Data-driven Analysis Platform for Indie Mobile Game Publishing

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ABSTRACT
With the appearance of mobile game devices and third-party game distribution channels, such as *App Store* and *Google Play*, more and more independent (Indie) game studios are doing mobile game development and publishing themselves. However, research on using game analytics to help these indie game developers with game publishing is scarce. In practice, due to lack of experience, it is hard for most indie game developers to get correct data and analyze it professionally. In order to guide indie game developers with mobile game publishing, this paper extends the existing ARM funnel model and provides a new concept of mobile game publishing, which can be recognized as two inputs and one output. Then, a mobile game publishing analysis platform called the F2PAP is designed and developed based on the new concept. It can guide indie game developers with data collection, analysis, and visualization for game business evaluation and improve game publishing performance.

Keywords
business intelligence, game analytics, metrics, indie game developer, marketing, distribution.

INTRODUCTION
The concept of value chain comes from business management and was first described by Porter (1985, p. 36): "*Every company is composed of a set of activities performed to design, produce, deliver, bring to market and support the product. All these activities can be represented by a value*". The traditional game industry value chain is a retail-driven value chain that includes the game developers, publishers, distributors, retailers, and consumers, as shown in Figure 1 (European Games Developer Federation, 2011). According to the retail-driven value chain, the game developers release software to make players play digital games with specific devices. Game publishers are software marketing companies that market the game titles and distribute them to retailers and end-consumers. Distribution and retail sale to the end-user is made through specialized agents that sell the game in exchange for a fee based on the sales. This value chain is derived from the giant game companies producing big title games (Egenfeldt-Nielsen et al., 2016). From the retail-driven value chain, it is clear that the game business was dominated by big companies who owned the game distribution chain themselves, such as *Nintendo* and *Sony*. It was hard for indie game developers to compete with these giants as they controlled the whole game industry process from hardware development to the game distribution to the players for a long time in the past. However, the industry is moving away from shipping "box" product games to operating "live" service games, and indie game studios indeterminately support and periodically release and publish content incrementally for existing games instead of developing new games(Dubois and Weststar, 2021)

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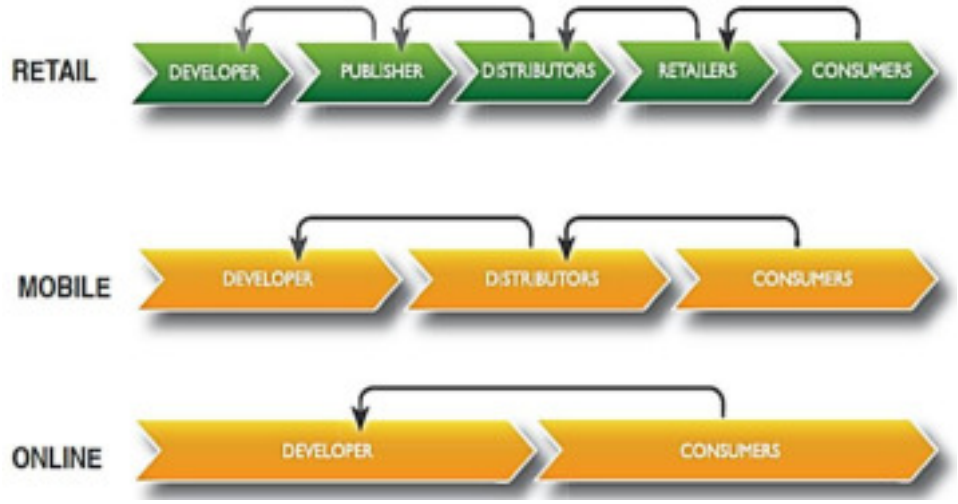

Figure 1: Comparison with different game value chains (from European Games Developer Federation, 2011).

With the appearance of mobile game devices and third-party game distribution channels, such as *App Store* and *Google Play,* the original retail-driven value chain has been complemented with the mobile and online value chains. The mobile value chain refers to a situation where the game developer can develop a game for the mobile phone and publish it on all app stores themselves. However, many indie game studios that are good at game development lack experience in game publishing (Guevara-Villalobos, 2011). They do not know how user acquisition works or how to transfer users into loyal and paying players (Mendez, 2017). The indie game developer is compared with the AAA game company who lacks game development resources (Gnade, 2013). There is a disjunction of three different types of independence that can be used to define independent games: financial, creative, and publisher independence. Financial independence means that the developer funds its own game with no external finance from any third party. Creative independence means that the creative process is flexible, and the developer can create what they want. Lastly, publishing independence means self-publishing, where the developer is also the publisher (Garda and Grabarczyk, 2016). Compared with financial independence and creative independence, helping the indie game developer with game publishing is the most meaningful part.

As for the definition of game publishing, Limpach (2020) points out that it is challenging to deliver the one universal explanation of game publishing. Because the individual market players each have their subjective view of publishing. Game publishing sums up everything, which helps as many users enjoy the game as possible. The publishing needs to implement analytics to monitor acquisition, gameplay, retention, and monetization (Limpach, 2020). Besides this, with the emergence of the *IOS App Store* and *Google Play*, these distribution channels also provide indie game developers with some tools for publishing, such as *iTunes Connect* and *App analytics*. These tools provide the basic functions for indie game publishing, including impressions, product page views, installations, sessions, active devices, crashes, and simple community management. These tools help indie game developers to do publishing. However, these basic tools cannot explain the indie game developer about mobile game publishing. They cannot provide clear guidance to the indie game developers, such as what kind of data they need to collect, how to do the analysis, and how to do the marketing during their game publishing (Su et al., 2020).

In order to address the above issues, this paper first extends the existing ARM (Acquisition, Retention, and Monetization) funnel model and proposes a new concept

about mobile game publishing. Based on this new concept, a data analysis platform called the F2PAP (Free-to-Play Analysis Platform) is designed and developed to guide indie game developers with their mobile game publishing. This platform provides solutions about two inputs and one output from the new concept and addresses publishing challenges by automatic data analysis. It can be used for different free-to-play (F2P) mobile game publishing, choosing the free download and in-game payment mode. A unified solution is provided, constructed based on the new concept of mobile game publishing. The rest of this paper's structure is as follows: Section 2 introduces recent research on game analysis and potential problems. Section 3 discusses the research method and process. Section 4 provides a new concept of game publishing and analyzes the player's behavior changes during the mobile game publishing. Section 5, based on the previous new concept of game publishing, the F2PAP is designed and developed to address the main challenges of indie mobile games and provide data-driven solutions for indie game developers. Section 6 presents the application of the F2PAP with three different scenarios. Finally, in Section 7, the conclusion is made about the application of this platform, and the future work is discussed.

RELATED WORK

Business Intelligence (BI) combines operational data with analytical methods to present complex and competitive information to decision-makers (Negash, 2004). BI can be applied in many industries to improve efficiency and save costs through effective decision-making. Stackowiak et al. (2007) define BI as the process of taking large amounts of data, analyzing data, and presenting a high-level set of reports. It condenses the essence of data into the basis of business actions, enabling management to make fundamental business decisions. Sturdy (2012) views BI as the way and method to improve business performance by providing powerful assists for executive decision-makers and enable them to have actionable information at hand. The role of BI at most companies is to help interpret the data and turn it into actionable strategies for the company to move forward.

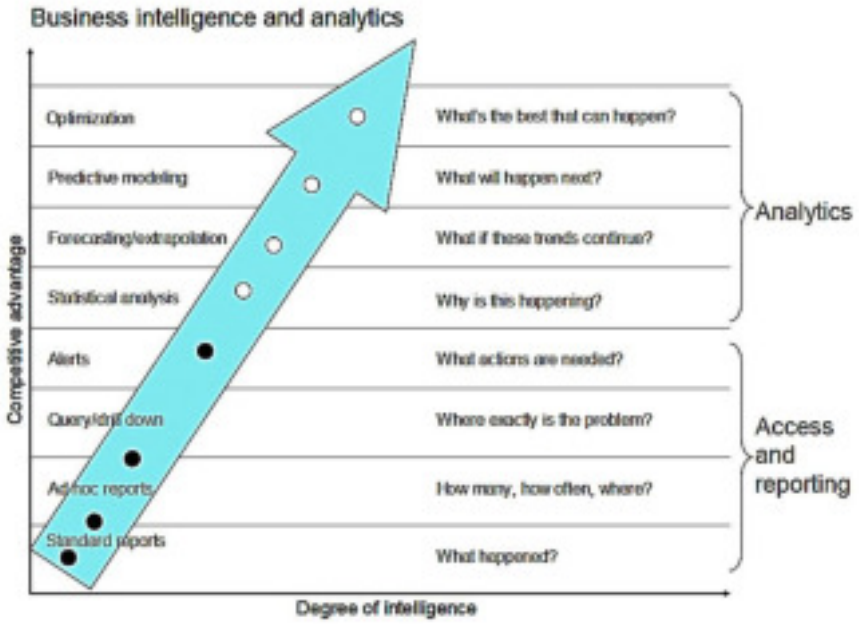

Figure 2: Degree of business intelligence and analytics (from Davenport and Harris, 2007).

Analytics means the extensive use of data, statistical and quantitative analysis, explanatory and predictive models, and fact-based management to drive decisions and actions (Davenport, Harris, and Morison, 2010). Many organizations use analytics to

segment their customers and identify their valuable customers. For example, many companies analyze data to understand customer behaviors, predict customer requirements, and offer suitable products and promotions. As for the relationship between BI and analytics, analytics can be recognized as a subset of business intelligence, a set of technologies and processes that use data to understand and analyze business performance. According to Davenport and Harris (2007), there are different degrees of intelligence, as shown in Figure 2. BI includes both data access reporting and analytics. Access and reporting are only based on the standard reports and focus on what happened, how many, how often, where it happened, where the problem is, and what actions are needed. However, analytics focus on statistical analysis, forecasting and extrapolation, predictive modeling, and optimization compared with access and reporting. Analytics is valuable for discovering why things happen, understanding trends, and figuring out what will happen next. It can be used for prediction, and that is also a valuable part of game analytics.

Game analytics is the process of identifying and communicating meaningful patterns that can be used for decision-making. Drachen et al. (2013) point out that game analytics can thus be understood as applying analytics to game development and game research. Game analytics can identify in-game balancing issues (Kim et al., 2008), visualize the player's movement path on the map (Moura et al., 2011), reduce game development costs (Hullett et al., 2011), and find game bugs and fix them (Zoeller, 2013). However, by now, most of the research topics focus on how game analytic can be used for game development and game research (Drachen et al., 2013).

As for the related mobile game analytics, Flunger et al. (2019) focus on analytical and predictive models for F2P games. They discuss the use of game analytic in the F2P game, especially for helping the game developers with game player churn prediction and player lifetime value prediction. Drachen et al. (2018) provide a heuristic-based approach to predict player retention. This fast prediction uses the first session from the player’s activity and the day and week of information to achieve reasonable and comparable performance. Petersen et al. (2017) developed a lab-based mixed approach to evaluate the user experience of the mobile game. It was also applied across many participants to different genres evaluation. Isaksen and Nealen (2016) provide a statistical analysis of player improvement and achieving high scores based on game analytics. They found that the more players play, the faster the chances of getting a high score by analyzing the probabilities of two popular mobile games. However, the application of game analytics in the mobile game area is in its infancy, and the available knowledge is heavily fragmented (Drachen et al., 2016).

As for the game analytics used for indie game developers, Koskenvoima and Mäntymäki (2015) surveyed small and medium-size game developers about why they use game analytics. They analyze the collected data through in-depth interviews with a group of small and medium-sized game developers. Research results show that the main reason for using game analytics includes three parts: First, game analysis can assist the development and game design. Second, based on data analysis, the game developer can effectively reduce game development and publishing risk. Third, through game analytics, the developers can negotiate with investors and publishers. However, this research only explains why indie game developers use game analytics instead of exploring the main challenges for indie game developers during their game publishing process and how to use game analytics to address these main challenges.Whitson (2019) summarized three kinds of analytics tools used for F2P mobile games and pointed out that analytics create new resource barriers and literacies that restrict who can collect, analyze, and make data actionable, limiting which indie game studios enter the mobile sector.

As for the game publishing model, Moreira et al. (2014) use the ARM funnel model as the basic analysis. It was created by *Kontagent* and was originally only used for social games (Aaron, 2011), as shown in Figure 3. It just visualizes the process of how gamers pass through a funnel that can be used for visualizing the mobile game publishing process by the three stages: acquisition, retention, and monetization. The acquisition for social games mainly comes from viral channels, which are more valuable to game developers because they help reduce user acquisition costs. The K factor is a key indicator of game virality and can show the number of players who join the game through viral sources. So, the ARM funnel model mainly focuses on the viral K factor promotion effect if K-LTV (Life Time Value) is greater than CAC (Customer Acquisition Cost).

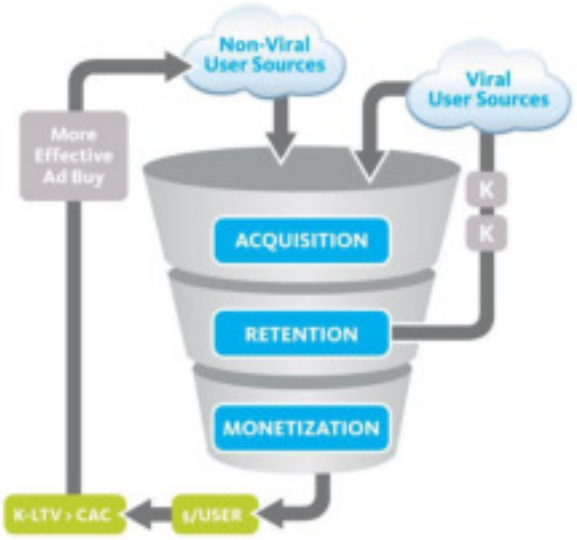

Figure 3: ARM funnel model (from Aaron, 2011)

However, the ARM model only describes the player life cycle from awareness to purchase. It cannot show how the game content affects acquisition, retention, and monetization. It ignores the game content itself, and the relationship between the new players from the channels, new content, and the revenue is hard to capture by the ARM funnel model. The ARM funnel model cannot solve the potential issues beyond acquisition, retention, and monetization. It is hard for indie game developers to understand and use during their mobile game publishing.

Limpach (2020) also pointed out that new updates need to be developed after the initial game release, and publishing needs to implement analytics to monitor gameplay, retention, and monetization. Based on the previous interviews with indie game developers, they face challenges when using the BI in their game publishing. They are not very clear about what data need to collect, how to do the analysis, and how to do the marketing (Su et al., 2020). Therefore, it is essential to provide a new concept about mobile game publishing and let the indie game developers know the mobile game publishing logic, the related metrics, and analysis methods.

RESEARCH METHOD

Design Science Research (DSR) creates this type of missing knowledge using design, analysis, reflection, and abstraction (Vaishnavi and Kuechler, 2015). Hevner et al. (2004) point out that design science creates artifacts that satisfy a given set of functional requirements by the knowledge expressed in the form of constructs, techniques and methods, models, and instantiations. They discuss that design science addresses

research by building and evaluating artifacts designed to meet the identified business needs. The design science in information system research describes the conceptual framework for understanding, executing, and assessing information system research. As this research focus on addressing indie mobile game publishing challenges and plan to create and develop a new artifact, the DSR method is suitable.

In practice, there are three stages to choose the different indie game studios that cooperated, created, and developed this artifact. The main challenges of the indie game studio are identified through interviews with five indie game studios based in Sweden and China (Su et al., 2020). Then, the artifact is created and demonstrated with four indie game studios based in Sweden. Finally, the artifact is evaluated with more different indie game studios based in Asia. These selections followed the DSR research process, and different stages have different aims for artifact development and iteration. The focus of this paper is to describe the artifact design (i.e., the F2PAP) and its practical and theoretical foundations. The early choice of indie game studios was to understand these indie game developers, the main challenges they faced in the game publishing process, and provide a solid research foundation. The middle stage of the cooperation with indie game studios is used to **design, test** and iterate the artifact. With these indie games studios, especially involving their actual game publishing projects, the artifact can be further optimized and iterated to address the main challenge found before. The final stage of the cooperation with indie game studios is to test how well the artifact can help the indie game studios address the main challenges during their mobile game publishing.

NEW CONCEPT ABOUT MOBILE GAME PUBLISHING

The idea to extend the ARM funnel model for mobile game publishing originally came from a literature review and interview research with different indie game developers. Through interviews with indie game developers, they have used third-party game analysis tools, such as *Firebase* and *Game analytics.* These tools have also introduced ARM funnel model elements into the functional design of these tools, such as Acquisition, Retention, and Monetization. However, they still have challenges with mobile game publishing. Because with the abstraction of the ARM funnel model, indie game developers still lack an understanding of mobile game publishing. They do not know the basic logic of mobile game publishing and how to use BI to guide mobile game publishing, especially what data need to collect and how to do the data analysis and how to do the marketing based on data analysis (Su et al., 2020).

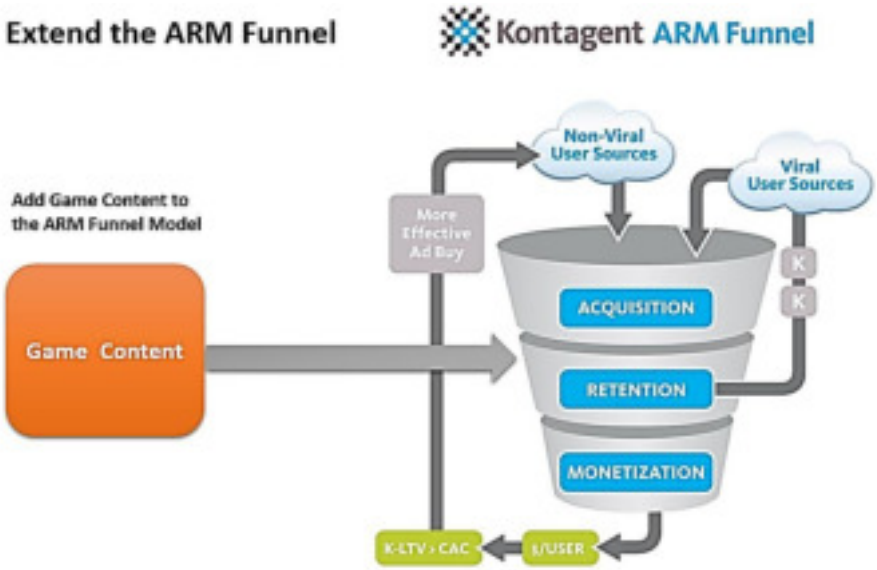

Figure 4: Extend the ARM funnel model

Besides this, the ARM funnel model is initially designed for social games, not for mobile games. It ignores the game content itself, significantly how the new content affects acquisition, retention, and monetization. The ARM funnel model is extended from social game publishing to mobile game publishing, add the game content into the existing ARM funnel model, and introduce more metrics and analysis methods to guide indie mobile game publishing in a structured way, as shown in Figure 4.

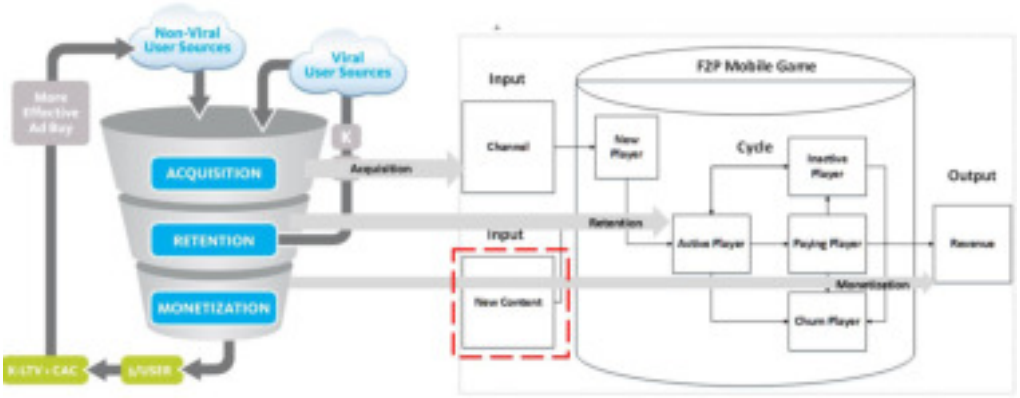

Figure 5*:* Compare the ARM funnel model with the new concept of mobile game publishing logic

Compared to the previous ARM funnel model, the game content is introduced into the existing model, and a new concept for mobile game publishing is proposed. Based on this new concept, mobile game publishing can be regarded as two inputs and one output. The related game metrics and data analysis methods are introduced for different parts. As shown in Figure 5, the new concept of mobile game publishing logic extends from the ARM funnel model, so it includes acquisition, retention, and monetization inside. However, for mobile game publishing, the developers need to do the channel promotion for user acquisition, release the new content, increase the revenue for monetization, and track player behaviors changes, especially for retention. So it contains two inputs, the channel and new content, one output, the revenue, and player five behavior status changes, including new player, active player, inactive player, churn player, and paying player. During the mobile game publishing process, the new player mainly gets through *App Store* and *Google Play* channels. When new players enter the game, they will become active players. Active players can generate game revenue by payment in the game and convert to the paying players. However, as time changes, active players can become inactive players or churn players. Paying players also can change to churn players and inactive players. The indie game developers need to consider maintaining active players during the game publishing process, reducing the churn players, stimulating inactive players, and making more active players pay in the game.

Channel: The main role and value of the channel for mobile game publishing is the acquisition. How to obtain potential players through effective marketing is vital for mobile game publishing. For mobile game publishing, the primary demand is to get effective users through channel promotion, which can be obtained through the *App Store* or *Google Play* channels. The quality of players can be evaluated from different channels by defining different metrics related to the channel.

New Content: The new content constantly represents iterating game content and continuously releasing new game content during the mobile game publishing process. Generally, new game content means the update of a new game version. In mobile game publishing, new version updates are beneficial for maintaining active players and

driving revenue. The effects of different game version updates can be evaluated by defining a series of metrics related to new content and guiding further version optimization.

Revenue: The revenue is the output of mobile game publishing, which is related to the monetization. Game developers face issues with a revenue forecast for their games during the game publishing process. Based on the revenue forecast, they can make a business plan for marketing promotion, such as how much marketing budget needs to be spent. It is also possible to follow up on game development costs and set up benchmarks for evaluating game publishing performance.

Player behavior changes: During mobile game publishing, the player behavior occasionally changes, especially when giving different inputs. These inputs will affect the player's behaviors, which leads to the conversation between different states. This part is also related to the retention.

- First, the new player is coming from the channels. Channels are the essential sources of user acquisition for mobile game publishing. How to optimize the user acquisition process through channel analytics, reduce user acquisition cost, and improve user acquisition efficiency is vital for game publishing.
- Second, the active player needs to be maintained during game publishing. From the aspect of stimulating activity, how to promote player activity through new game version updates is a potential issue for mobile game publishing. The improvement of player activity is to maintain existing active players, avoid the active player churn, and turn inactive players into active players.
- Third, the paying player is the key to the revenue. How to get more paying players benefits monetization. The goal is to convert the active player to paying players through effective game publishing activities. It means to increase the proportion of payment for games.
- Fourth, the in-active player is the majority in the game. How to reactive the inactive player is the meaningful part of mobile game publishing. How many in-active players return to the game and become active players is related to retention. Besides this, using of push notifications can help reactive the inactive players during the new version update and the marketing promotion.
- At last, how to reduce player churn, increase retention is also a valuable part of game publishing. Effectively reducing the churn rate can be based on game optimization and bringing new content to attract the churn player.

In short, based on the new concept of F2P mobile game publishing, a new artifact is designed and developed, the F2PAP with application guidelines to drive mobile game publishing through game analytics and address the main challenges from the indie game publishing side. Reasonable decisions and solutions should be provided by data-driven which will benefit the mobile game marketing promotion, guide the new version update, predict the game revenue and set it as a benchmark to drive the mobile game publishing process.

F2PAP ARCHITECTURE

In order to address the indie mobile game publishing main challenges, the analysis platform is developed with four parts, including the publishing theory and three functions. The publishing theory includes the mobile game publishing task, publishing logic, and player scenarios. The three functions include the new version update evaluation, marketing evaluation, and revenue forecast. These three functions come from the new concept about mobile game publishing logic which can be recognized as two inputs channel promotion evaluation, new game content evaluation, and one output revenue forecast. The main challenges about indie game publishing, especially the data

collection, data analysis, and marketing challenges, can be addressed by the Free to Play Analysis Platform (F2PAP), shown in Figure 6.

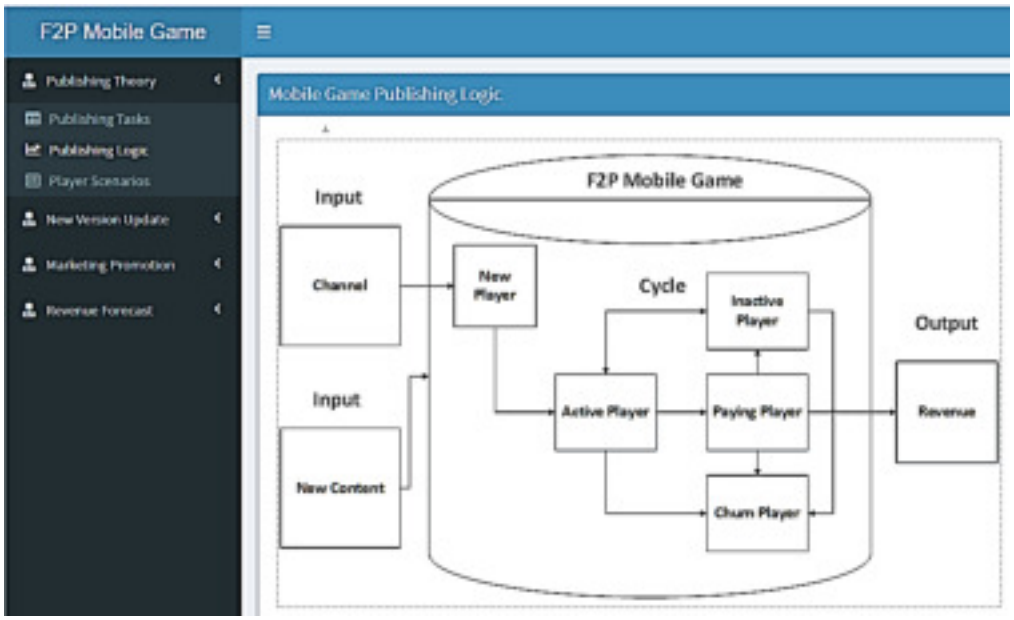

Figure 6: F2PAP (https://sutor-yan.shinyapps.io/F2PAP/),

The F2PAP provides the indie game developers the online web tool to upload their game publishing data and get the comparative and correlation analysis results and also the revenue forecast by clicking the related tags. In practice, the F2PAP provides two different analysis methods, one time series prediction model and colorful visualizations of different inputs and output that follows the new concept of mobile game publishing logic. The F2PAP contains various functions, including the new version update evaluation, marketing promotion evaluation, and revenue forecast. All of these functions execute automatically after related data is loaded into F2PAP. It can quickly provide the data analysis result and the suggestions for the subsequent optimization.

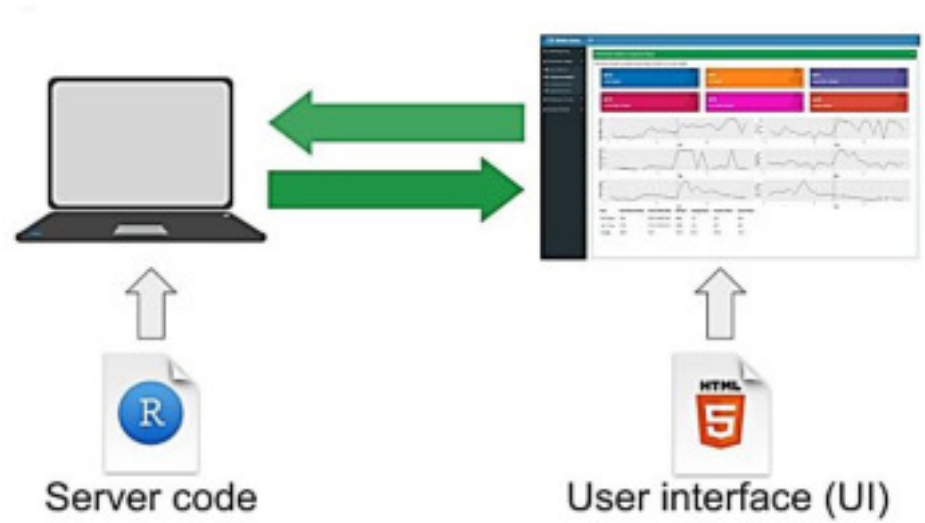

Figure 7: Host the F2PAP on a webpage

About the creating process, the F2PAP is developed by R *ShinyApp*, which can put the R code in the Shiny and release the online web tools for indie game developers. Shiny

is an R package that makes it easy to build interactive web apps straight from R. The standalone apps can be hosted on a webpage or embed them in the *ShinyApp* dashboard, and the indie game players can access the F2PAP by online address, as shown in Figure 7. According to the data collection template, the indie game developers only need to upload their mobile game publishing data and get the analysis result by clicking the related tags.

Input: New Version Update Evaluation. According to the mobile game publishing logic, how the new content input affects the in-game players and output revenue is addressed. The F2PAP is designed and developed for the indie game developers and uses the new version update metrics, including the New Version Change Rate (NVCR), to measure different new version update performance by comparative analysis. Based on the analysis result, the indie game developers can conclude the new version update performance evaluation. It can also point out the weak performance of the new install or active players and any problem with the new player or active player payments by correlation analysis and suggestions for the next version update.

Input: Marketing Promotion Evaluation. The channel promotion evaluation focuses on how the channel input affects the in-game players and the output revenue based on the mobile game publishing logic to address the marketing promotion challenge. The related metrics and analysis methods for the marketing promotion evaluation are also provided. For mobile games, marketing promotion can be recognized as choosing different channels for user acquisition. In the F2PAP, the channel metrics, including the Cost Per Click (CPC), Click Through Rate (CTR), Conversion Rate (CVR), Cost Per Install (CPI), eCPM (Cost Per Mile), and also the in-game metrics such as install, paying player, revenue, DAU(Daily Active User), inactive player, and churn player can be used to do the evaluation. It can find out potential issues and give suggestions to indie game developers about their mobile game marketing promotion.

Output: Revenue Forecast. As for the output revenue forecast, game developers face issues on how to do a revenue forecast for their games during the game publishing process. Usually, the revenue forecast is calculated by MAU (Monthly Active Users) and ARPU (Average Revenue Per Users) (Financial-Modelling.net, 2012). The artifact is iterated with new metrics and a time series prediction model based on historical data. Combined with the mobile publishing logic, the revenue forecast can be recognized as output, especially for the revenue part. In the F2PAP, the metrics such as the Monthly Revenue (MR), and the prediction method are provided to get the forecast result. In addition to comparing the revenue forecast with the real revenue, the most valuable part is setting the revenue forecast as a benchmark for developers to evaluate whether their game publishing performance meets this benchmark. Otherwise, suggestions are provided to analyze the reasons and take action to improve the game performance. The F2PAP can provide revenue forecasts for indie game developers. They only need to upload the historical data based on revenue metrics and get the prediction result directly.

F2PAP APPLICATION

Based on the new concept of mobile game publishing, the F2PAP is created and developed, then apply it to indie game projects and guide indie game developers to publish mobile games and address their main challenges, which were found in previous research. Therefore, those who want to use and implement the F2PAP should be indie game developers or indie game studios doing mobile game publishing themselves. Besides this, the indie game developers have three different scenarios to use this analysis platform and mainly focus on guiding the F2P mobile game publishing.

Example Scenario: New Version Update Evaluation

An indie game studio has just launched its mobile game. They usually need to keep releasing new versions during the mobile game publishing process to attract and maintain game players and extend the mobile game lifetime. However, it is hard for them to know if players favor their new content. Combined with the new concept of mobile game publishing, the new version update can be recognized as new content input. The relationship between the new content input, in-game players, and revenue output needs to be determined. In the F2PAP, the new metric New Version Change Rate (NVCR) is added to measure the new version update performance. It includes the install change rate, DAU change rate, inactive player change rate, paying player change rate, churn player change rate, and revenue change rate.

Figure 8: New version update evaluation with comparative analysis

In practice, two different analysis methods are used. The comparative analysis focuses on similarities and differences in values of variables (Pickvance, 2001). The comparative analysis mainly focuses on explaining the differences before the new version update and after the new version update, as shown in Figure 8. Besides this, correlation analysis is also involved, which can help game developers deeply analyze variables related to the game version update, as shown in Figure 9.

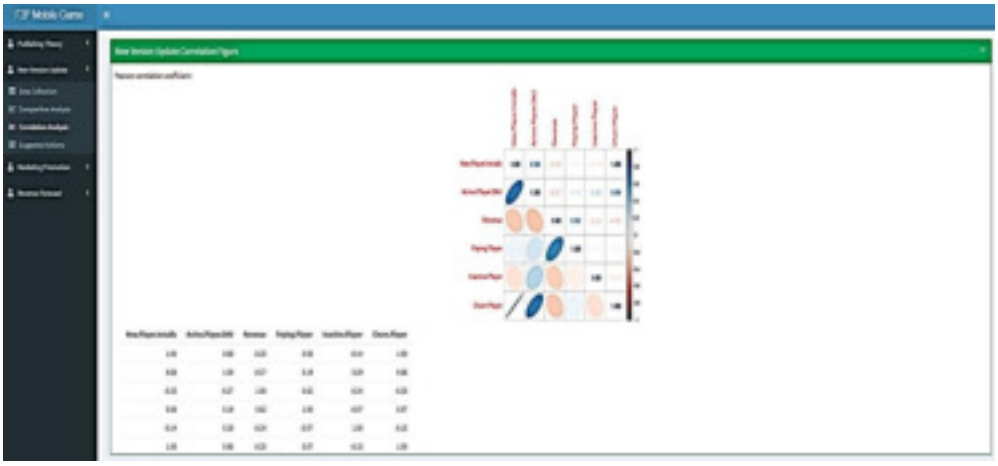

Figure 9: New version update evaluation with correlation analysis

By comparative analysis and correlation analysis, the indie game developers can comprehensively evaluate the new version update and find out the potential problems behind the data related to the new version update, such as if the new version update has issues with the new player acquisition, retention, or monetization. Then the F2PAP also provides suggestions based on the analysis result and guides the indie game developers to improve the performance for the next version update. These suggestions include sending push notifications to in-active players during the new version update, encouraging them to play, and providing the first payment rewards for new players.

Example Scenario: Marketing Promotion Evaluation

An indie game studio has just finished developing its new mobile game and plans to do the marketing. Due to their lack of game publishing experience, they have issues with marketing, getting potential players, and choosing the appropriate promotion channel through data analysis. These can be implemented based on the F2PAP, as marketing is the channel input in the F2PAP. The main role of the channel is to input high quality new players by marketing promotion. In the F2PAP, the channel quality is related to marketing promotion and also the performance of new players in the game. For example, the higher the proportion of new players converted to payment players, the better the quality of this channel. Through the F2PAP new metrics and analysis method, the indie game developers can evaluate the quality of the different channels not only by the channel metrics such as CPC, CPI, eCPM, CVR, CTR, and Budget but also by the in-game metrics such as install, DAU, Paying Players and Revenue. It will benefit the indie game studio to lock high-quality marketing channels for user acquisition and revenue, give up the low-quality channels, and save the game marketing budget.

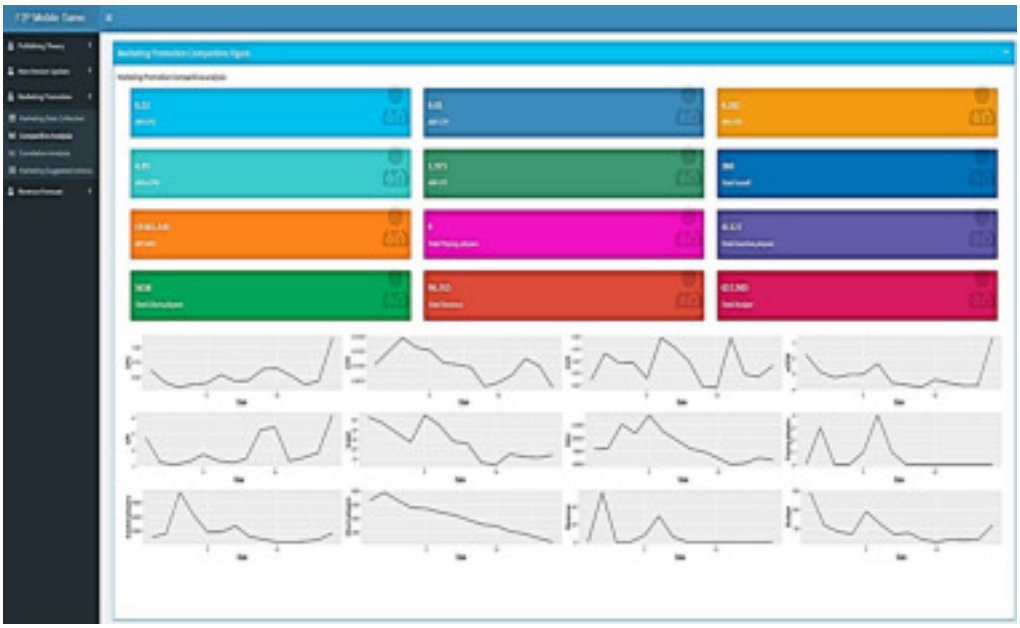

Figure 10: Marketing promotion evaluation with comparative analysis

In practice, the solution is provided to do the data analysis for the marketing promotion, including the comparative analysis and the correlation analysis. The comparative analysis compares the different channel performances during the marketing promotion and finds the best channel for user acquisition and monetization, as shown in Figure 10. Correlation analysis is used to find out all the variables' relationships with the marketing promotion by Pearson's correlation coefficient and dig out potential problems with marketing promotion, as shown in Figure 11.

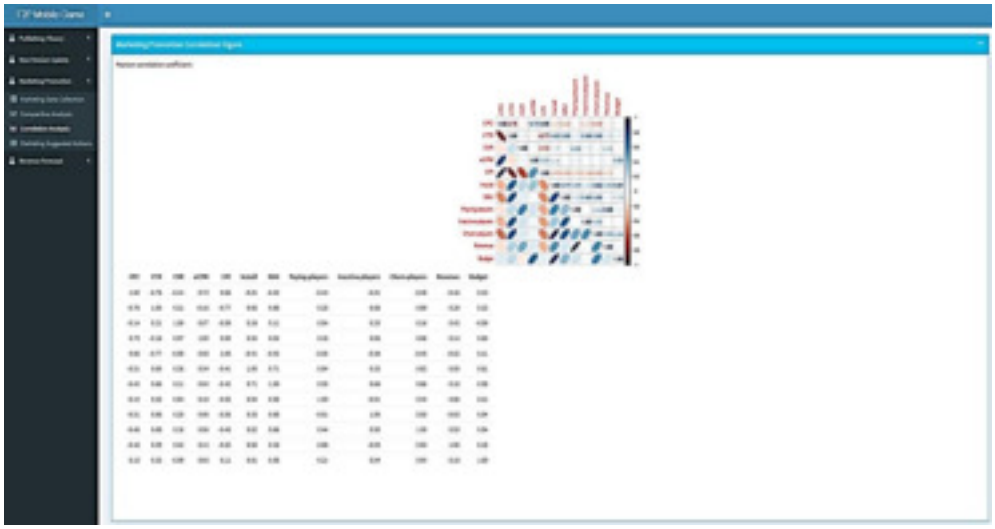

Figure 11: Marketing promotion evaluation with correlation analysis

Using the F2PAP, the game developers only need to upload the related data based on the marketing promotion data template, including channel metrics and in-game metrics. Then they can get a comprehensive evaluation of their marketing promotion and explore the potential problems behind the data related to their game marketing, such as which channel is not suitable for the user acquisition and which channel needs to be improved. Then the F2PAP also provides suggestions based on the analysis result and guides the indie game developers to improve the marketing promotion. For example, it suggests the indie game developers change marketing strategies and replace marketing materials such as banners, icons, and screenshots and do the AB testing about the new player's acquisition. Besides this, it also suggests that indie game developers spend a tiny budget trying different marketing channels first, then, based on the F2PAP, find out the high-quality channels for the next promotion.

Example Scenario: Revenue Forecast

An indie game studio had launched its mobile Tank game for more than two years. However, during the game publishing process, they face issues on how to do a revenue forecast for their Tank game and predict the revenue for the following year. Based on the revenue forecast, they can plan how much marketing budget needs to be used for user acquisition. It is also possible to follow up on game development costs and set benchmarks to evaluate game publishing performance. However, making the revenue forecast is hard, especially for indie game developers with fewer resources to do game development and have little or no revenue forecast experience. Because the traditional game revenue forecast method (Financial-Modelling.net, 2012), which relies on personal experience, is unavailable to indie game studios.

Based on the new concept of mobile game publishing, the revenue is the output part, and it has a relationship with the inputs channel and the new content. It is also related to the player's in-game behaviors. The F2PAP is developed with the revenue forecast function, which can guide the indie game developers to make revenue forecast and then set the revenue forecast as a benchmark to drive the game publishing process. In practice, this F2PAP can help indie game developers to get an internal revenue benchmark by making a reliable prediction based on the Holt-winters prediction model (Chatfield, 1978). It uses historical revenue data as input, and the predicted revenue can be gained by just clicking the revenue forecast tag, as shown in Figure 12.

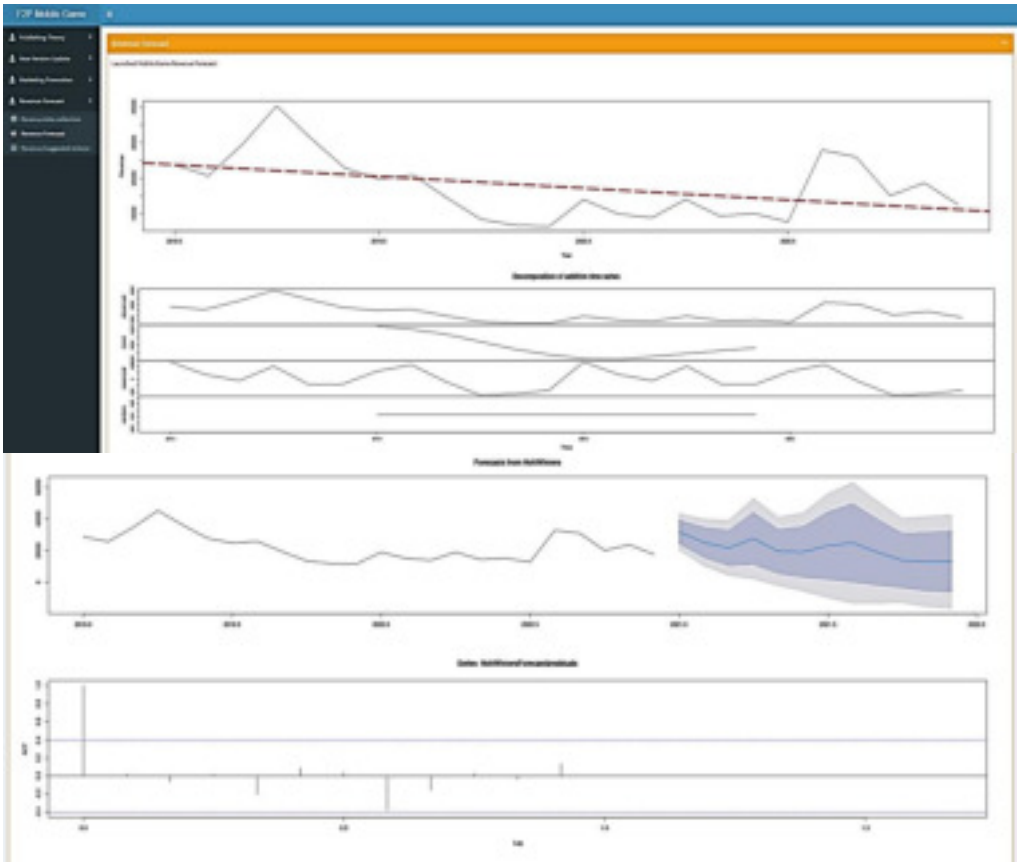

Figure 12: F2P mobile game revenue forecast

The F2PAP can guide indie game developers in uploading the historical revenue based on the revenue forecast data template and getting the prediction directly. Then it reminds the indie game developers to set the revenue forecast as a benchmark and compare it with the real revenue. If the real revenue cannot meet the benchmark, it also proposes suggestions based on data analysis to drive indie mobile game publishing. These suggestions include releasing the new content to incentivize active players to pay, recommending hardcore players with their favorite items, providing rewards and discounts to paying players, avoiding paying player churn, and delivering more revenue.

CONCLUSION AND FUTURE WORK

The application of game analytics in the mobile game area is in its infancy, and the available knowledge is heavily fragmented (Drachen et al., 2016). This research aims to address the indie game publishing main challenges (Su et al., 2020), combines the mobile game content, extends the existing ARM funnel model (Moreira, 2014), and provides a new mobile game publishing concept. In practice, the game content is introduced into the existing ARM funnel model and presents a new concept for mobile game publishing logic. Based on this, mobile game publishing can be regarded as two inputs and one output. The related game metrics and data analysis methods are introduced for different parts. In order to help indie game developers use game analytics to guide mobile game publishing, the F2PAP is designed and developed based on the new concept of game publishing. The platform revolves around the inputs and output of the mobile game publishing logic, providing different solutions for two inputs and one output. Indie game developers only need to provide the corresponding data according to the new version update, marketing promotion, and revenue forecast data templates, upload the data to the platform, and automatically get the data analysis results. Specific suggestions for optimization are also provided based on the analysis

results. The related data analysis includes the new version update evaluation, marketing promotion evaluation, and revenue forecast solutions. The F2PAP can address indie game developers' main challenges during mobile game publishing. It mainly targets indie game developers with challenges using BI in game publishing and provides automated data analysis solutions for F2P mobile game publishing.

However, the F2PAP is developed and built on the new concept of mobile game publishing. Mobile game publishing can be recognized as two inputs and one output, and related solutions are proposed for indie mobile game publishing. All analyses and suggestions are universal solutions applied to different F2P mobile games. More indie game studios will be involved in the evaluation in the future. These assessments specifically include the new concept of mobile game publishing and the usability and usefulness of the F2PAP. The surveys are conducted with indie game studios before and after using the F2PAP, and related comparisons will be made. Besides this, the interviews with indie game developers will be done after using the F2PAP. The corresponding feedback will be collected and analyzed for the next step of iterating and optimization.

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