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TECHNOLOGIES FOR SAVING SYSTEMS IN ELECTRONIC GAMES

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ABSTRACT

The article explores the implementation of economy systems in electronic games, focusing on microtransactions, business models and technologies necessary to sustain player immersion and ensure secure transactions. The use of virtual currencies, microtransactions and the impact on the mobile gaming market stand out.

Keywords: Microtransactions, Economy system.

INTRODUCTION

The mechanics of a video game may include an economy system. The internal economy system within a video game plays a key role in gameplay, player immersion, and creating a dynamic virtual environment for the player to stay engaged in the game.

The economy system defines the business model of the electronic game, in which several sources of revenue and profit generation for the electronic game industry can be used, including: microtransactions; ads that must be watched to continue playing or use a microtransaction to unlock them; subscription services, where the player pays a subscription to have full access to a game or sets of games that are on a platform; season pass that the player buys to download all available content; loot boxing, where the player buys "boxes" that contain random items to customize the game (TOMIĆ, 2018).

With microtransactions, players can purchase in-game "extras" through the use of real money. A large percentage of players use microtransactions. According to Raimundo (2022), 71.4% of players have already spent money on microtransactions in games. In the reports released by the consultancy Newzoo regarding the gaming market in 2022, of the approximately US$92 billion that were moved by the mobile gaming industry, US$2.4 billion

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correspond to microtransactions. These microtransactions are based on small purchases of skins, accessories, avatars and/or powers for the games, for between US$1 and US$10. The same consultancy Newzoo defines as a trend for 2023 the continuity in the use of various monetization methods in games, including microtransactions (WIJMAN, 2022; WIJMAN, 2023).

The in-game economy system should support these microtransactions and favor the player's immersion in the game. To this end, coins, points, gold, silver, credits, gems or other names defined by game designers are part of the games and in many cases these resources can be used to gain advantages in the game or be exchanged for real money. The implementation of these mechanics requires information technologies to ensure the relationship between the game and the players.

OBJECTIVE

This article covers several topics related to saving systems in video games. Initially, the mechanics of the economy system for electronic games and its main requirements are defined. Then, the technologies necessary to implement an economy system in a video game are identified. For each of the technologies (transaction mechanics, databases, balancing and security algorithms), a topic is dedicated, where the general characteristics and some of the technologies that can be used are presented.

METHODOLOGY

This article presents a study of the requirements and technologies required to implement an economy system in an electronic game. It presents in a general way what are the current trends and good practices. The methods used in the research are fundamentally based on literature review. The survey covered books and articles published in English and Portuguese until 2023. In the research stage, several keywords were used, as the topics were intentionally broad. Thus, the following keywords related to electronic games were used: economy system, microtransactions, transaction system, databases for games, security of transactions in games, production rules for games, balancing algorithms for games. The main literature search engine used was Google Scholar. For the study, 55 books and/or articles published between 2005 and 2023 were selected.

DEVELOPMENT

Electronic games are considered reward systems, where players earn rewards for performing certain actions. These actions include obtaining resources or money within the game, which are the key elements of an economy system. An economy system is a series of business rules and mechanics that govern how resources are collected, stored, traded, and used within the game, and how this economy system affects the overall player experience. The player can trade resources in the game, either with the game itself or with other players and this trading system forms a simple economy. Economic systems, in turn, influence and encourage certain behaviors of players. These behaviors, when represented in the game, contribute to the player's experience (FULLERTON, 2019; SCHREIBER; ROMERO, 2021).

There are varieties of savings in a game, from simple barter to complex markets. Game design must ensure the relationship between the economic system and the overall structure of the game. The economy must be directly related to the objectives of the game and be balanced with the exchange value and scarcity of resources that it involves. The actions that the player performs in relation to the economic system should help or hinder the player's progress in the game (FULLERTON, 2019).

The implementation of an economy system in a video game depends on the type of game and the experience you want to offer players. Some of the requirements that can be considered in a game to support the economy system are: existence of a virtual currency in the game; generation of resources that players can earn, produce, or purchase using real money; convert earned resources into in-game benefits; have a virtual store; facilitate the trade of resources between players and have mechanisms to limit resources in the game based on rarity (SCHELL, 2020, SCHREIBER; ROMERO, 2021).

The economy system should be balanced, so players can earn enough money to spend in the store, but not so much that they make the game too easy. It is important to maintain a good balance to ensure that players have a fair and challenging experience. It is important to incorporate into the economy system an insight into the player's progress in the game, the player must know what his resources are in the game and how he can use them (SCHELL, 2020).

The development of an economy system in an electronic game requires the use of different types of technologies depending on the type of game and the complexity of the economy system itself. In general, an economy system can be supported by (SAUNDERS; NOVAK, 2012; SCHREIBER; ROMERO, 2021):

- Transaction mechanics: mechanics to secure in-game transactions, whether between players or between the player and the game. This should include buying and selling in-game items or services. It may be necessary to have an in-game payment and/or e-commerce system to support these transactions.

- Database: a database for storing information related to the player and the virtual resources he gains and loses in the game. The database can be integrated into the game system to manage the flow of virtual resources and ensure that player information is saved correctly.
- Balancing algorithms: the economy system should ensure that players can progress through the game without feeling too restricted or, on the contrary, without it being too easy to gain resources. This may require the use of balancing algorithms that monitor the flow of virtual resources and adjust the game's rewards and challenges to maintain balance.
- Security: it is an important point that should not be neglected in electronic games that incorporate mechanics to acquire resources using real money or that make it possible to exchange resources obtained in the game for real money.
- The technologies listed are important for the development of an economy system and to ensure that the game runs smoothly and fairly for all players. In the following topics, the main characteristics and good practices of each technology will be analyzed in general.

TRANSACTION MECHANICS

The mechanisms by which players perform economic transactions within the game define the transaction mechanics. Transactions can include the purchase and sale of resources, items, virtual currency, or any other type of asset present in the game. In this way, an economic system is created within the game that allows players to acquire and exchange items of value within the virtual environment (LEHDONVIRTA; CASTRONOVA, 2014).

Several approaches can be used for Transaction Mechanics in video games. The economy system can be based on a virtual currency, where players earn or purchase a specific in-game currency and use it to acquire items, or on the possibility of direct exchanges between players, allowing them to trade items with each other. Additionally, mechanics may include the existence of in-game virtual stores where players can purchase items directly from the developers or from other players. Auction systems can also be included, where players can put items up for sale and other players can bid to acquire them.

Whatever transaction mechanics are used, they should be designed to create an engaging gaming experience, allowing players to earn rewards, customize their characters, and progress within the game. However, it is important that these mechanics are balanced to avoid imbalances in gameplay, such as unfair advantages for players who invest more real money in the game.

The mechanics of transactions in electronic games have generated discussions regarding regulation and ethics. Some games have been criticized for practices deemed unfair or predatory, such as the implementation of random loot boxes, where players spend real money in search of rare items. This type of practice has raised concerns about gambling and the impact on vulnerable gamblers, resulting in debates about government regulations (SPICER et al., 2022).

Implementing transaction mechanics in a video game involves several steps and considerations. Initially, the objectives of the economic system in the game must be defined, which items will be tradable, how the economy will affect the progression of players and if there will be a monetization aspect involved. A monetization model should be chosen, which can be: one-time purchase of the game, free-to-play with in-game purchases (microtransactions), a subscription system or a combination of these models, always considering the expectations and preferences of the target audience. Design virtual currency by defining how players will acquire it, whether through in-game achievements, real-money purchases, or a combination of both. Consider how players will be able to spend virtual currency and what items or services will be available for purchase. It is convenient to include in the game a virtual store, inventory screens, purchase options, auctions or any other form of interaction related to transactions (LEHDONVIRTA; CASTRONOVA, 2014).

Item values, prices, virtual currency earning rates, and other economic system factors should be adjusted to ensure proper balance. Avoid creating a system where players who spend real money have an unfair advantage over players who don't. Ensure that players can progress and obtain valuable items through in-game effort in addition to transaction options.

This entire process must be accompanied by extensive testing of the economic system to identify any problems, imbalances, or usability failures. Observe player feedback and make adjustments as needed. Finally, do not neglect ethical concerns and regulations related to the mechanics of transactions in electronic games. Avoid practices that are considered unfair, predatory, or that can be interpreted as gambling (LEHDONVIRTA; CASTRONOVA, 2014).

DATABASE

The database (DB) is a technology that ensures the persistence of data in software systems, including saving systems in electronic games. In video games, these databases are used to store information about items, virtual currencies, transactions, prices, and other aspects of the game's economy. Some of the data related to the economy system that can be stored are: inventory, player, transactions and trade between players and between the player and the game and player progression. In addition, the database allows you to manage and track economic events within the game, such as a temporary drop in prices, for example. Databases are valuable to game designers and the development team, as they provide data on player behavior, the game's economic trends, and other useful information. This data can be used to: balance the game's economy; identify problems; create monetization strategies and; Make decisions to improve the player experience.

Database technologies can be used to support the economy system in a game, such as: Relational databases, which store structured data in tables with defined relationships between them (examples: MySQL, PostgreSQL and Oracle); NoSQL databases, designed to handle large volumes of unstructured or semi-structured data (examples: MongoDB, Cassandra, and Redis); Databases in RAM memory to provide fast access to data, ideal for scenarios where speed is a priority (examples: Redis and Memcached); Databases distributed across multiple servers to ensure scalability and high availability and that are suitable for systems that need to handle large workloads and store data redundantly (examples: Apache Cassandra, Hadoop, and CockroachDB) (DEMERS et al., 2009; NYSTROM 2014).

DATABASE AS A SERVICE

In databases-as-a-service (DBaaS), it is possible to use a database through a cloud service provider. This way of using BD offers several benefits for the product and for the developers. First, the cloud service provider is responsible for deploying, configuring, and managing the database, so developers don't have to worry about these activities. Security is guaranteed by the provider, which has built-in security features such as authentication, encryption, and access controls. Scalability, high availability, and redundancy characteristics are also guaranteed, facilitating the continuity of the economy system, even in case of failures, and adapting to the ever-evolving needs of the economy system of an electronic game, especially at times of peak players (VIKIRU et al., 2023).

On the other hand, DBaaS offer a variety of database options, such as relational databases and NoSQL databases. This allows you to choose the database that best suits the specific needs of the e-game economy system.

Examples of database-as-a-service services are: Amazon RDS, Azure SQL Database, Google Cloud SQL, and Firebase Realtime Database. Each cloud service provider offers its own DBaaS offering with specific features and options. Since 2018, Epic Games (Epic) (one of the most renowned game studios in the international market) has been using the storage, analytics, and scalability capabilities of Amazon Web Services (AWS) for its business (Amazon Web Services, 2022).

The choice to use a database as a service will depend on the needs of the e-game economy system, the preference and financial possibilities of the developers, and the resources offered by the cloud service providers. It is important to carefully evaluate the available options and consider factors such as performance, cost, scalability, security, and compliance before making a decision.

BALANCING ALGORITHMS

Balancing and balancing a game is the process of ensuring that the game meets the goals that have been set for the player's experience. This includes that the game has the scope and complexity that it was designed for, and that the elements of that system work together and without unwanted results. In this balancing process, it may be necessary to use mathematics and statistics, as it can be a complex process to be carried out and must be planned in detail.

The economy system is present in many video games and must be aligned with the game's objectives and ensure players' engagement in the game. Thus, the balance must be considered by the game's game designer. In the literature, several balancing algorithms are identified that can be used for in-game economy systems. Some examples include (SCHREIBER; ROMERO, 2021):

- Price adjustment algorithm: Algorithm for monitoring the virtual market within the game and automatically adjusting the prices of items and services based on supply and demand. This helps prevent players from accumulating excess virtual resources and becoming too wealthy;
- Controlled Inflation Algorithm: This algorithm limits the amount of virtual resources that can be created in the game to prevent inflation and ensure that players do not lose the value of their resources. This can be done by limiting rewards or limiting the increase in item prices;

- Power Balance Algorithm: This algorithm analyzes the power level of players relative to other players and adjusts the game's difficulty and rewards accordingly. This helps to ensure that less powerful players can progress through the game and gain resources, while more powerful players still have significant challenges to face;
- Class Balancing Algorithm: This algorithm analyzes the effectiveness of each character class within the game and adjusts the amount of resources each class can gain relative to the others. This helps to ensure that all character classes are useful in the game and that players are not encouraged to only play with a specific class;
- Random Event Creation Algorithm: An algorithm that creates random events that affect the game's economy. For example, a natural disaster event can destroy some agricultural production, affecting food supply and increasing prices;
- Reward Balancing Algorithm: An algorithm that adjusts the amount and type of rewards players receive. For example, if players are getting too many rewards for a certain activity, the algorithm can reduce the amount of rewards to balance the game.

In-game trading can be regulated by setting price controls and controls on the timing and quantity of items that can be traded. In addition, there is the possibility of letting players trade with total freedom (FULLERTON, 2019).

In the game design, four important elements must be defined:

i. If the size of the economy increases over the course of the game and if this growth is controlled by the game;
ii. How the money supply is controlled;
iii. Whether prices are controlled by market forces or set by play and;
iv. Whether there are restrictions on trading opportunities between players.

These elements can be defined in various ways, creating combinations that define types of savings. Table 1 shows a classification of the different types of economy based on the definitions given by Fullerton (2019) and another similar classification that can be consulted in Schreiber and Romero (2021).

The Game Designer is tasked with relating the economic system to the structure of the game and ensuring satisfying gameplay. From this, the game implements algorithms to define when, how and in what quantity resources and currencies will be generated in the game, and what are the rules that establish trade within the game. Both types of rules can be represented in the development of a game using production rules.

Table 1 – Varieties of savings in electronic games

Economia	*Quantidade de produto*	*Estoque de dinheiro*	*Preços*	*Oportunidades de negociação*
Troca Simples	Fixo	n/a	Fixos	Sem restrições
Troca Complexa	Crescimento controlado	n/a	Valor de mercado com limite	Restrito por turno
Mercado Simples	Fixo	Crescimento controlado	Valor de mercado	Sem restrições
Mercado Complexo	Crescimento controlado	Crescimento controlado	Valor de mercado com base	Sem restrições
Meta economia	Crescimento controlado	Crescimento controlado	Valor de mercado	Sem restrições

PRODUCTION RULES

Production rules are one of the main concepts in the field of knowledge-based systems and expert systems. They are used to represent declarative and procedural knowledge in a structured format. This knowledge is represented by a set of conditional statements and their corresponding actions, which specify how the system should infer new information or perform certain tasks based on specific conditions.

In video games, production rules can be used to represent the behavior of NPC characters (non-playable characters) and the logic of the game. The game logic includes the balancing mechanisms of the economy system. One of the simplest ways to implement production rules is by using statements in the form "IF... THEN..." directly in the programming language. In this way, it is possible to have procedures observing and evaluating the production rules at all times and making decisions for the game, for example: increasing the value of a resource, decreasing the supply of a resource, generating new resources, limiting trade between players or releasing trade.

These rules must be based on economic indicators within the game. These indicators represent a quantitative measure, which provides information about the health and performance of the game economy. Some of these indicators can be: trade volume, price indices, trade balance or competitiveness index. Examples of some of these rules are: IF the trade volume of resource "A" decreases by 10% THEN decreases the value of resource "A" AND increases the supply of resource "A"; IF price index in trade between players decreases by 5% THEN propose new features to players.

Production rules can be static (they don't change over time) or dynamic (when new rules can be added to the game at runtime). Embedding production rules in the code itself is not the most efficient way to develop the economy system in the game, particularly if there are many rules and if those rules are dynamic. For this, other strategies can be used, including:

- Scripting Systems (SS): Systems that allow production rules to be written in separate scripts and interpreted by the game engine at runtime, providing a more flexible and interactive way to define and modify rules without having to recompile the entire game. Examples: The Unity Scripting API and Blueprints Visual Scripting.
- Expert Systems (SE): Expert systems are designed to solve specific problems in a particular domain, for example, the economy system.
- Declarative Methods (DM): methods that allow describing the rules, constraints, and relationships between the elements of a problem in a more abstract way than the SE and SS. DM focuses on the expression of logic and the definition of conditions and actions to achieve an outcome. Examples: Prolog, CLIPS, Drools, CLP (Constraint Logic Programming), AWS (Answer Set Programming), Game Description Language.
- AI systems: It is possible to use more advanced artificial intelligence systems, such as behavior trees, finite state machines, and machine learning, to define the logic of the game. For these cases, AI frameworks such as TensorFlow or Unity ML-Agents can be used.

SECURITY

Security in a game's economy system is essential to protect player data, prevent fraud, and ensure the integrity of the game's economy. Security is a continuous and constantly evolving process and among the main practices are: presence of a robust authentication and authorization system, need to validate input data, implement auditing systems on transactions, ensure the protection of personal data, use security tests to identify possible vulnerabilities, educate players about security practices and keep the game up to date with the latest security fixes (CANO, 2016; TAVAKKOLI, 2018).

There are several technologies and practices that can be implemented to ensure security in electronic game transactions. One of them is encryption to ensure that information is transmitted and stored securely, preventing it from being intercepted and accessed by third parties. Another is two-factor authentication, which adds an extra layer of security by requiring users to provide two different forms of authentication to access an account. A third is the verification of the integrity of the data when a purchase occurs in the game, to ensure that items are not falsified or altered in a fraudulent way.

Additionally, systems must be able to monitor transactions for suspicious activity, such as large-scale unusual transactions, unauthorized access attempts, or excessive use of resources. In this sense, anomaly detection algorithms can be implemented to identify these patterns and trigger preventive measures. Protection against denial-of-service (DDoS) attacks should be implemented, as these attacks can overwhelm the game's servers, resulting in service interruptions and unavailability for players. It is important to verify the identity of players during transactions, especially those involving payments. This can be done through personally identifiable checks such as name, address, and payment information. Finally, reputation systems can be put in place to identify and prevent fraudulent transactions.

These are some of the technologies and practices that can be implemented to ensure security in electronic game transactions. It is important for developers and service providers to always stay up-to-date on emerging threats and take appropriate measures to protect players and their information.

FINAL CONSIDERATIONS

The business model of a video game is defined by the policies of the development team (managers, artists, testers, and developers). If as a model it is decided to use transactions and/or microtransactions, it is necessary to design and develop an economy system for the game. The economy system must be designed by game designers so that it integrates with the game and allows the player to have fun, immersion and engagement. To this end, the economy system must be supported by a transaction mechanism that guarantees the acquisition and trade of resources within the game and must be controlled and managed by balancing algorithms to maintain a balance in the game economy, which favors the player's experience, according to the defined objectives. In the economy system, databases are used to store the player's information, their transactions and evolution within the game. Attention should be paid to the security of the game in order to prevent fraud and to ensure a trusting environment for the game and the players. The article focused on the main characteristics of these four analyzed technologies and summarizing the main current trends.

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