, it makes sense that the OLS regression explains slightly over half of the data. As mentioned earlier,
10,311 games of the original approximately 30,000-list had corresponding concurrent data. While a better fuzzy matching algorithm could increase the sample size, a high value like 94% would be most problematic, suggesting that the model is overfitting. Thus, having a close to 0.52 R-squared value shows that a reasonable level of variability is present in this analyzed dataset, despite a $\frac{1}{3}$ match.

Near the bottom of the table, we will discuss the validity of using the OLS method:

- Omnibus tests if the residuals have a normal distribution across the data. The Prob(Omnibus) tests the probability of the error being normally distributed. Here a 0.41 Omnibus value having a 73% probability shows that the data is normal to some degree but it has the potential to be more normally distributed.

- The Durbin-Watson value tests if the variance of the residuals is consistent in the dataset (also known as homoscedasticity). Ideally it would be between 1 and 2; here, the data is narrowly within bounds.

- The Condition Number (Cond. No.) value measures if the 16 independent variables are truly independent and not influence each other, distorting what the model truly represents. Since the number is less than 30, there is no multicollinearity.

Therefore based on these results, using the OLS method is valid.

In this paper, the independent variables are examined at the 95% significance level. That said, we see that price ($x_1$) and discounted price ($x_2$) are both statistically significant and positive. This is not a surprise; it is intuitive that the game companies will charge more for a decent game where they invest in substantial amounts of time and labor during its development.

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2 Thank you once again to Victoria for walking me through what these numbers meant and how to articulate this into the validity of the OLS method.
So a higher price generally translates to more gamers attracted to a high-quality game, especially for major commercial titles. Switching over to the next feature, the higher standard error in discounted price indicates that some games have problems being sold at retail price; thus, there is a higher variability in the discount component than at its regular price. Additionally, while the total number of reviews (x3) is not significant, the number of positive reviews is significantly positive. As expected, games with a higher number of positive reviews will have a higher number of concurrent players.

Next in regards to the genre category, the variables indicating action, adventure, indie, racing, RPG, simulation, or strategy genres are insignificant. These results are reasonable, considering that the single most notable racing game is *Rocket League* which was trending in the YouTube Gaming videos around two years. Unlike other racing games, *Rocket League* transforms a regular soccer game with racing cars instead of human players in a hilarious, enjoyable multiplayer setting. Other than *Rocket League*, a common alternative would be to play popular racing games sold on consoles such as *Mario Kart*. However, it is surprising to see that the indie games does not statistically stand out, even though previous literature cites that the indie game community has high engagement (Lin et al, 2019). It seems that while the community itself is dedicated, its overall player base may not be as significant as we had thought it would be. In addition, the casual game genre is surprisingly listed as significant and positive. Typically instead of using features that help automate even tedious aspects, most of the gaming experience would take pride in time-consuming activities or adventures with high reward when accomplished. Having casual games being statistically significant may be due to indicate a shift in gamer preference or a change in the Steam gaming demographic. The multiplayer category
also has a significantly positive coefficient in predicting a higher number of retained players. Having multiplayers helps with engaging more friends to play a specific game; thus, it is no surprise that would significantly help a game’s popularity. While this data was not part of the collection phase, it would be interesting to see if multiplayer games experience a significantly higher gameplay as opposed to their single-player counterparts.

Finally in terms of game tags defined by users, both open world and story driven are statistically significant with positive coefficients. These games also tend to be more expensive, even when the price is discounted. Open world games such as No Man’s Sky, Terraria, and the Grand Theft Auto Series allow players almost endless amounts of time to explore and enjoy their game-specific worlds and Easter egg content for their fans. These games tend to enjoy a large, dedicated fanbase loyal to a series like Grand Theft Auto. Similarly, a notable story-driven game is the Portal series and also enjoys a large gamer base.
Concluding Thoughts and Future Avenues of Research:

To start, I noted that due to issues of small sample size, the analysis was potentially inaccurate because small changes in the data set could ultimately produce dramatically different results. Thus even though I proceeded with the analysis, I cautioned that the results were likely to be strongly influenced by small sample size. While I mentioned that the OLS model had some validity, it is not completely robust. However the results still map the general direction of the Steam store and which PC games tend to have more players: games in the multiplayer and casual genres have a more concurrent players on average. Games with story-rich content and is open world also tend to do well in the Steam store. Finally, it is strongly suggested to invest money and skill into the development stages in order to produce a high-quality, well-designed game.

While I chose to analyze players using a linear regression model, another way would be to research a train/test split to yield more reliable estimates of concurrent players. Realistically, I believed the main obstacle was data collection, which was complicated. Upon pulling it, it was unfit for analysis in its premature stages. Much of my time this academic year was focused on aligning the data with Victoria and Joe to structurally improve its suitability for analytics. I also wanted to see if there was a specific download number that a game needed to hit in order to sustain its popularity and how many people are typically retained. But given that this data was not readily available for most games, I abandoned that route.

Secondly, one game can have multiple tags which can also overlap with specific genre names. It can vary from ‘RPG’ to ‘Great Soundtrack’. For instance, the following screenshot shows all the tags for the game DOTA 2:
During the collection phase, the high number of tags on each game led to an extreme number of categorical variables. So, I reduced it down to variables that had higher counts; then after helping me run multiple regressions with different tags, Victoria and Joe both strongly suggested using the two specific tags “Open World” and “Story Driven” as they were known to be popular.

Other than using a test/train split analysis, other models such as classification and Natural Language Processing (NLP) could be used. However adding more variables would likely run into severe multicollinearity issues. Additionally given that my data wasn't sufficient, running these models and analyzing them would likely yield confusing or contradictory results. Instead, a better alternative would be to gather more data. As the Epic Games expands its store, it would be worthwhile to collect playtime and user information if possible through further web scraping methods. However even though I learned a lot more about various data collection processes from Jimmy and through taking EECS 317, collecting additional datasets would realistically require more logistical planning that I did not have an appropriate amount of time after changing my thesis topic.

Ideally, using a diffusion model would prove simple if you have access to player data across multiple games. The diffusion or contagion model discusses how something like a game spreads in a population over time. Original assumptions include having a fixed relevant population, constant market potential, and uniform spread so that everyone can be exposed to the phenomenon of interest. However, since churn rates differ across players (i.e. each person starts, plays, and quits a game at different times,) we cannot use the diffusion model. Fortunately, this
type of data shows up in other fields such as reliability engineering and biostatistics. These areas utilize Mean Cumulative Function (MCF) to analyze recurrent events and associated costs. For the future research, the MCF model can provide estimates of the expected number of plays, purchases, and total playtime. In regards to retention, the estimated number of purchases indicates that the player has invested some amount of money in order to boost their progress in the game (Viljanen et al, 2017).

Designing a proxy for this was a difficult process and having the right data would mean either being intimately close to the game’s development process or getting this information through questionable means. For my research, I centered it around concurrent players, which does not truly differentiate a new player from a user who has been playing since the release date; rather, the concurrent number includes both. If we had the opportunity to extract such data, it would be a worthwhile process to see if other proxies can work. For instance, can specific game updates drive buy-rates and retain a bigger player base for longer periods of time? On the other hand, if the first few reviews on a new game is generally positive, would players be going into the game with a biased impression? Would the game in sense perpetuate reviews that are also positive and echo the same sentiment as the first batch of reviews? In this case, one should conduct a classification and/or NLP analysis. However as a mere economics major, I do not have the analytical rigor to do this accurately during the year. Regardless of which model is used, the collected data ultimately drives the appropriate type of model and thus determines which attributes of a game are truly significant and insignificant to its success and retention rate.

To conclude, these findings offer only supplemental evidence to related studies, while expanding the knowledge base of player retention in the PC games. Once again, I reiterate the
important fact that these results are marred by having a small sample size, and I recommend that further research in combination with a stronger data set are necessary to test more specific conclusions.
Works Cited


Appendix:

**Sample of BeautifulSoup code (courtesy of Jimmy)**

```python
# Sample of what the game data looked like in the preliminary stages of putting it together, showing the number of players from steamDB:

<table>
<thead>
<tr>
<th>AppID</th>
<th>Name</th>
<th>Release Date</th>
<th>Current Players</th>
<th>Day Peak Players</th>
<th>All-Time Peak Players</th>
</tr>
</thead>
<tbody>
<tr>
<td>105600</td>
<td>Terraria</td>
<td>5/16/2011</td>
<td>16,537</td>
<td>18,229</td>
<td>159,175</td>
</tr>
<tr>
<td>238960</td>
<td>Path of Exile</td>
<td>10/23/2013</td>
<td>16,473</td>
<td>25,685</td>
<td>98,445</td>
</tr>
<tr>
<td>552500</td>
<td>Warhammer: Vermintide 2</td>
<td>3/8/2018</td>
<td>8,792</td>
<td>13,398</td>
<td>73,316</td>
</tr>
<tr>
<td>264710</td>
<td>Subnautica</td>
<td>1/23/2018</td>
<td>3,360</td>
<td>4,130</td>
<td>51,156</td>
</tr>
<tr>
<td>489520</td>
<td>Minion Masters</td>
<td>5/24/2019</td>
<td>425</td>
<td>1,692</td>
<td>10,329</td>
</tr>
</tbody>
</table>
```

*(Formerly - For Professor Ferrie) Winter Milestone Meeting Minutes - Factors that Contribute to Virality and Player Retention in Mobile Games*

Total revenue from the mobile game industry hit at least $60 billion two years ago and is expected to pass $80 billion by the end of 2021. Many technology analysts attempt to attribute the mainstream success of viral mobile games such as *Candy Crush* and *Game of War* to many qualitative factors such as market timing, an easy gameplay structure, and especially luck. But, knowing where to broadcast a game or implement a "sharing" feature can make a difference in having a game with 1000 downloads or an instant hit with 500 million downloads in its lifetime. But we can also look at what games do well in terms of marketing. Additionally, due to over-saturation in this market, creating a viral game that also retains its player base is quite difficult, especially when Blizzard and Riot Games declare their intent to making mobile versions of their popular PC and video games. Thus, my thesis will look into factors that contribute to virality and player retention in mobile games.

In regards to existing literature analyzing consumer preferences, papers mainly focus on game-driven factors that boost download rates. One paper found that perceived ease of use is important to players who prefer games that maximize simplicity. On the other hand, actual enjoyment is crucial to younger players and those with prior gaming experiences. The most relevant paper to my topic concerns elements of game design. These contribute to playability metric. The basic idea is that if players have smooth gameplay in the beginning, they are likely to
keep playing. But if there are problems at the start, the player base will find it more difficult as they reach higher levels or endgame content. However, these previously mentioned findings confirms what makes sense. Therefore, pre-existing data on mobile games and, especially mobile users, is lacking or out-dated.

So far, I have looked into publicly available datasets and looked into ways to clean and re-align this data. I have met with Professor Markovich who has expertise in disruption and multi-market competition in IT and FinTech markets. We went through my current datasets, those that I have re-aligned and structurally improved its suitability for analytics so far.

The original plan was to utilize a variation of diffusion model, which discusses how something like a mobile game spreads in a population over time. Original assumptions include having a fixed relevant population, constant market potential, and uniform spread so that everyone can be exposed to the phenomenon of interest. However, since churn rates differ across players (i.e. each person starts, plays, and quits a game at different times,) we cannot use the diffusion model. Fortunately, this type of data shows up in other fields such as reliability engineering and biostatistics. These areas use Mean Cumulative Function (MCF) to analyse recurrent events and associated costs. For the thesis, MCF can provide estimates of the expected number of plays, purchases, and total playtime. In regards to retention, the estimated number of purchases indicates that the player has invested some amount of money in order to boost their progress in the game. As we move into the next quarter, I will continue to look into pre-existing Kaggle projects if supplemental data is needed and fill out IRB forms to assist survey data for Screen Time usage.

As more and more people are willing to pay for convenience, exposure to new games rely on ads and marketing. But as the mobile industry continues to grow, it is important to look into not only factors to attract new players but also strategies to retain players (i.e. what level of event spamming is appropriate, having certain updates that improve usability). It would be interesting to see what updates have the most effect on both adoption and retention rates (i.e. number of new active players versus number of retained or returning players.)

**MOBILE COUNTERPART:** This is relevant because many games want to do mobile versions of their PC/steam counterparts. One of the most highly anticipated games is DOTA Auto Chess from Valve who created DOTA 2, one of the more popular

**MICRO TRANSACTIONS:** specific trend within the gaming industry is transforming one-time game purchases into a microtransaction-driven industry. This is due to the low costs of virtually developing in-game goods and the ease of selling it in this business model.

**Formerly - For Professor Ferrie) - Literature Review on Mobile Games:**

In the "Determinants of Adoption" paper, the authors explores technology acceptance model (TAM) of mobile game acceptance. Existing literature overlooks major psychological influence, and thus, the authors consider gender, age, and prior experience to segment users.
Using data from forty-three university students in three days to draw a 1011-response sample size, the paper first concludes that perceived enjoyment has the most substantial effect on the intention to play games, implying that psychological factors have more importance in the game industry. Second, perceived ease of use is important to actually enjoying the game, so developers should maximizing simplicity in game design. Third, perceived usefulness and enjoyment is important to a user's flow experience. If users familiarize themselves with one game, they are less likely to play a new one because they are immersed in their first one. Fourth, acceptance of a new game depends on age: the female demographic tend to rely on perceived ease of use than men do so. Finally, younger people and expert gamers care more about actual enjoyment than older people and starters. Therefore, the authors conclude that the market should find ways to improve public perception of their mobile game products in the two prior groups.

In the paper "Playability Heuristics for Mobile Games", the authors Korhonen and Kovisto deep dive into specific technical aspect of mobile games to identify playability problems based on mobility, usability, and gameplay. Usability heuristics include supportive audio-visual representation, efficient and visually pleasing screen layout, understandable terminology, and containing game help. Whereas, mobility heuristics was evaluated by how the game responds in diverse and unexpected environments, and gameplay through clear goals, meaningful rewards, and balance between challenge, strategy, and pace. After analyzing five mobile games, they found 235 playability problems. Some were more severe than other, but all have an effect on the overall game experience. The authors found that usability is the easiest to violate with 151 problems identified: common ones include having navigation issues, terminology-related problems, or unnecessary memorization aspects to the game. There were 10 mobility violations in regards to interruption of SIM cards and ease of launching games in any setting. Finally, the authors found 64 gameplay problems, primarily focused on having understandable goals (which is a core feature), letting the player be in control, and developing a balanced game. The main risk is that these problems increase as the game becomes more complex.

In Liang and Yeh's "Effect of Use Contexts" paper, the authors explore an extension of the TAM model and suggest that service providers must consider the effect of use contexts and specific audience needs when design mobile services. Integrating TAM and the theory of reasoned action (TRA), Liang and Yeh investigate whether contextual factors significantly impact a user's intention to use mobile games, clarify crucial factors in influencing the use of mobile games, and evaluate whether TAM can be a better predictor for the intention to use mobile games. The research framework includes variables such as playfulness, ease of use, player attitude, and subjective norm on continuance intention. They initially hypothesize that the attitude towards playing mobile games is influenced by perceived playfulness and ease of use, and that the intention to continue playing is determined by the previously mentioned factors in addition to the attitude towards playing and the subjective norm of the user when playing the game. Through their experiment on student and non-student groups, they found that the TAM fits best for students under pressure of having another task in hand and fits relatively poor when
non-students have no tasks. Subjective norms can influence students who have tasks, while perceived playfulness is a significant factor on continuance intention when students have homework and when they are at home. The authors also found that when users had no tasks, the intention to play is mainly determined by personal attitude and personal perception of whether the reference group agreed on playing the game, and that when users had to play the game under pressure of completing another task, the subjective norm had no effect, and personal attitude toward the game dominated the person's intention to play, accounting for the nature to unwind or shift attention during a pressure situation. Therefore, the authors suggest that use contexts and different lifestyle groups should be considered when new mobile services are introduced.

In Rosenkranz and Myers' paper, they leverage a machine learning and real-time predictive modeling tool to assess location-based activity in mobile phones within the Santa Monica city of California. They define small-radius areas (20 meters) as "micro" geofences and citywide or neighborhoods as "macro" geofences, and measure each of the clickthrough rates. They find that macro geofenced ads had a significantly higher click through rates than micro ads; in other words, mobile users outside of the micro geofence clicked on ads more frequently than those within the fenced locations. They also found that web ads had significantly higher click through rates than in-app ads. There also exists a significant interaction between the advertisement type and location.

Even though ads in both web and apps have significantly higher click rates in the macro geofenced condition, the difference in clickthrough rates between micro and macro geofenced ads was the largest in the web. Finally, there are no significant differences in clickthrough rates among advertisement size. The authors' interpretation of these various results is that many organization are hesitant in incorporating predictive technologies because they do not understand how exactly they work. Regardless, marketers can still profit off of these machine learning tools even in early development stages, as seen in this simple behavioral response through click through rates. The fact that users in macro geofenced areas click on ads more than those in micro geofenced areas supports the existing literature that the relevance of the message can be an important factor when implementing an effective digital advertising platform. The authors also suggest that if users feel that some location-based ads are intrusive to their privacy, it can cause some delayed action. One limitation was a shorter-than-ideal campaign period: a longer study can account for better optimization and forecasting in terms of ad content and design. Additionally, mobile sizes were limited to 320 by 50 pixels and 300 by 250 pixels; other formats like horizontal ad banners should be considered in future research.

In the "Mobile Location-Based Advertising" paper, Limpf and Voorveld delve into how information privacy concerns influence consumers' attitude and acceptance. The initial hypothesis is that privacy concerns may potentially hinder user acceptance and thus the effectiveness and growth of mobile location-based advertisement (LBA). The author design an experiment to test push (advertising delivered to phone upon request) and pull (delivered without explicit request) mobile LBA and track the acceptance rates of both. After carrying out an online
experiment, the authors found that privacy concerns had a significant negative effect on acceptance intentions and that the negative effect of privacy concerns on attitude toward mobile LBA was both stronger and significant for push, compared to pull LBA. The former is possibly motivated by users who are highly concerned about their privacy may perceive their freedom to control their privacy as threatened and subsequently feel defensive, exhibiting low acceptance rates towards mobile LBA. However, the authors also found that privacy concerns do not directly influence attitudes towards LBA; this can be explained by the significant interaction between privacy concerns and the type of mobile LBA.

As more and more people are willing to pay for convenience, exposure to new games rely on ads and marketing. But as the mobile industry continues to grow, it is important to look into not only factors to attract new players but also strategies to retain players (i.e. what level of event spamming is appropriate, having updates that improve usability). It would be interesting to see what updates have the most effect on both adoption and retention rates (i.e. number of new active players versus number of retained or returning players). Furthermore, my thesis paper will also explore the criteria of the mobile app store uses for specific genres to provide insight of not only the barriers-to-entry of this market but also the general trend of industry.

- End of appendix -