International Journal
of Applied Information Technology

http://journals.telkomuniversity.ac.id/ijait/

Adaptation Atomic Design Method for Rapid Game Development Model

Rickman Roedavan [1,*], Agus Pratondo [1], Bambang Pudjoatmodjo [2], Yahdi Siradj [1]

[1] *Multimedia Engineering Technology, School of Applied Science, Telkom University, Indonesia*
[2] *Centre for Advanced Computing Technology (C-ACT), Faculty of Information and Communication Technology, Universiti Teknikal Malaysia*
rikman@telkomuniversity.ac.id, agus@telkomuniversity.ac.id, p031810011@student.utem.edu.my, yahdiinformatika@telkomuniversity.ac.id

A R T I C L E   I N F O

Received February 16th, 2021
Revised March 16th, 2021
Accepted March 17th, 2021
Available online May 8th, 2021

Keywords: Rapid Game Development, Game Development Life Cycle, Rapid Atomic Design Methodology

A B S T R A C T

Prototyping a game is a process to build the core game mechanics for use in the final game. This process is essential because it can save cost, time and reduce the potential for errors. There is a lot of study and research on the Game Development Life Cycle (GDLC). Some existing GDLC's were developed based on the waterfall model, while others were developed based on prototyping models. However, most of these models are not considered the cost and time factor. This research proposes a new Rapid Game Development (RGD) model, adapted from our previous work in developing the Game Mechanic Framework for Unity Game Engine. The experiment result showed that this method could be used to create a game faster while keeping the budget in mind during the development process.

* Corresponding author at:
School of Applied Science, Telkom University
Jl. Telekomunikasi No. 1, Terusan Buah Batu, Bandung, 40257
Indonesia
rikman@telkomuniversity.ac.id

ORCID ID:
- First Author: 0000-0003-3169-2663
- Second Author: 0000-0002-6976-7459

https://doi.org/10.25124/ijait.v4i02.3658

1. Introduction

Games are interactive multimedia products that are built by combining various disciplines. In addition to entertainment, games can also be developed as simulation products, military training, education, and medical training tools [1][2][3]. As a product that looks easy and fun, the game development process is complex [4].

There are many research and studies on the Game Development Life Cycle (GDLC) [5][6][7]. Most GDLCs developed based on the Waterfall model in the Software Development Life Cycle (SDLC). Most models only focus on developing the game without considering the cost, time factor, and error potential in the development process.

In reality, the waterfall model of development is slow, rigid, and difficult to adapt to change. Statistics show that 80% of games released on the market by indie studios fail [8]. Reducing failure can be done by detecting errors earlier in the development process using rapid prototyping methods.

Rapid Application Development (RAD) is a method in software development [9][10], which was popular in the 1990s [11][12]. However, this method is still relevant to us today. This method can produce digital products quickly, speed up the evaluation process by the user, and reduce errors that arise during the development [13][14].

This research continues our previous research results, namely developing the Game Mechanic Framework on the Unity game engine [15]. This research aims to produce a new Rapid Game Development (RGD) model, speeding up the game development process. Most importantly, this model can guide developers to consider the costs required during the development process.

2. Development Model Analysis

2.1. Game Development Life Cycle

Most of the GDLC proposed by practitioners and researchers have a similar development pattern [5][6]. Figure 1 shows that, in general, all GDLC models can be divided into three main phases: pre-production, production, and post-production. When viewed from the production process, GDLC can be divided into Linear GDLC and Iterative GDLC. In Linear GDLC, each phase is resolved sequentially for each phase. While in Iterative GDLC, the development phase is carried out through an iteration process before entering the post-production phase.

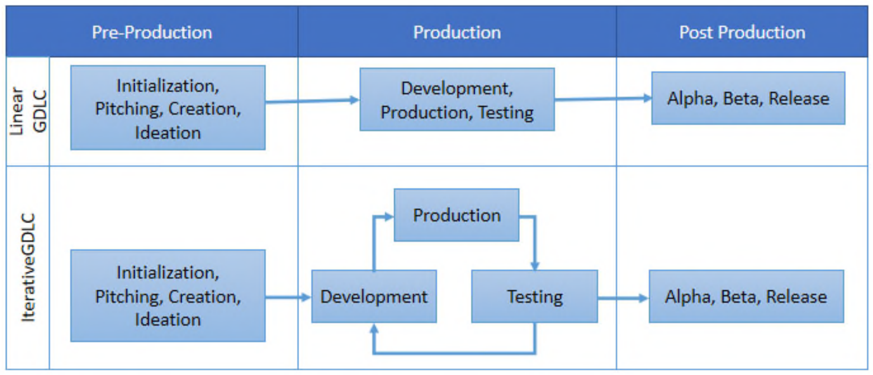


Figure 1 Game Development Life Cycle Pattern

Linear GDLC was adapted from the Waterfall method [7], while the Iterative GDLC was adapted from the prototyping method. Iterative GDLC is better than Linear GDLC because it can build products quickly and reduce errors in the development process.

The most popular GDLC among academics is the Rido Ramadan version, as shown in Figure 2. This GDLC has timeline elements and its output version but not considering cost elements. While in real game development, the cost is an important element that should not be ignored in the development process.

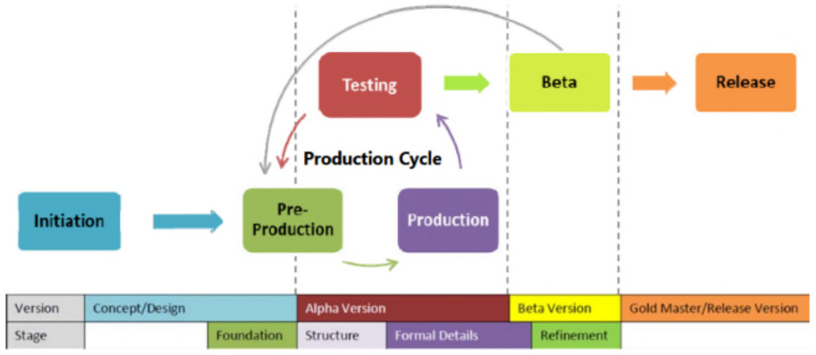


Figure 2 Rido Ramadan's GDLC consists of Six Development Phases

Some indie developers or game studios tend to develop their versions of GDLC to solve a cost problem. One example is the Agate Studio version shown in Figure 3. This GDLC adds evaluation and monitoring elements by relevant stakeholders at each stage of its development. [6]. This element is added to prevent funds to prospective games that are deemed to have no potential for success.

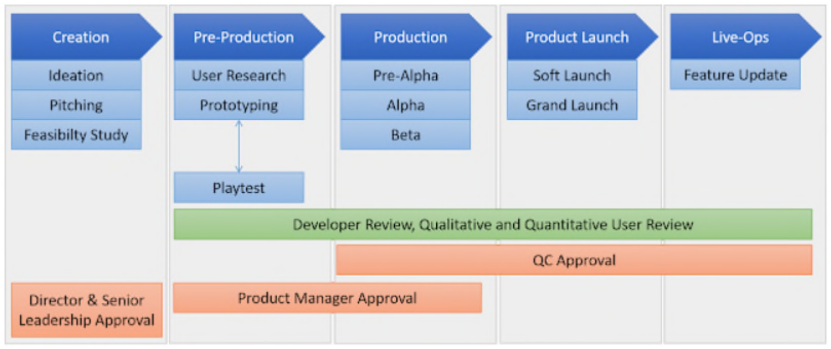


Figure 3 Agate Studio's GDLC Consists of Five Development Phases

At a glance, this element is perfect because it can control the budget and prevent loss of game funding. But on the other hand, this model has a high probability of termination of the game candidate in the middle of the development process.

This causes the development process can be very long and immeasurable. However, this problem can be overcome by using a generic asset or game template in development. Using a reusable object in the game development process is key to create a prototype faster and adapted to meet stakeholder needs.

2.2. Rapid Application Development

RAD method is best used for making project-based applications with well-defined requirements. Figure 4 shows the most popular version of RAD, which is divided into six main stages. Namely, Analysis and Quick Design, Develop, Demonstrate Refine, Testing, and Development. The Develop, Demonstrate, and Refine phases become the core that makes up the prototyping iteration.

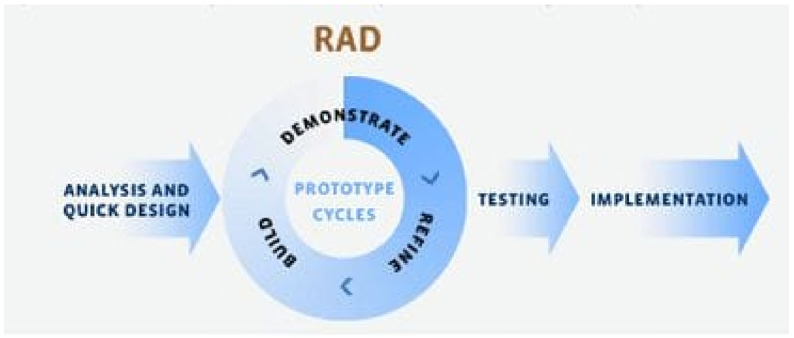


Figure 4 RAD Consists of Six Development Phases

The RAD implementation is very diverse in the real development process; some software company combines its method to create a hybrid development model. Figure 5 shows that the RAD pattern consists of three main parts: Modeling, Prototyping, and Deployment.

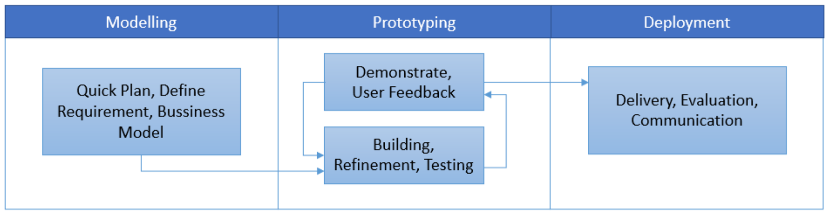

Modelling
Prototyping
Deployment
Quick Plan, Define Requirement, Bussiness Model
Demonstrate, User Feedback
Building, Refinement, Testing
Delivery, Evaluation, Communication

Figure 5 Rapid Application Development Pattern

RAD purposes are developing high-quality software systems more quickly. There are at least five essential success factors to achieve this, namely determining Application Purposes, understanding of Technology knowledge, easy access to Asset / Materials, ability to translate Product Complexity, and Estimation of cost and time [16][17][18].

2.3. Atomic Design Method

Atomic Design is a method for combining different stages of application development hierarchically [19]. This model was originally developed to build a website using the atomic theory approach in natural science. The atomic design has five stages of development: Atom, Molecule, Organism, Template, and Pages, as shown in Figure 6.

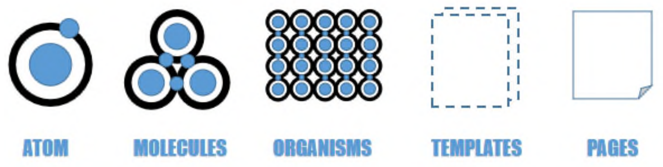


Figure 6 Atomic Design Methodology

Atoms are explained as the smallest part of website development, like HTML tags. Molecules are a collection of HTML tags that will form a user interface group with one specific function. Organisms mean larger collections of molecules with more complex functions. Header, Footer, and Content are terms that are the most suitable analogy for Organisms. The collection of Organisms into templates can accelerate the development process to create a web page as a final result.

3. The Proposed Model

The model we propose combines the Ramadan, Agate, and other popular GDLC models [5][6][7]. We use the Atomic Design Method's advantages to map all game development processes according to their classification. We also add key success factors for the RAD method and some important game development process elements.

Table 1 Game Development Atom

Development Phase					
Pre-Production		Production		Post-Production	
Development Activity					
Activity 1	Activity 2	Activity 3	Activity 4	Activity 5	Activity 6
Initiation	Prototype	Creation	Design	Quick Design	Foundation
Pre-Production	Pre-Production	Pre-Production	Develop	Build	Structure
Production	Production	Production	Evaluate	Demonstrate	Formal Detail
Testing	Beta	Product-Launch	Test	Refine	Refinement
Beta	Live	Live-Ops	Review Release	Testing	-
Release	-	-	Release	Implementation	-
Development Consideration					
Consideration 1	Consideration 2	Consideration 3	Consideration 4	Consideration 5	Consideration 6
Project-Based	Linear	User Research	Generic Assets	Application Purposes	Testing
Product-Based	Iterative	Feasibillity Study	Genuine Assets	Technology Knowledge	Deployment
Cost Estimation	RAD	Pitching	Prefabrication	Asset/Material Access	Evaluation
Time Estimation	Prototype	Approval	Blueprint	Product Complexity	User Feedback
Development Output					
Pre-Alpha	Alpha Version	Beta Version	Gold Master	Release Version	Final Version

Table 1 contains the results of solving the complexity of game development and several supporting factors. The results consist of 4 groups of organisms, namely the development phase, development activity, development consideration, and development output.

Each organism consists of several molecules derived from pre-existing models. And each molecule consists of a collection of cells, which refers to the main activity of game development or game terminology. We combine all the cells obtained to produce a new Rapid Game Development (RGD) Model, as shown in Figure 7.

In general, the RGD model consists of 3 main phases. Each phase consists of several activities that are carried out by considering the success factors in the rapid prototyping model and cost development.

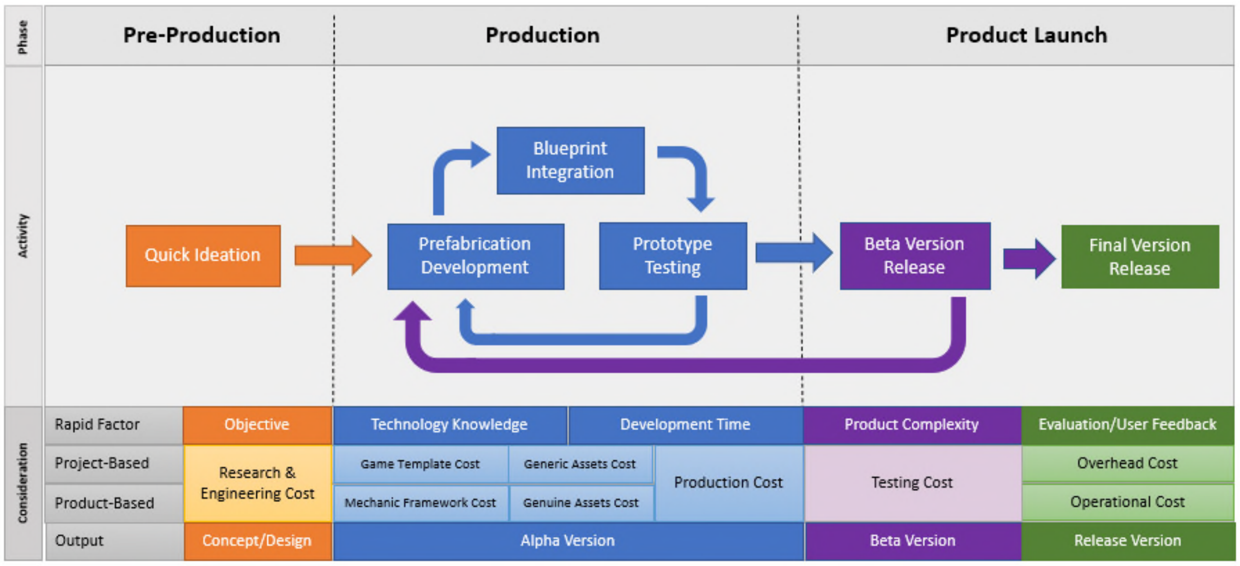


Figure 7 Rapid Game Development Model

1. Pre-Production. This phase has one main activity, namely Quick Ideation, which results in the game's initial design concept. This activity must also be able to determine whether the game to be built is product-based or project-based. Understanding this will significantly affect the research time and engineering costs that will be used in further development.
2. Production. This phase consists of three activities, which are the main activities in the entire rapid development process, namely Prefabrication Development, Blueprint Integration, and Prototype Testing.

    a. Prefabrication Development. This activity aims to build a game foundation using templates, frameworks, or independent assets that already have basic functions. Some examples of a basic common function are character movement, finger-gesture detection, and an inventory system. Each game engine has a different workflow. So it is crucial to understand the technology used and the functions in it. This activity also needs to determine which parts of the game require original assets and which parts can use generic assets to speed up the development process.

    b. Blueprint Integration. This activity aims to modify and integrate all existing assets into a functioning game mechanic. Using various types of generic assets, script, or game element prefabrication has its problems in practice. The development team must understand how each asset works and get them to communicate with each other. This process is time-consuming and costly. But it's still a lot shorter than creating the entire asset from scratch.

    c. Prototype Testing. This activity aims to produce a game prototype that functions mechanically and already has an interesting initial visualization.

Based on indie game developers' experience, game prototypes should be produced within 1-2 Weeks [20]. Testing the game prototype can be used as evaluation material for improvements in the next development stage iteration.

3. Product Launch. This phase consists of two activities related to product releases, namely Beta Version Release and Final Version Release.

    a. Beta Version Release. This activity produces beta game products that are fully functional. This beta product is released for testing to players or tested with clients for suggestions and feedback on a project-based basis. It depends on the complexity of the game being built, but in general, the feedback needed for this phase is essential. So if needed, independent user testing must be carried out, and that requires a budget.
    b. Final Version Release. This activity is the last activity whose output is the final product game. For online-based games or requiring an operating server, some costs must be considered. Even though it has entered the final phase, it does not mean that the released game will be free from bugs. So it takes a reserve of overhead funds for making game patches if needed.

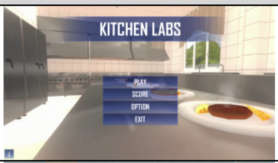
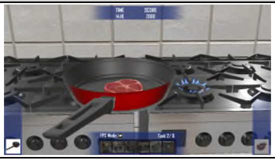
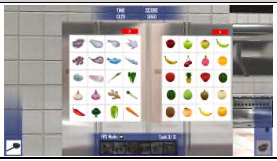
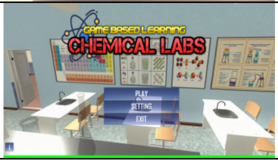
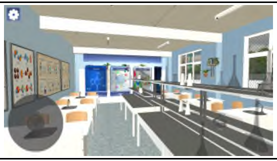
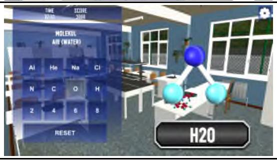
4. Experimental Results

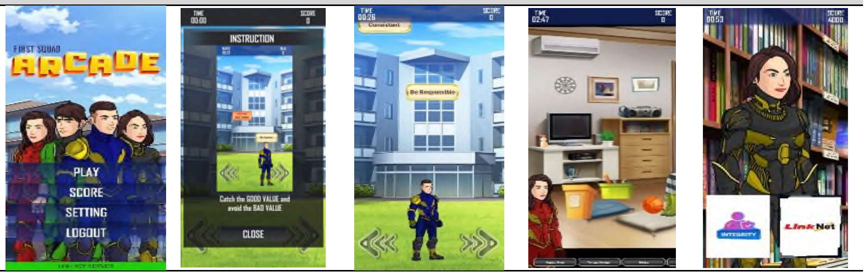
We tested this model's use in a Telkom University Multimedia Labs research team consisting of only 3-4 people. This team must work on three-game projects in parallel, which came from 3 different clients. Games that must be made have varying deadlines between 3-6 months, and limited development costs range from $2.000- $5.000.

The first game that must be made is a 3D cooking simulation game intended as a learning medium in the hospitality study program. The second game is an educational game for elementary school chemistry learning. And the third game is a 2D mobile game for introducing a positive culture for a private communication company.

The result was that the team managed to complete all three games in parallel with limited time and budget. There is a lot of potential for improvement, but in general, all clients love the games they make. Table 2 shows some screenshots of the games that have been created.

Table 2 Screenshot of The Game

Game ScreenShot			
1			
2			

	Game ScreenShot
3	 FIRST SQUAD ARCADE PLAY SCORE SETTING LOGOUT INSTRUCTION Catch the GOOD VALUE and avoid the BAD VALUE CLOSE Be Responsible INTEGRITY LinkNet

Measurement of user satisfaction results is tested by 30-40 respondents using the User Experience Questionnaire (UEQ), which consists of a 26 item questionnaire [21][22]. Figure 8-10 shows the overview UEQ results for all the games.

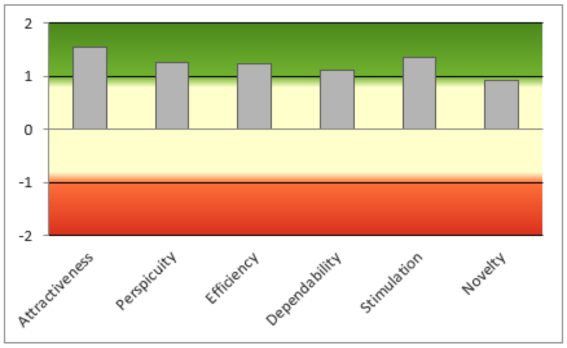


Figure 8 UEQ Result of Game 1

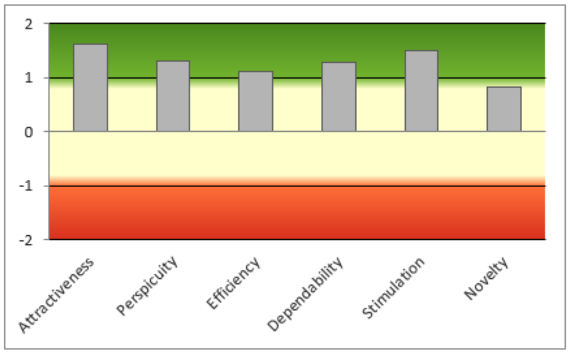


Figure 9 UEQ Result of Game 2

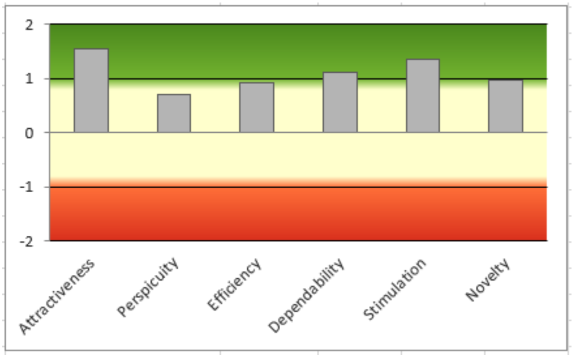


Figure 10 UEQ Result of Game 3

UEQ encapsulates all user experience points into six major groups: Attractiveness, Perspicuity, Efficiency, Dependability, Stimulation, and Novelty. The UEQ score scale ranges between -2 (horribly bad) and +2 (extremely good). In general, all the games that have been developed have scores ranging above 0.5 and 2. The highest score lies in the points of Attractiveness and Stimulation. This is because the game built has a good visual aspect and is equipped with a game mechanic that is exciting, interesting, and challenging for players.

5. Conclusions

The proposed RGD consists of 3 main phases consisting of 6 main activities. Several factors are considered for carrying out each activity, especially those related to development time and cost.

This model results from a combination of the GDLC model from academics and practitioners' points of view. In general, this model will depend on the mastery of technology or the game engine used. The availability of various generic or prefabricated assets is also needed to speed up the development process.

The test results show that this method's use can significantly accelerate the game development process, even within a limited time and budget. However, further research is still needed to verify this model's validation to create a more complex game and variety mechanic.

Bibliography

[1] Laamarti, Fedwa & Eid, Mohamad & El Saddik, Abdulmotaleb. "An Overview of Serious Games". International Journal of Computer Games Technology. 10.1155/2014/358152. 2014.

[2] Sun, Hanqiu & Ricciardi, Francesco & De Paolis, Lucio Tommaso. "A Comprehensive Review of Serious Games in Health Professions". International Journal of Computer Games Technology. 2014

[3] Darwesh, Aso, "Concepts Of Serious Game In Education". International Journal Of Engineering And Computer Science. 10.18535/Ijecs/v4i12.25, 2016

[4] Aleem, Saiqa & Capretz, Luiz & Ahmed, Faheem. "Game Development Software Engineering Process Life Cycle: A Systematic Review". Journal of Software Engineering Research and Development. 2016.

[5] Ramadan, Rido & Widyani, Yani. "Game development Life Cycle Guidelines". 95-100. 10.1109/ICACSIS.2013.6761558. 2013

[6] Zetcil, Game Development Life Cycle Review, [Online], https://www.zetcil.com/2019 /12/game-development-life-cycle-overview.html [Accessed 15 October 2020].

[7] Blitz Games Studios, "Project Lifecycle," [Online]. Available: http://www.blitzgamesstudios.com/blitz_academy/game_dev/ project_lifecycle. 2011. [Accessed 18 March 2020].

[8] Jonassen, Emmy. “Successful Indie Game Marketing” [Online] Available from: https://forum.unity.com/threads/the-scary-stats-about-indie-developer.473305 [Accessed 13 April 2020].

[9] Lotfi, Elaachak & Belahbib, Amine & Bouhorma, Mohammed. (2014). Adaptation of Rapid Prototyping Model for Serious Games Development. Journal of Computer Science and Information Technology. 2. 173-183. 10.15640/jcsit.

[10] Tizkar, Ali & M. Tabatabaei, Naser. (2009). Rapid Prototyping for Software Projects with User Interface. Scientific Bulletin of University of PITESTI, Electronics and Computer Science Series. 2. 85.

[11] Beynon-Davies, Paul & Carne, C & Mackay, Hugh & Tudhope, D. (1999). Rapid application development (RAD): An empirical review. European Journal of Information Systems. 8. 10.1057/palgrave.ejis.3000325.

[12] Skidmore S. (1996) Rapid Application Development. In: Introducing Systems Design. Computer Science Series. Palgrave, London

[13] Rodríguez-Martínez, L. & Mora, Manuel & Rodriguez, Francisco. (2009). A Descriptive/Comparative Study of the Evolution of Process Models of Software Development Life Cycles (PM-SDLCs) (PDF). Mexican International Conference on Computer Science. 298-303. 10.1109/ENC.2009.45.

[14] Mishra, Apoorva. (2013). A Comparative Study of Different Software Development Life Cycle Models in Different Scenarios. International Journal of Advance Research in Computer Science and Management Studies. 1. 64-69.

[15] Roedavan, Rickman. Zetcil: Game Mechanic Framework for Unity Game Engine. IJAIT (International Journal of Applied Information Technology), [S.l.], v. 3, n. 02, p. 96-105, July 2020. ISSN 2581-1223.

[16] Chen, yonghua & Chen, Zhe. (2010). Major Factors in Rapid Prototyping of Mechanisms. Key Engineering Materials - KEY ENG MAT. 443. 516-521. 10.4028/www.scientific.net/KEM.443.516.

[17] Wolfe, Emmy. (2017). Keys To Successfull Prototyping [Online] Available from: https://blog.trimech.com/keys-to-successful-rapid-prototyping [Accessed 13 April 2020].

[18] Engineering Production Design. “Rapid Prototyping Process Selection Key Factor”. [Online] https://engineeringproduct design .com/ rapid-prototyping-process-selection-key-factors [Accessed 13 April 2020]

[19] Frost, Brad. “Atomic Design”. 2016. Pittsburgh: Self Publishing. ISBN13: 9780998296609

[20] Gray, Kyle. “How To Protoyping a Game in Under 7 days” [Online] https://www.gamasutra.com/view/feature/130848/how_to_prototype_a_game_in_under_7_.php [Accessed 8 November 2020]

[21] Laugwitz, Bettina & Held, Theo & Schrepp, Martin. (2008). Construction and Evaluation of a User Experience Questionnaire. USAB 2008. 5298. 63-76. 10.1007/978-3-540-89350-9_6.

[22] Schrepp, Martin & Hinderks, Andreas & Thomaschewski, Jörg. (2014). Applying the User Experience Questionnaire (UEQ) in Different Evaluation Scenarios. 383-392. 10.1007/978-3-319-07668-3_37.