Software Ecosystems and Digital Games: Understanding the Financial Sustainability Aspect

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Abstract: The digital games industry has a deep alignment with the field of Software Ecosystems (SECO). Despite the strict relationship, actors of the games industry do not apply the SECO perspective to understand the dynamics of the environment. Financial sustainability is considered a key factor for the permanence of these actors on the platforms and directly impacts the sustainability of an ecosystem. This paper presents a qualitative analysis in that challenging aspect of the digital game industry based on SECO concepts. A survey research that identified the benefits, problems and challenges aspects reported by games actors of digital games SECO in Brazil bases the statements and the analysis of this study. The focus was on exploring the reports of financial sustainability through the SECO perspective in order to help actors to understand the technical, business and social elements of this global and interconnected industry in the area of Information Systems. Finally, some ideas for academic research are listed, such as the need to use knowledge management to support studies on the business dimension of digital games SECO and the need to explore further relationships among games industry actors in the Brazilian context.

1 INTRODUCTION

The approach of using a common technological platform that integrates several software products has replaced the development of a unique software product (Santos and Werner, 2012). Big companies such as Apple, Google, Amazon, and Microsoft are practical examples of this change in the software market (Santos et al., 2012; Manikas, 2016). Such approach is related to a research area in Software Engineering known as Software Ecosystems (SECO).

With the advent of several SECO in the market, the software industry changed its operation, affecting the games industry. The leading digital games platforms (e.g. GooglePlay, AppleStore, Nintendo Wii, Xbox Live, PlayStation Network, Steam) can be characterized as SECO, demonstrating the dominance of this strategy in the current scenario. The growth of the digital games industry in Brazil in recent years (Fleury et al., 2014; Sakuda and Fortim, 2018) and the challenges that such industry faces over the years (Nahar et al., 2012; Fleury et al., 2014; Sakuda and Fortim, 2018; Martins et al., 2018; Mäntymäki et al., 2019) leverages the need to explore the dynamics and relationships of the players immersed in this new market scenario.

The SECO strategy has enabled the exponential growth of the networks of actors that make up the software industry. The saturation of new products, among them digital games, has brought a high degree of competition among actors. As a result of this dispute in the digital games market, we observe the emergence of a critical challenge regarding the financial sustainability (Kasurinen et al., 2017; Sakuda and Fortim, 2018; Sormunen et al., 2019).

The sustainability of a SECO is directly linked to the constant collaboration among actors over time, aiming to promote the ecosystem (Dhungana et al., 2010). The frequent participation of external actors considered a crucial feature in SECO (Bosch, 2009; Santos and Werner, 2012) depends on the advantages and benefits they achieve by collaborating/contributing to the ecosystem. In order to support an understanding of this relationship, it is necessary to analyze a SECO in dimensions (Santos and Werner, 2012; Barbosa et al., 2013), being the business dimension responsible for dealing with economic aspects between the common technology platform and its actors.

The growth of networks of actors on technologi-

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cal platforms over the past few years has made SECO emerge as a research area in academia (Bosch, 2009; Manikas and Hansen, 2013; Berg, 2015; Manikas, 2016). Among the different studies of SECO, some highlight the need for mapping the network of actors as one of the challenges for the field (Jansen et al., 2009; Santos et al., 2012; Serebrenik and Mens, 2015; Alves et al., 2017; Santos, 2017).

In this context, the main objective of this work is to use the theoretical lens of SECO to explore the challenge of financial sustainability of players in the digital games industry in Brazil. We conducted a survey research covering all macro-regions of the country. This survey sought to identify benefits, problems, and challenges of actors participating in SECO that encompass digital games operating in Brazil. We applied Grounded Theory (GT) to support our analysis. This paper focused on the aspects related to the challenge of financial sustainability identified in this survey research.

This work is organized as follows: Section 2 addresses the theoretical background. Section 3 presents the methodology methodology to conduct survey research as well as the analysis procedures. Sections 4 and 5 present the results of the survey. Section 6 brings the discussion based on the results. Section 7 complements the discussion by highlighting the limiting points of this study. Finally, Section 8 presents the final considerations, listing some opportunities of future work.

2 SOFTWARE ECOSYSTEM AND DIGITAL GAMES

A game is an ancient element in humanity. There are records of games developed around 3,000 B.C. (Finkel, 2007). Another example is the oldest chess game in the world, which dates from 700 B.C. (Banaschak, 1999).

New modalities and game forms have emerged and are influenced by technological advances throughout human history. The era of digital games began with the launch of the first computer game in 1952 and the first video game console in 1958. The creation of the electronic entertainment by 1980s consolidated the digital games (Neto et al., 2009). Some studies highlight the relationship between digital games and the software industry (Engström, 2019; McKenzie et al., 2019; Toftedahl and Engström, 2019).

In this context, the "SECO" can be better understood when addressing the meaning of the word "ecosystem" in isolation, which comes from biology. The word "ecosystem" is used in different contexts to understand the evolutionary nature of processes, activities, and relationships (Dhungana et al., 2010; García-Holgado and García-Peñalvo, 2018). By adding the word "software" a focus is given to the software components that form more complex systems (García-Holgado and García-Peñalvo, 2018).

SECO is the interaction of software and actors through a common technological platform, which results in a set of direct or indirect contributions and influences to the community (Manikas, 2016). It is important to emphasize that this term have several definitions in the academic literature (Manikas and Hansen, 2013; García-Holgado and García-Peñalvo, 2018).

There are also several ways to analyze a SECO, and this study uses the definitions addressed in (Santos and Werner, 2012; Barbosa et al., 2013). The dimensions of SECO help in the understanding of dynamics and relationships are a perspective aligned with the objective of this research.

- Technical - addresses topics such as the life cycle, features, and architecture of the centralizing platform;
- Business - related to the flow of knowledge, resources and information through the business view; and
- Social - explore how the network of actors evolves to achieve its objectives.

Another relevant term in SECO literature for this study is "sustainability". Sustainability in SECO is the ecosystem's ability to increase or maintain its user/developer community over time, ensuring its survival against inherent changes regarding new technologies, products, competitors, users and attacks/sabotages (Dhungana et al., 2010).

According to Barbosa et al. (2013), sustainability is considered a fundamental aspect of the business dimension and a critical element in SECO. As such, SECO must be attentive to the maintenance/enhancement of its user/developer community for long periods, and the financial sustainability of the actors is a crucial factor for SECO platforms.

3 SURVEY

The methodological approach adopted was an online survey research using a questionnaire technique with open and closed questions. The survey research is a comprehensive survey method that aims to describe, compare and explain knowledge, attitudes, and behaviors through data collection. In turn, a question-

naire is an instrument that groups questions in a written format to facilitate the administration of data collection (Shull et al., 2007).

For data analysis, this study uses the Grounded Theory (GT) procedures. Although GT proposes the construction of theories, Corbin and Strauss (2014) state that it can be applied to achieve specific research objectives, such as the understanding of phenomena or scenarios.

3.1 Planning

The survey research aimed to characterize the Brazilian scenario of digital games industry. To do so, questions about benefits, problems, and challenges for participating in digital games SECO from actors working in industry and academia were prepared. It is important to notice that the objective of this paper was to presented an specific part of our research related to the challenge of financial sustainability from the opinion poll.

The planning starts with the definition of the survey questionnaire. The characterization questions involve the academic level, the job profile (academy, industry or both), the expertise area (administrative or technical), and the institution information (name, website and social network). The last three questions are open questions that asked about the challenges, problems and benefits faced by the respondents.

3.2 Execution

The survey was made available via GoogleForm[1] from October 17, 2018 to February 1, 2019. The survey reached 287 participants, 200 of whom were within the survey target profile. The valid participants work in institutions from all regions of Brazil.

3.3 Analysis Procedure

To start the analysis of the open questions, the codification phases in the GT (Corbin and Strauss, 2014) were observed: (1) open, (2) axial and (3) selective. In the open coding, a detailed reading of the answers suports the codes that represent terms/expressions. In the axial coding, the relationships/hierarchizations of the codes emerged. In selective coding, the central idea of the study arises, that is, the category to which the others are related.

The GT's coding process is finalized when the theoretical saturation is reached and the insertion of new data does not produce new knowledge, revisions or

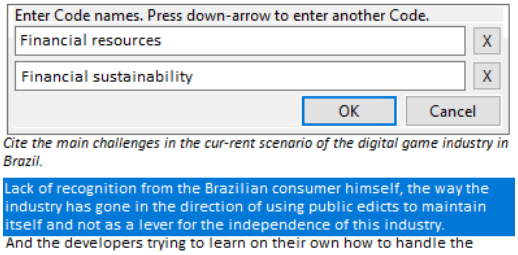

Figure 1: Opened Coding Stage in Atlas.TI.

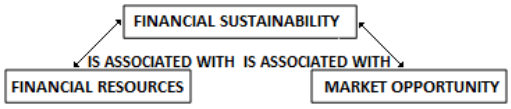

Figure 2: Axial Coding Stage in Atlas.TI.

reinterpretations (Stol et al., 2016). To assist the coding process, the software Atlas.TI[2] was used. In the open coding, the answers were analyzed in detail as illustrated in Figure 1, aiming to create codes related to specific fragments or direct quotations.

In this study, direct quotes finish with the respective participant identification, named by the letter "P" followed by his/her identification number. The number follows the total number of survey participants (maximum number of 287) to maintain the integrity of the data in the use of Atlas.TI.

After defining the codes, axial coding starts as illustrated in Figure 2, identifying the categories and relationships between codes. In Atlas.TI, the relations between codes are represented by a solid black arrow.

4 QUANTITATIVE RESULTS

Among the 200 valid participants in the opinion poll, 135 (67.50%) mentioned at least one of the challenges highlighted in this study. From 135 participants, 62 (45.92%) identified themselves as members of the academy (A), 51 (37.77%) as members of industry (I), and 22 (16.29%) as members of academia and industry simultaneously (A&I), according to Table 3.

In total, 6 codes related to financial sustainability were identified in the challenge group. Table 1 provides a brief description of the codes based on the participants' reports. Table 2 counts the total number of citations per participant profile regarding the Academy (A), Industry (I) and Academy and Industry (A&I). A participant might have concentrated quotations for more than one code.

[1]Tool that allows to collect user information through a survey.

[2]https://atlasti.com/

Table 1: Description of codes.

Code	Title	Description
C1	Financial Sustainability	Balance and financial support of the actors.
C2	Bureaucracy	Rules and procedures related to the activities of the sector.
C3	Production Cost	Resource values for production.
C4	Financial Resources	Raising of monetary resources.
C5	Tax Burden	Cash collection on the activities of the sector.
C6	Market Opportunity	Market/business conditions.
C7	Attract Audience	Engagement and attraction of users.

Table 2: Code citations.

Code	A	I	A&I	Total	%
C1	4	15	5	24	12,37
C2	1	3	3	7	3,61
C3	9	6	1	16	8,25
C4	38	26	14	78	40,20
C5	5	11	2	18	9,28
C6	10	9	2	21	10,82
C7	14	10	6	30	15,47
Total	81	80	33	194	100

Table 3: Participants profiles.

Role	Quantity	%
Academy	62	45,92
Industry	51	37,78
Academy and Industry	22	16,30
Total	135	100

5 QUALITATIVE RESULTS

The following subsections discuss the details of the definitions and relationships that permeate the challenge of financial sustainability of the digital games SECO's actors. Two researchers were responsible for drafting codes and relationships.

5.1 Financial Sustainability

This code represents the central point of the study. Financial sustainability addresses monetary order aspects concerning the integral performance and long-term permanence of players in the digital games SECO. To achieve this challenge, it is necessary to understand the codes related to it.

5.2 Bureaucracy

Bureaucracy addresses processes and regulations that hinder the operation and, consequently, the growth of sustainability of the SECO actors. This code permeates the maintenance of companies, processes in government entities, and access to financial resources for investment or billing. This code also involves academic activities.

5.3 Production Cost

This code was identified in fragments that describe financial challenges for the execution of the actors' activities. The acquisition of equipment, software, team building and maintenance of product quality form this challenge.

As a cause for the high cost of production, some participants point the tax burden for importation and the need for specialized and experienced labor. In turn, diversification of the public beyond entertainment and the use of specific platforms emerged as alternatives for the cost in the production process.

This code contributes to the lack of sustainability of the sector, as the initial input needed for production is considered high by national standards. Consequently, the high cost of production also affects the final cost of the product to the consumers, impacting to some extent the financial sustainability of the of the independent studios that develop games.

5.4 Financial Resources

This code focuses on the investment/financing sources for market-oriented products and academic projects. In other words, terms involving investment or financial or economic resource acquisition issues belong to this code.

Regarding the financing from industry and academia, the loss of resources for the execution of the project can have a direct impact on the maintenance capacity of institutions/companies. The way financial resources raise, whether through public tenders or private investments, also contributes to the challenge. Public support is considered an essential factor in this regard.

> "**Low public investment in the sector**; immaturity of the national industry in general, **reducing the interest of private investment**." [P267]

A dependency between access to finance and prior financial sustainability appeared. There is a specific need for market stability to access some investments

and, consequently, develop products that can make a difference in the company sustainability. Bureaucracy also contributes to the challenge of access to financial resources, despite the efforts of some government agencies.

Exploring the relationship between funding and public attraction shows a contradiction. Access to public investment may be discouraging innovation in the digital games industry and providing a false impression of sustainability for some players.

> "[...] the way the industry has gone in the direction of **using public edicts to maintain itself and not as a lever for the independence of that industry**." [P40]

Some actors also claim that projects aimed at diversifying audiences, such as educational games, have easy access to financial resources. It suggests that diversification of use is a possible solution to the lack of resources. In the same direction, development driven to platforms with low investment needs can help to outline the lack of financial resources.

5.5 Tax Burden

As seen in the two previous subsections, the tax burden is part of the sector's high production costs. In some cases, it is a prerequisite for accessing financial resources. The high import taxes, tariffs for receiving from abroad and lack of government support for tax incentives are examples of how tax burdens affect the sustainability of national players.

5.6 Market Opportunity

The market opportunity brings together factors related to business between companies and with the consumer market. It joins reports of challenges regarding consumption potential, economic scenario, internationalization, competition, production, and research activities. The difficulty of taking advantage of the opportunities that the market provides ultimately affects the ability of players to remain active in the sector.

5.7 Attract Audience

The attraction of the target audience is associated with how actors convince consumers to use their products. Aspects of innovation, such as the creation of methodologies and the diversification of the consumer audience are addressed by this code.

This challenge is related to the high cost of the final product to the consumer, the production of games focused on marketing/dissemination, the lack of visibility of Brazilian products, the high production of games for specific platforms (e.g. mobile), and the lack of diversification of the audience beyond entertainment.

The choice of specific platforms and the use beyond entertainment can make difference in financial sustainability. Diversification of use influences the access/need for financing and, consequently, the sustainability of the actors.

> "**Many independent studios focusing on mobile because of the ease and speed of development [...]. We are still far from self-sustaining**." [P62]

6 DISCUSSION

Figure 3 illustrates and typifies the relationships between the search codes. The lack of support in the relationship between the actors and the holders of the technological platforms is part of the national reality of the digital games industry. The actors lack formal support from such holders. However, they depend on them to reach the target audience and achieve the financial sustainability of their business.

Another definition that supports this relationship is the concept of SECO sustainability. Sustainability in this context encompasses business aspects (Dhungana et al., 2010). The financial sustainability of the actors that contribute to the promotion of a SECO is part of this dimension. The high cost of production (Martins et al., 2018; Sakuda and Fortim, 2018) makes this challenger harder when it comes to the ongoing collaboration of actors towards SECO. The lack of financial sustainability may result in the change/loss of these actors, thus becoming a critical factor for the overall sustainability of the involved ecosystems.

As the main result of this research, it is possible to mention the understanding of aspects that permeate the actor's financial sustainability in the game industry. It was observed that the challenge is related to six others: bureaucracy, production cost, financial resources, tax burden, market opportunities, and attraction of the target audience.

The approach of encompassing related challenges in the analysis helps to observe the dynamics and behaviors. The flow between codes clarifies some possible points of action which, in turn, create research opportunities. To understand this approach, it is necessary to dive into these flows between the challenges.

The difficulty of staying financially healthy is associated with high production costs. In turn, the

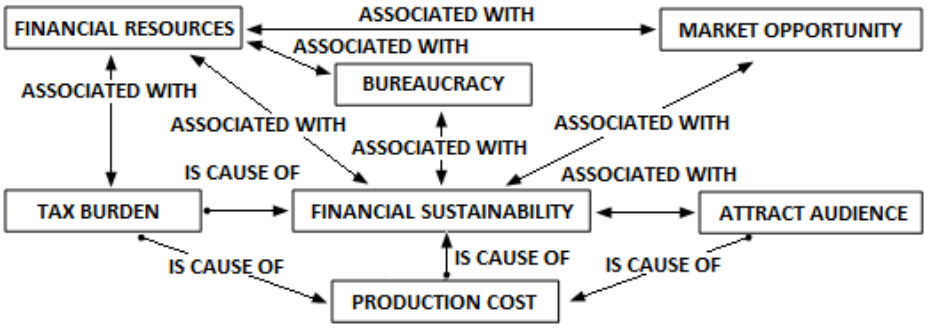

Figure 3: Financial sustainability relationships.

high costs make it difficult to attract professionals and maintain teams, impacting on the quality of projects and devaluing the software product (digital game). This cycle emerged thanks to the macro view and the qualitative analysis applied in this study.

The choice of technological platforms, i.e. the SECO to which a independent studio focuses its work, was pointed out by **P62** with a factor that influences the execution of projects. Each platform has a form of integration, and some tools from the game industry (e.g., Unit, Unreal) facilitated the distribution of a software solution (digital game) to several platforms. However, this transposition does not happen for the entire production process. This fact can be verified by the preference for mobile platforms, due to speed and ease in project execution. Despite the distribution over several platforms, the choice of a SECO platform influences in project execution, being a critical factor for the independent studio's sustainability.

A possible solution identified for financial sustainability is the diversification of the use of digital games. Games that transcend only entertainment emerged as a possible solution for raising financial resources. On the other hand there is a need to stimulate the acceptance of digital games in educational environments. This contradiction of reports demonstrates the lack of knowledge of some actors about the reality of the national scenario of digital games. In the games industry census (Fleury et al., 2014; Sakuda and Fortim, 2018), it was highlighted such emerging state of the area in Brazil. In other words, the actors of this industry are in an early stage of playing in the market and this is a fact that justifies the lack of knowledge of the real problems or benefits of the national scenario.

Another point of reflection of relationships is in project financing. In a shallow analysis, financing could be a solution to the specific problem of financial sustainability, providing flexibility for team maintenance and other costs. However, as reported by **P40**, access to this type of resource can have a reverse effect, giving some actors a false impression of success.

The strategy of pursuing investments until financial sustainability is a valid approach in some markets. However, as reported by **P267**, investors in Brazil have high resistance to invest in the gaming area, making this strategy unfeasible in the national context.

The scope of this work also include academic research. In the case of academic projects, the relationship with funding can be understood as essential, since some academic research projects have no market bias. Therefore, the concept of financial sustainability is applied differently in these cases, requiring a specific focus to meet the category of research institutions.

Access to equipment, software, and team maintenance are factors that contribute to the challenge of production costs. The production cost also includes aspects of methodology, as reported by **P62**, which highlights the complexity and project's execution time as a factor that influences costs. Such code exposes the need to define methodologies focused on the profile of the national industry actors.

The difficulty in entering the national market itself is a challenge that requires a specific investigation. One of the reports points out the high cost to the final customer as a possible motivation. However, this reason does not explain the success of equally expensive international products in the Brazilian scenario. Another factor linked to the execution of projects, which may influence the acceptance of national products, is the difficulty with marketing and dissemination actions. A methodology or model to support the planning of national studios at the business level can help in related difficulties.

Another concept that supports the understanding of the the digital games sector is that of the dimensions of SECO (Santos and Werner, 2012; Barbosa et al., 2013). Figure 4 frames the codes identified in Table 1 Figure 3 among the SECO dimensions. By observing the distribution of the codes, we can observe a concentration on the business dimension. In other words, there is a need to a deep investigation on

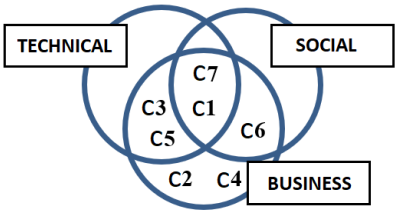

Figure 4: Challenges in the dimensions of SECO.

such dimension in the Brazilian digital games industry.

The conduction of studies focused on business aspects needs to enter into different disciplined related to this field. Studies supported by the Information Systems area, together with concepts and theories from other disciplines, such as Business and Software Engineering, are fundamental to explore and propose solutions to the identified challenges.

7 LIMITATIONS

Despite the number of participants, Brazil is a country with different realities within its territory. As a consequence, it is not possible to generalize to a large extent the results and analysis of this study. This argument also underlies part of the identified contradictions, and there is a need for analyzing each local community to achieve a deep understanding.

The data used in this study came from a survey research whose objective is to identify benefits, problems, and challenges of the Brazilian digital games industry. In turn, this work focused on exploring in detail one of the several identified codes. Although this strategy to explore a specific challenge, this approach did not take into account the impacts of indirectly related aspects.

Communication via groups and social network pages does not provide adequate control for the measurement of participation rate, but this strategy entirely agrees with the primary goal of our survey research. As a consequence of the disclosure in groups and social network pages, it was necessary to insert an exclusionary factor as exposed by the question about respondent's profile (acedemy, industry, or both). Responses from actors who are not in one of this profiles were discarded.

Regarding the qualitative analysis, it is necessary to recognize the influence of the researchers' knowledge. Some short answers and direct citations of terms with generic meanings may have an interpretation bias. However, the analyses were verified in several interactions with a third researcher to reduce this bias and portray the identified results.

8 FINAL CONSIDERATIONS

Through a qualitative analysis of the survey data, it was possible to identify six codes related to the challenge of financial sustainability code itself. Exploring the relationships between the codes deepened the understanding of how the challenge is realized by the participants. The perspective of SECO is an important approach to achieve the objective of the study.

The growing digital games industry in Brazil means that more people are venturing into SECO. The sustainability of these ecosystems is crucial for new players, which corroborates the importance of this issue that has been addressed by both industry surveys and academic studies.

The SECO vision helped us to explore and analyze the Brazilian context from our study. Through this vision, it was possible to identify the importance of external actors in the sustainability dynamics. This work contributes to the understanding of the dynamics of digital games SECO and provides insights to academic research intertwining these two topics (SECO and digital games).

As the main topic for future research, it was possible to identify a need to explore the business dimension of digital games SECO in Brazil. As a starting point, it is necessary to explore the Business area to identify points of intersection with this SECO dimension.

Another future work refers to the use of qualitative approaches to deepen the understanding of the relationships among the aspects of the digital games industry. The Brazilian scope of out survey research allowed us to highligh actors's concerns in achieving a big picture of the dynamics of the digital games industry - a fact that reinforce the importance of this type of study.

Other suggestions for future work are: (1) use other SECO concepts to support the analysis, such as life cycle, health, and technical, human and organizational factors; and (2) explore other codes related to challenges, benefits, and problems identified in the survey research.

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