The Fish Tank Model for Mobile Game Publishing Business Performance Evaluation

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Abstract

Business intelligence has been applied in the area of game development research for many years. However, few systematic research efforts are focusing on the game publishing side, especially for the mobile game publishing business. We aim to identify and remedy the shortcomings of the existing ARM funnel model for free-to-play mobile game analytics by introducing a new model, the Fish Tank Model, which combines the analysis of players' behavior with in-game system data to drive the whole process of mobile game publishing. Based on the new model, we also bring and create relevant metrics for effectively measuring the business performance of mobile game publishing. Our main contributions are a survey of business intelligence used in game research and an analysis to reveal the insufficiency of an existing model for game publishing. Finally, we discuss business requirements for mobile game publishing and propose a brand-new model which better suits the free-to-play mobile game publishing business performance evaluation.

Keywords: Business Intelligence, Game Analytics, Game Publishing, Game Metrics, Model-driven.

1. Introduction

Business intelligence (BI) combines operational data with analytical tools to present complex and competitive information to the decision makers. BI can be applied in many industries to improve efficiency and save costs by effective decision-making. Stackowiak et al. [18] define BI as the process of collecting amounts of data, analyzing data, and presenting reports for decision making. It condenses the essence of data into business actions, enabling management to make business decisions. As a subset of BI, analytics means the extensive use of data, statistical and quantitative analysis, explanatory and predictive models to drive decisions and actions [2]. Analytics can be recognized as a set of technologies and processes that use data to understand and analyze business performance. Many industries use analytics to identify and segment their customers [3]. This paper mainly addresses the use of BI in the free-to-play mobile game publishing process.

Game analytics can be understood as the application of analytics to game development and research. It is the process of identifying and communicating meaningful patterns which

can be USED for decision making [16]. For mobile game analytics research, as some data analysis involves confidential business information for many companies, it is hard to conduct deep communication with the game industry. Sometimes, even the definitions of game metrics differ, which results in a non-standardized data analysis in the field of mobile games. Drachen et al. [5] point out that the field is still in its infancy, due to game analytics interdisciplinary nature and lack of standardization and knowledge sharing between academia and industry.

Game publishing is an important part of game promotion using effective ways of connecting the games with their target users. After the game is developed, the game developer delivers the game to a publisher to promote it to the target users. The mobile game publishing process includes the soft launch (only launch on some small areas for testing), the global launch (launch on all areas), and the online services (keep update after global launch). Matej [12] points out that a successful soft launch is the best way to optimize the game benchmark for the global launch. Soft launch allows developers to collect data, identify bugs, and receive early feedback from players. Global launch focuses on the global market and makes sure that the marketing promotion can reach potential players at a low cost. Game online services are needed to keep updating after the global launch to maintain the hardcore players and increase the revenue. For mobile game business, more and more games have adopted a free-to-play business model which means free download but charged by virtual goods [16]. However, so far there are no associations of game analytics that can help promote knowledge sharing about game publishing [5]. This is since some data analysis involves confidential information for many companies. So it would be better to set up a standard mobile game publishing model to evaluate business performance and drive the mobile game publishing.

In this paper, we focus on how to support and evaluate the free-to-play mobile game publishing business. This is done by analyzing the problems and insufficiency of the existing model and by proposing a new model that drives the whole game publishing. Then based on the new model, we also bring and create relevant metrics for effectively measuring the business performance of mobile game publishing. It includes market promotion, player acquisition, game retention, in-game system analytics, channel analytics and also game revenue analytics. Our research will be valuable for guiding the mobile game publishing process and provide effective solutions for mobile game publishing business performance evaluation based on data analytics. This paper is organized as follows. Section 2 discusses related work about business intelligence already used in game areas. Section 3 provides the research methods used in our research. Section 4 based on literature review, combines with business requirements, and analyzes the shortcomings of the existing model. Section 5 proposes the new Fish Tank Model for model-driven mobile game publishing and describes the business performance evaluation metrics for the Fish Tank Model. While Section 6 proposes a strategy to apply this model for performing evaluations during the game publishing. Finally, Section 7 presents our conclusions and further work.

2. Related Work

Game analytics has many applications in game development, mainly to monitor the process of game development. Hullett et al. [11] explore how data can drive game design and decisions in game development by a case study. According to the classification from Seif El-Nasr et al. [16] game development analytics focuses on the whole game development process, not only including the analytics of core gameplay, in-game behavior, interface interaction analytics, but also system analytics, process analytics, and performance analytics. Donoho and Tanner [4] discuss the visualization approach for analyzing players' game behaviors. Usually, this kind of analysis is based on different levels of analysis which can help to make the right decision for game development. Günter et al. [7] describe a case study discussing the advantages and disadvantages of using data collection and data visualization during game development and provide a solution to integrate user telemetry into the development process. Stanton et al. [19] also use survival analysis techniques for

analyzing time-series data and drop-out rates and explore players' gameplay patterns to understand player dropout in games.

Game publishing analytics focus on the publishing process and analysis after the game is brought to the market. By now, compared with game development analytics, little research focuses on the game publishing side. To the best of our knowledge, the previously proposed analytics model in this field is presented by Moreira et al. [13] who use the ARM (acquisition, retention, and monetization) funnel model for mobile games as a basis for analysis of game publishing, including acquisition, retention, and monetization.

Game acquisition analytics focus on how to save the cost of attracting new users. It also pays attention to how many new players enter the game, at what stage of the game life-cycle and how many players completed the tutorial [21]. A publisher often needs to get users by buying ads or through various viral distribution channels on social networks. The aggregate of all of these costs divided by the total number of users represents the User Acquisition Cost (UAC) [16]. How to reduce the cost of user acquisition is an important part of game publishing.

Retention analytic is used for measuring the stickiness of the game. It measures how players are immersed in the game and can be used to evaluate the game quality. The concept of retention rate first came from marketing research [8]. Yee [22] mainly analyzes the mechanisms of player retention in massively multiplayer online games and provides solutions on how to improve retention. Three key metrics are introduced: weekly play time, stop rate, and how long respondents have been playing. Simon et al. [17] focus on player retention research in League of Legends (Riot Games, 2009) by using survival analytics. The final results show that the duration between matches is the strongest indicator of the potential retention rate.

Revenue analytics concerns how much money can be earned during the whole game life-cycle. For free-to-play (F2P) games, the revenue mainly comes from In-App Purchase (IAP) or advertisement. Hsu et al. [10] present a new concept for analyzing purchase decisions and helping online game designers and researchers to observe players' behavior and purchase decisions. Drachen et al. [6], through a case study of more than 200,000 players, present an analysis of the relationship between the social features in free commercial casual mobile games and their revenue. The final results show that social activities will benefit game revenue.

3. Research Method

Our research starts with the literature review. Based on our review of related work, we find that the previous BI research in the game area mainly focus on the game development side and little of the research focus on the game publishing side [5]. Besides this, as the ARM funnel model is originally designed for social games, it has a lot of limitations for mobile game publishing. So, the research question for this paper is: how to drive the whole mobile game publishing process and effectively evaluate the publishing business performance?

Hevner et al. [9] point out that design science is the creation of artifacts that satisfy a given set of functional requirements by the knowledge expressed in the form of constructs, techniques and methods, models, and mature theories. As our research plan to provide a new model to drive the mobile game publishing, a design science research method should be suitable for our research, especially for creating the new model stage. Our research is an adaptation of the design science research process model developed by Vaishnavi and Kuechler [20]. It includes five steps, the awareness of problem, suggestion, development, evaluation, and conclusion. The proposals made in this paper is to a large extent based on the researchers' professional experience. This includes more than ten years of work experiences in the game industry and involvement in multiple famous mobile games publishing business. From the perspective of game industry business requirements, the new model will visualize the mobile game publishing and drive the publishing process input and output and provide different evaluations to free-to-play mobile game publishing and meet the business requirements.

4. Shortcomings of the Existing Model

As for free-to-play mobile game publishing, Moreira et al. [13] use the ARM funnel as the basic analysis, as shown in Figure 1. This funnel model is originally developed by the company Kontagent [1]. It just visualizes the process of how gamers pass through a funnel which can be used for visualizing the mobile game publishing process by the three stages: acquisition, retention, and monetization. As it's originally designed only for social games, mainly focus on the viral K factor promotion effect evaluation whether K-LTV (Life Time Value) is great than CAC (Customer Acquisition Cost). It only evaluates how the player's performance changes by tracking three stages, and it can't guide the mobile game publishing whole process. Some shortcomings are listed below:

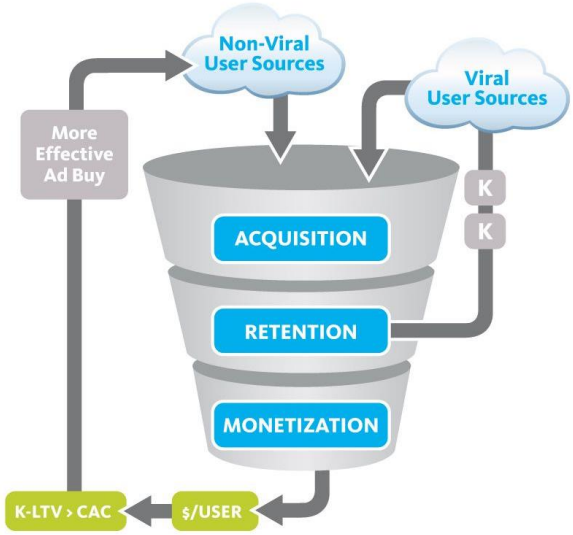

Fig. 1. ARM Funnel Model [13]

- **Ignoring the channels' attributes and performance.** As the ARM funnel model is originally for social games, the user sources only include viral sources such as the friend's invitation and non-viral sources as shown in Figure 1. However, as for mobile games, the user sources mainly come from the channels, such as the App Store and Google Play, it ignores the channels' attributes. So it can't track and evaluate the channels' performance for user acquisitions, especially for reducing the user acquisition cost [16] from the channels designed side.
- **Ignoring the in-game system performance.** The ARM funnel model, which only considers how the players pass through the funnel, ignores the interaction between the players and the in-game system. So it is hard to evaluate the in-game tutorial system, in-game level system and also the in-game economic system performance, such as how many players completed the tutorial [21]. However, these systems have a deep relationship with the mobile game publishing performance.
- **Ignoring players' behavior changes.** For game players, during the game publishing process, their behavior change from time to time, so analyzing time-series data is important [19]. For example, they can change from being an active player to become a silent player or even turn into a churn player during the game period. However, the ARM funnel only visualizes the process of how gamers pass through a funnel, ignoring these in-game behavior changes. As for mobile game publishing, it's vital to maintain the hardcore player and track the players' behavior changes.
- **Ignoring revenue changes and performance.** As for game revenue, it will change dynamically during the game publishing process. It has a deep relationship with new game content updates and user acquisitions from the channel side. Besides this, it is also related to players' behavior and decisions, especially for purchase decisions [10]. However, the ARM funnel model ignores all of these changes, issues such as: how new game version updates impact the game revenue, how the channels improve the game revenue and how the in-game players'

behavior changes affect the revenue.

- **Ignoring new game content performance.** The ARM funnel only recognizes the players as customers and has no relation with games, it ignores the new game content especially for new game version updates after launch. For mobile games, it is necessary to evaluate each new version update performance and give guidance for further game development [11]. So how to evaluate the new content performance still need to be improved.

In short, as the ARM funnel model only shows the players' changes in three stages, the relationship between the players with the channels, new content also the revenue can't be captured by ARM funnel model. The potential issues beyond acquisition, retention, and monetization can't be solved by ARM funnel model. So we propose a new model which can be used to solve these potential issues and drive the mobile game publishing process and give solutions about the channel, new game content, in-game system, players' behavior changes and also the revenue performance evaluation.

5. The Fish Tank Model - Redefining the Publishing Model

5.1. Mobile Game Publishing Business Requirements

As for the game publishing business, Peitz and Waldfogel [15] describe that the main tasks for game publishing include advertising, marketing, and distribution efforts. Besides these, for online games, players need to connect with the internet for playing. During the game publishing process, the main requirements also include handling game community management, maintaining the core players, updating content and also increasing revenue [14]. The main tasks of the mobile game publishing business can be summarized as shown in Figure 2.

Fig. 2. Mobile Game Publishing Main Tasks

5.2. Concept for the Fish Tank Model

We propose the Fish Tank Model for mobile game publishing to solve the shortcomings of the ARM funnel model and meet the business requirements. The Fish Tank Model supports the entire publishing process taking the specific requirements of mobile game publishing into account. The main publishing systems can be tracked from each link through the construction of the Fish Tank Model.

In the Fish Tank Model, mobile game publishing can be understood as the main process of how to combine the game product with the target user. In the main process, the game publisher needs to clearly understand where the player is coming from, how to make the player active, how to make the player pay, and how to prevent player churn. So we propose a Fish Tank Model to visually drive and evaluate the business performance and ensure the overall ecology of mobile game publishing, as shown in Figure 3. We can recognize the mobile game publishing process as an analogy of maintaining a fish tank. How to make more fish survive, grow and multiply are key issues in a fish tank which explains the metaphorical meaning for mobile game publishing.

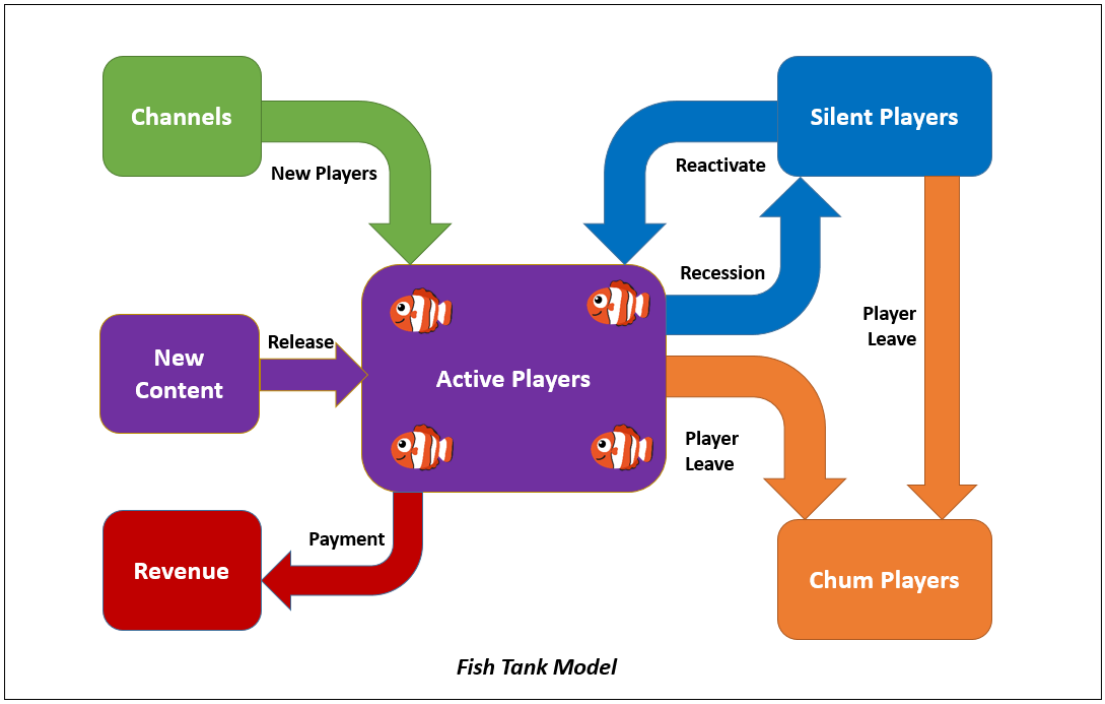

Fig. 3. Fish Tank Publishing Model

5.3. The Fish Tank Model Publishing Flow Chart

The new Fish Tank Model for mobile game publishing extends the ARM funnel model and introduces game analytics into the process. As shown in Figure 4, this model drives the process of mobile game publishing as an input, cycle, and output process. The input includes the new user from different channels and also the new content from the game developer side. The cycle mainly focuses on players' behavior changes. For example, how they change between active players to silent players or churn players. The output for the game should be the revenue and how players interact with the in-game systems during the cyclic process and generate revenue. The Fish Tank Model has the great potential to make the mobile game publishing process more clear and easy to track. The process of mobile game publishing is reduced to control different inputs to ensure the circulation of the internal game system and maximize revenue output.

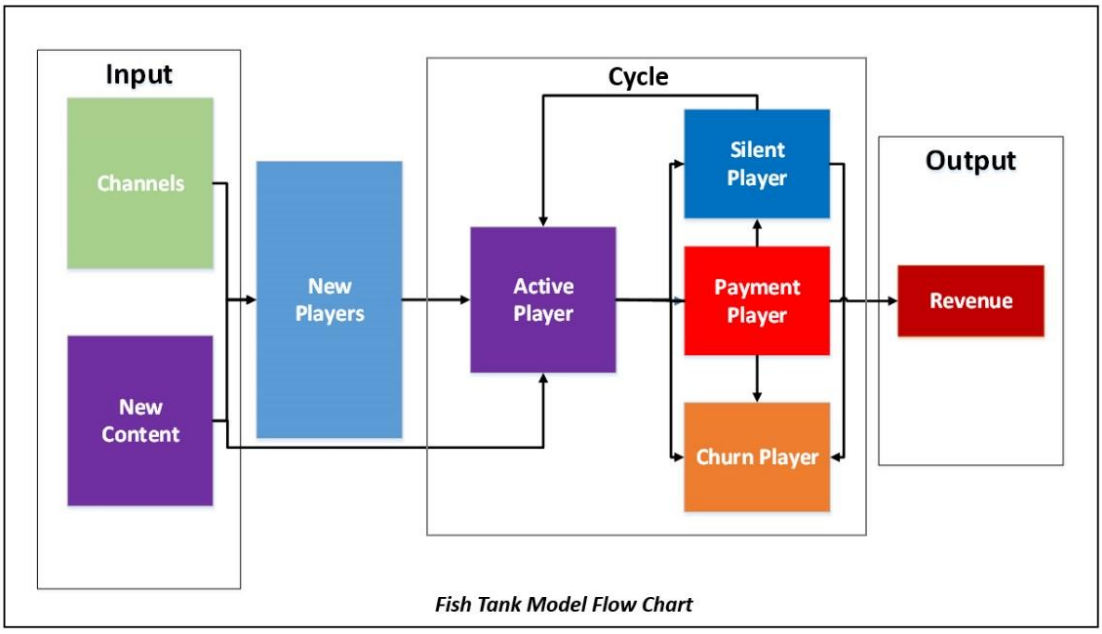

Fig. 4. Fish Tank Model Flow Chart

First, from the channel side, channels are the important 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 [21]. An effective channel can bring new players to the fish tank which may convert to be active, retain and pay, just like fish in the tank can be active, grow and reproduce.

Second, from the aspect of stimulating activity, how to promote players' activities through new game version updates, is a potential issue for mobile game publishing. The improvement of player activity is not only to maintain existing active players, but also to prevent active players from recession to silent players, and turn silent players into active players again [19]. Active players, like the healthy fish in aquariums, bring vitality to the fish tank which should be the guarantee for the healthy development of the entire fish tank.

Third, for active players, the goal is to convert them to payment players through effective game publishing activities [10]. It means to increase the proportion of payment for games, and analyze the in-game system for the consumption of items to ensure the balance of the economic system. In-game economic balance is also a vital part of mobile game publishing and the changes of the in-game economic system can be dynamically adjusted based on data analytics. It can eliminate potential risks and ensure that the entire fish tank can work well for a long time. This means to nourish the fish tank into a sustainable eco-system.

At last, how to reduce player churn, increase the retention rate are also valuable parts of game publishing [22]. Effectively reducing the churn rate can be based on the churn prediction. The use of data analytics to predict the risk of players leaving in advance will reduce their churn rate. This is done by analyzing players' behavior which indicates the risk of leaving the game [19]. As for Fish Tank Model, it means to reduce the fish death rate in the fish tank and this kind of prediction will benefit the growth of an ecological fish tank.

In short, the goal of our research is to provide a new model to drive mobile game publishing through game data analytics and to give different solutions for mobile game publishing performance evaluation. The reasonable decisions and solutions should be driven by game data analytics which will be valuable for reducing publishing costs and maximizing game revenue.

5.4. Performance Evaluation Solutions in the Fish Tank Model

In order to drive and evaluate the whole mobile game publishing process, according to the game business requirements, we provide the performance evaluation solutions for the free-to-play mobile game publishing business by the Fish Tank Model.

Channels Performance Analytics Solution

Channel performance analytics is overlooked by the ARM funnel model. However, in the specific mobile game publishing process, the channel has its attributes. As for the Fish Tank Model, especially for the input phase, the question of how to optimize user acquisition according to different channel attributes is significant. So channel quality is the benchmark to evaluate the publishing effects and make sure the ROI (Return on Investment) is high enough, which is shown in formula 1:

$$ROI(Return\ on\ Investment) = \frac{LTV\ \ (Life\ time\ value)}{CPI\ \ (Cost\ per\ install)} \times 100\% \qquad (1)$$

Return on Investment (ROI) is a performance measure used to evaluate the efficiency of investment for games. Life Time Value (LTV) is the total amount of money a user will contribute to a game. Cost Per Install (CPI) is a measure of the total amount of money spent to market a game divided by the number of total installs [21]. In order to evaluate the

channels' quality, we use the different metrics to measure these performances, including the ROI (Return on Investment), CPI (Cost Per Install), CPA (Cost Per Active) and also CPP (Cost Per Payment). These kinds of metrics can be classified as the channel metrics group which will help to find out potential target mobile game users with lower market budget and ensure the ROI well. Once ROI established, it can be used to guide the market strategy during the mobile game publishing process based on effective analytics of channels performance.

In-game System Performance Analytics

The in-game system analytics involves multiple aspects of game analytics, including in-game level system research, in-game tutorial system research, as well as in-game economic system research. The goal of in-game system analytics is to give guidance to the indie game developer how to improve the mobile game quality during the self-publishing process.

In order to evaluate the in-game system performance during the cycle phase, in the Fish Tank Model, we provide three different types of metrics called the in-game system metrics group to measure the changes. The metrics group includes the new tutorial complete rate and game levels distribution, such as the player distribution among each level and player pass rate among each level and also the in-game economy balance, such as the balance between the number of game currencies output and also the number of currencies consumption.

Players' behavior Analytics Solution

The study of players' behavior involves statistics and analytics of potential behaviors from the player side during the cycle process in the Fish Tank Model, such as retention, activity, and payment analytics. The purpose of this analytics is to ensure that players can get a better game experience during the publishing process, and the game can be further optimized to meet the publishing benchmark required by different markets and channels.

As for player activity, we introduce the DAU (Daily Active User) and MAU (Monthly Active User) to measure the activity in the Fish Tank Model. DAU is a measure of the number of unique users per day. MAU is a measure of the number of users in a given calendar month [21]. In order to measure the player changes from active to silence during the game lifecycle, we use the PSR rate (Player Silence Rate) to measure. As for the changes from silent to the active player, we use the PRR (Player Reactive Rate) to measure these changes.

As for player retention, in the Fish Tank Model, we use the metrics retention rate for the evaluation which includes the day 1 (D1) retention rate, D3 retention rate, D7 retention rate and also the D30 retention rate. The retention rate defines the percentage of users that returned. It's calculated for the game player base on a particular day from the moment of the installation [21]. DN retention rate shows the percentage of game players who install the game today and return on day N after installing, which is shown in formula 2:

$$DN\ Retention\ Rate = \frac{Number\ of\ players\ who\ install\ game\ today\ and\ return\ on\ Day\ N}{Number\ of\ players\ who\ install\ game\ today} \times 100\% \quad (2)$$

D1 retention rate informs about the first impression from players about games. D3 retention rate can be used to measure how attractive this game is, as players keep playing after installation. D7 retention rate can be used to measure how game stick with players, as they get to know the game better after a week. D30 retention rate shows the percentage of players who are familiar with this game and keep playing it.

As for player churn rate, it is import to identify which players will lost before they leave the games. We use four different churn rates to measure these behaviors in the Fish Tank Model, such as the D1 player churn rate, D3 player churn rate, D7 player churn rate and also the D30 player churn rate. Churn rate is the percentage of players who leave the game during a given time period [21]. For D1 player churn rate, it can be used to measure the marketing promotion effects whether the users are the potential players for the game. D3

player churn rate can be used to measure the early stage of game experience is good or not. D7 player churn rate can be used to measure the middle stage of game experience is good enough to stay. D30 player churn rate can be used to measure the post-stage of game experience.

Revenue Performance Analytics Solution

Revenue performance focuses on the monetization measurement about the game and according to the Fish Tank Model, it should be the output phase. Different from ARM funnel model, we separate the revenue performance into three parts. The first part focuses on the common revenue analytics which includes the daily revenue, weekly revenue and also the monthly revenue and these metrics can measure the revenue performance over time. The second part focuses on the per revenue analytics which includes the ARPU (Average Revenue Per User) and the ARPPU (Average Revenue Per Payment User). These metrics can measure the revenue performance from each player side. ARPU is a measure of the total revenue for a given time period divided by the total number of players. ARPPU is a measure of the total revenue divided by the total number of payment players [21]. The third part focuses on the whole revenue performance analytics. We use the LTV to measure the whole life cycle payment for player which is shown in formula 3. Lifetime is defined as the average playing time for the player from install till leave game.

$$LTV = ARPU \times Lifetime \tag{3}$$

Revenue performance analytics is vital for mobile game developers. During the mobile game publishing process, it's important to effectively improve the game revenue and reduce the cost. So for the mobile game developers should keep tracking these three parts of revenue performance.

New Content Performance Analytics Solution

The mobile game life cycle determines the final performance of the game. During the mobile game publishing process, the mobile game developers usually keep releasing new versions and new contents to attract and maintain game players. However, how to effectively measure the new version performance and how to collect the player needs to guide the subsequent game version development and iteration, can't be shown in the ARM funnel model.

The new content update performance can be recognized as input as well in the Fish Tank Model. What we need to do is to find out the relationship between the content input, in-game cycle and also the revenue output. We can measure the changes from two sides. On one side, we define the new version rating metrics which can be obtained from the App Store new version rating or the Google Play new version rating. These kinds of ratings are based on the players' reviews about each version which are suitable for measuring the new content performance. On the other side, we provide new metrics to measure the New Version Change Rate (NVCR) including the new version revenue change rate and also new version DAU change rate compared with the old version. If the rate is positive, it means the new content is favored by players, otherwise, the new content needs to be improved.

5.5. Evaluation Metrics for the Fish Tank Model

Once the mobile game publishing performance metrics have been identified, generic measures are then associated with these metrics for deep evaluation. The Fish Tank Model is a generic model to ensure it can be used in different free-to-play mobile game publishing projects. In order to make it more clearly, we decompose the Fish Tank Model into measurable metrics for different mobile game publishing performance evaluations. As shown in Table 1, it includes five different mobile game publishing performance

evaluations with relevant metrics.

Table 1. Decomposition of Fish Tank Model into Measurable Metrics

Game Performance	Measure	Metrics
Channels Performance	ROI	Return on Investment (Each Channel)
	Cost Per Install	CPI (Cost Per Install)
	Cost Per Active	CPA (Cost Per Active)
	Cost Per Payment	CPP (Cost Per Payment
In-game system Performance	New Tutorial Completion	New Player Tutorial Completion Rate
	In-game Levels Pass Rate	Player Distribution Among Each Level
		Player Pass Rate Among Each Level
	In-game Economy Balance	Number of Game Currency Output
		Number of Game Currency Consumption
Players' behaviors Performance	Player Activity	DAU (Daily Active User)
		MAU (Monthly Active User)
		PRR (Player Reactive Rate)
		PSR (Player Silence Rate)
	Player Retention	D1 Retention Rate
		D3 Retention Rate
		D7 Retention Rate
		D30 Retention Rate
	Player Churn	D1 Player Churn Rate
		D3 Player Churn Rate
		D7 Player Churn Rate
		D30 Player Churn Rate
Revenue Performance	Common Revenue	Daily Revenue
		Weekly Revenue
		Monthly Revenue
	Per Revenue	ARPU (Average Revenue Per User)
		ARPPU (Average Revenue Per Payment User)
	Whole Revenue	LTV(Life Time Value)
New Content Performance	New Version Rating	App Store New Version Rating
		Google Play New Version Rating
	New Version Change Rate	New Version Revenue Change Rate
		New Version DAU Change Rate

6. Applying the Fish Tank Model for Mobile Game Publishing

The typical mobile game publishing process mainly consists of the following business tasks: marketing promotion, maintain core-players, community management, new version update and also the increased revenue which we discussed in Section 5.1. Based on the Fish Tank Model, the performance of each task of mobile game publishing can be evaluated by using different metrics combination:

- **Marketing Promotion Evaluation.** Marketing promotion can be recognized as different channels for user acquisition. We can use the Fish Tank Model channel performance evaluation metrics including the ROI (Return on Investment), CPI (Cost Per Install), CPA (Cost Per Active) and also CPP (Cost Per Payment).
- **Maintain Core-players Evaluation.** The maintenance of the core-players evaluation can use different metrics from the Fish Tank Model. Such as the player activity metrics including the DAU (Daily Active User), MAU (Monthly Active User), PRR (Player Reactive Rate) and also PSR (Player Silence Rate). Player retention metrics include D1, D3, D7, and D30 retention rate and also the player

churn metrics include D1, D3, D7, and D30 churn rate for deep evaluation. Besides these, the in-game system performance also should be the relevant metrics to measure the player distribution among each level, especially for the hard-core players in the high game levels.

- **New Version Evaluation.** As for new version performance evaluation, we can use the new update metrics from the Fish Tank Model to measure the performance directly including the new version rating and also the new version change rate.
- **Revenue Evaluation.** As for the revenue evaluation, according to the Fish Tank Model, we can measure the revenue performance by common revenue, per revenue and also the whole revenue during the whole game lifetime. Besides these, the in-game system performance should also be relevant metrics to measure the in-game economy balance, especially for the currency output and consumption.
- **Community Evaluation.** As for community evaluation, we can combine the player performance and the new version update metrics from the Fish Tank Model to measure the performance. It includes the new version ratings from App Store or Google Play and also the player activity metrics for communities.

Based on the above metrics combination, each task can be tracked and evaluated by the Fish Tank Model from the theoretical side. Besides this, it's also easy to find out in which part of the mobile game publishing process needs to be improved through the Fish Tank Model as well.

7. Conclusions

According to the mobile game publishing business requirements, we present a brand-new model which creatively recognize the mobile game publishing process as an analogy of maintaining a fish tank. It provides different solutions to analyze and evaluate business performance and ensure the overall ecology of mobile game publishing. The Fish Tank Model combines players' behavior with the in-game system data to drive the mobile game publishing. Besides this, based on the new Fish Tank Model, we also bring and create standardized game metrics to measure and improve the publishing process. It can be used for evaluating the free-to-play mobile game publishing business performance including the channel, new game content, in-game system, players' behavior and also the revenue performance.

In order to evaluate the Fish Tank Model and make it more suitable for the free-to-play mobile game publishing, future work should include the validation of the proposed model and metrics with the participation of mobile game developers. We plan to use the new model to drive the free-to-play mobile game publishing with real game projects and evaluate the new model by different case studies including the soft launch, global launch, and online services. Then we will use the metrics to measure and analyze the free-to-play mobile game publishing business performance and keep iterating the Fish Tank Model.

References

1. Aaron H.: Top 7 Social Game Metrics of 2011, In: GDC (2011), http://twvideo01.ubm-us.net/o1/vault/gdceurope2011/slides/Aaron_Huang_SOGS_Top.pdf. Accessed March 10, 2019
2. Davenport, T. H., Harris, J. G.: Competing on Analytics: The New Science of Winning.1st ed. Harvard Business Review Press (2007)
3. Davenport, T. H., Harris, J. G., Morison, R.: Analytics at Work: Smarter Decisions, Better Results. 1st ed. Harvard Business Review Press (2010)
4. Donoho, D.L., Tanner, J.: Neighborliness of Randomly Projected Simplices in High Dimensions, vol. 102, no. 27, PNAS (2005)
5. Drachen, A., Nicholas, R., Julian, R., Rafet, S.: Stylized Facts for Mobile Game Analytics. In: Conference: IEEE Computational Intelligence in Games (CIG), pp. 20-23, Santorini, Greece (2016)
6. Drachen, A., Pastor, M., Liu, A., Fontaine, D.J., Chang, Y., Runge, J., Sifa, R.: To be or

not to be...social: incorporating simple social features in mobile game customer lifetime value predictions. In: ACSW '18 Proceedings of the Australasian Computer Science. Week Multi conference Article No. 40 (2018)

7. Günter, W., Simone, K., Florian, G., Michael, H., Jochen, K.: Game user telemetry in practice: a case study. In: Proceedings of the 11th Conference on Advances in Computer Entertainment Technology (ACE '14). pp. 45:1-45:4, ACM, New York (2014)
8. Hennig-Thurau, T., Klee, A.: The Impact of Customer Satisfaction and Relationship Quality on Customer Retention: A Critical Reassessment and Model Development. Psychology and Marketing, Vol. 14, pp. 737-765 (1997)
9. Hevner, A.R., March, S.T., Park, J., Ram, S.: Design science in information systems research. MIS Quarterly, 28 (1), pp, 75-105 (2004)
10. Hsu, S.Y., Hsu, C.L., Jung, S.Y., Sun, C.T.: Indicator products for observing market conditions and game trends. In: Proceedings of the 12th International Conference on the Foundations of Digital Games. Hyannis, pp.14-17, MA, USA (2017)
11. Hullett, K., Nagappan, N., Schuh, E., Hopson, J.: Empirical analytics of user data in game software development. In: Proceedings of the ACM-IEEE international symposium on Empirical software engineering and measurement. Lund, Sweden (2012)
12. Matej, L.: A guide to soft-launching your mobile game. In: Pocket gamer (2018), https://www.pocketgamer.biz/comment-and-opinion/67713/soft-launch-guide/. Accessed January 17, 2019
13. Moreira, Á.V.M., Filho, V.V., Ramalho, G.L.: Understanding mobile game success: a study of features related to acquisition, retention and monetization. SBC Journal on. Interact system, Volume 5, pp 2-13 (2014)
14. Mullich, D.: What does a game publisher do? In: Quora (2015), https://www.quora.com/What-does-a-game-publisher-do. Accessed December 25, 2018
15. Peitz, M., Waldfogel, J.: The Oxford Handbook of the Digital Economy. Oxford University Press Published (2012)
16. Seif El-Nasr, M., Drachen, A., Canossa, A.: Game Analytics - The basics. In: Seif El-Nasr M., Drachen, A., Canossa, A. (eds.) Game Analytics - Maximizing the Value of Player Data. Ch.1, USA: Springer (2013)
17. Simon, D., Alexandra, M., David, B., Marco, T.: Player Retention in League of Legends: A Study Using Survival Analytics. In: Conference: Proceedings of Australasian Computer Science Week. Brisbane, Australia (2018)
18. Stackowiak, R., Rayman, J., Greenwald, R.: Oracle Data Warehousing and Business Intelligence Solutions. Wiley Publishing, Inc, Indianapolis (2007)
19. Stanton, M., Humberston, B., Kase, B., O'Brien, J.F., Fatahalian, K., Treuille, A.: Self-refining games using player analytics. ACM Transactions on Graphics (TOG): Volume 33, Issue 4 (2014)
20. Vaishnavi, V. K., Kuechler, W. L.: Design Science Research Methods and Patterns: Improving and Innovating Information and Communication Technology. 2nd Edition, CRC Press (2015)
21. Victor, T.: Game Industry Metrics Terminology and Analytics Case Study. In: Seif El-Nasr M., Drachen, A., Canossa, A. (eds.) Game Analytics - Maximizing the Value of Player Data. Ch. 4, USA: Springer (2013)
22. Yee, N.: Motivations of Play in Online Games. Journal of Cyber Psychology and Behavior, no. 9, pp. 772-775 (2007)