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# The Role of Game Engines in the Democratization of Digital Game Development

**Gabriel Pereira Costa**
Centro Universitário AlfaUnipac, Brazil
Corresponding author: gabrielpereiracosta1402@gmail.com

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## Abstract

Game engines have become a central element in the contemporary digital game industry, significantly contributing to the democratization of game development. By providing integrated tools, reusable systems, and accessible development environments, game engines have reduced technical and financial barriers that previously restricted game creation to large studios with substantial resources. This article examines the historical evolution of game engines, from proprietary solutions to modern, accessible platforms, and analyzes their role in enabling independent and small-scale development. Through a comparative and bibliographic methodology, the study discusses the main features of leading engines, their economic and market impacts, and their influence on the growth of the indie game sector. Additionally, the article addresses current limitations and challenges, such as technological dependence, licensing changes, and market saturation, while also exploring future trends, including open-source engines, artificial intelligence integration, and the standardization of development pipelines. The findings indicate that game engines have significantly expanded access to creative participation, although within persistent structural inequalities shaped by platform governance, market concentration, and global asymmetries.
**Keywords:** game engines; democratization of development; indie games; digital game industry; game development tools.

## 1. Introduction

The digital games industry has established itself as one of the most significant sectors of modern entertainment, generating billions of dollars and exerting global cultural and economic impact. This industry encompasses everything from simple mobile games to complex titles for consoles and PCs, being driven by technological advancements and the growing demand for interactive and immersive experiences (Pimenta, 2019).

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Initially, each game had to be developed almost entirely from scratch, with developers implementing all systems internally for each project. As technologies advanced, game engines emerged—sets of reusable modules that enabled the creation of graphics, physics, audio, and game logic without the need to rewrite these components for every new title. From the 1990s onward, with games such as *Doom* and *Quake*, this model became consolidated and evolved into modern engines that support multiple platforms and more accessible workflows (Foxman, 2019; Toftedahl & Engström, 2019).

The term *development democratization* refers to the reduction of entry barriers to game creation, allowing individuals and small studios to produce high-quality games without the need for large teams or substantial budgets. This has been made possible by freely available or low-cost tools, extensive documentation, and developer communities that share knowledge and resources (Foxman, 2019; Toftedahl & Engström, 2019).

The analysis adopts a critical perspective grounded in the political economy of digital platforms and socio-technical systems theory, as elaborated in the following section. In doing so, it frames democratization not as an automatic outcome of technological progress, but as a contested socio-economic process shaped by power relations, platform governance, and structural inequalities.

## 2. Methodological Clarification

This study adopts a narrative bibliographic review with comparative descriptive elements, rather than a systematic literature review. This methodological choice is appropriate given the exploratory and conceptual nature of the research question, which seeks to examine the socio-technical dynamics underlying the democratization of digital game development. Narrative reviews are particularly suitable for synthesizing heterogeneous bodies of literature, enabling critical interpretation, theoretical articulation, and conceptual integration where empirical standardization is neither feasible nor desirable (Grant & Booth, 2009; Green et al., 2006).

The literature search was conducted between January and February 2026 across major academic databases, including Scopus, Web of Science (WoS), ACM Digital Library, IEEE Xplore, and Google Scholar, restricted to peer-reviewed publications. Search strings combined keywords related to technological infrastructures and cultural production, such as “game engines”, “democratization of game development”, “indie games”, “platform ecosystems”, “creative labor”, and “software infrastructures”. This multi-database strategy was adopted to ensure interdisciplinary coverage across game studies, software engineering, media studies, and digital labor research (Webster & Watson, 2002).

Inclusion criteria comprised:
(I) peer-reviewed journal articles, conference proceedings, and academic books;

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(II) publications dated between 2015 and 2026, ensuring both recency and theoretical consolidation;
(III) explicit analytical engagement with game development tools, production platforms, or digital creative infrastructures. These criteria align with best practices for narrative reviews seeking analytical depth rather than exhaustive quantification (Boell & Cecez-Kecmanovic, 2015).

Exclusion criteria included promotional materials, opinion-based content, and sources lacking methodological transparency. Industry reports and market analyses were consulted exclusively as contextual material, supporting background discussion without serving as primary empirical evidence. This distinction preserves analytical rigor while acknowledging the relevance of industry dynamics to the studied phenomenon (Jessop, 2012).

## 3. Theoretical Framework and Epistemological Positioning

This study is grounded in the political economy of digital platforms, complemented by insights from socio-technical systems theory. Rather than treating game engines as neutral technological artifacts, the analysis conceptualizes them as infrastructural platforms embedded within broader economic, institutional, and labor arrangements. This approach enables an examination of how technical affordances intersect with power relations, governance mechanisms, and market structures in digital game production (Srnicek, 2017; van Dijck et al., 2018).

The concept of platform capitalism is employed to interpret game engines as intermediaries that actively structure access to production tools, define revenue models, and condition creative autonomy. From this perspective, democratization is understood as a contested and uneven process, shaped by licensing regimes, ownership structures, visibility algorithms, and global inequalities, rather than as an automatic outcome of technological accessibility alone (Langley & Leyshon, 2017; Nieborg & Poell, 2018).

Epistemologically, the study aligns with a critical socio-constructivist stance, recognizing that technologies do not determine social outcomes in isolation. Instead, technological affordances co-evolve with social practices, institutional constraints, and cultural norms. This position rejects technological determinism and emphasizes the relational dynamics through which digital infrastructures shape—and are shaped by—creative labor and production ecosystems within the game industry (Bijker et al., 2012; Orlikowski, 2007).

## 4. Concept and Function of Game Engines

### 4.1 Definition of a game engine

A game engine is a set of modules and tools designed to facilitate game development by providing core functionalities in an integrated manner. These modules allow developers to focus on the specific logic of their games without having to implement

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fundamental features such as graphics or physics from scratch (Universidade Federal do Ceará [UFC], 2022).

### 4.2 Main components

Modern game engines integrate several subsystems that address the most common needs in game development:

**Graphics rendering** – responsible for generating and displaying 2D and 3D images on the screen in real time, including texture manipulation, lighting, and visual effects (Ampatzoglou & Stamelos, 2010; Politowski et al., 2021).

**Physics system** – simulates physical laws such as collisions, gravity, and motion, enabling more realistic interactions between objects within the game (Ampatzoglou & Stamelos, 2010; Politowski et al., 2021).

**Audio** – manages the playback of sounds and music, enabling sound effects synchronized with in-game actions (Ampatzoglou & Stamelos, 2010; Politowski et al., 2021).

**Asset management** – stores and organizes resources such as models, textures, animations, and sounds, facilitating their reuse and integration into the project (UFC, 2022).

**Scripting / programming languages** – interfaces that allow the programming of game logic, events, and behaviors, using languages such as C#, C++, or proprietary engine-specific languages (Ampatzoglou & Stamelos, 2010; Politowski et al., 2021).

### 4.3 Advantages of using ready-made engines instead of developing from scratch

Using ready-made engines significantly reduces development time and costs, as a large portion of essential functionalities is already implemented and optimized. Furthermore, popular engines offer extensive documentation, active communities, and multi-platform support, which facilitates learning and capability expansion for beginner and independent developers (Politowski et al., 2021; Ampatzoglou & Stamelos, 2010).

## 5. Historical Evolution of Game Engines

### 5.1 Proprietary engines (1990s–2000s)

During the 1990s, the first game engines began to emerge alongside the advancement of 3D games, initially being used by large studios to reuse components and accelerate game production without the need to rewrite basic systems. This period was marked by innovative engines that enabled support for 3D graphics and improved performance on PCs and consoles. These early proprietary engines formed

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the technological foundation that would later be explored by more accessible commercial solutions in subsequent decades (Toftedahl & Engström, 2019).

### 5.2 Emergence of accessible commercial engines

In the late 1990s and early 2000s, engines such as Unreal Engine, created by Epic Games, began to be licensed to external studios, expanding opportunities for small teams to develop games using high-level technology. This commercial model represented an important transition from engines exclusive to major producers to tools that could be adopted by smaller developers (Foxman, 2019; Toftedahl & Engström, 2019).

### 5.3 Popularization of free or freemium engines

With the arrival of tools such as Unity, released in 2005 and designed to be accessible and multiplatform, game development became even more democratic. Unity offered free versions alongside paid plans with additional features, enabling students and small studios to create 2D and 3D games using a robust toolset with compatibility for consoles, mobile devices, and PCs (Haas, 2014; Foxman, 2019).

### 5.4 Impact of the internet, tutorials, and communities

The widespread adoption of the internet and the availability of free content, tutorials, and online courses further expanded access to game development. Active communities on forums and video platforms supported collaborative learning, allowing independent developers to quickly learn how to use modern engines, thereby reducing the need for formal education or substantial financial resources (Foxman, 2019; Denisova et al., 2024).

## 6. Comparison Between Major Game Engines in the Market

### 6.1 Unity

Unity is a multiplatform engine released in 2005, designed to serve both beginners and experienced developers, offering support for multiple platforms and a wide range of tools for creating 2D and 3D games (Foxman, 2019; Abramowicz & Borczuk, 2024).

**Primary language (C#)** – Unity primarily uses C# as its scripting language, which facilitates learning and code readability, making it a popular choice among both novice and professional programmers (Nicoll & Keogh, 2019).

**Ease of learning** – Its intuitive interface and extensive documentation make Unity one of the most accessible engines on the market, particularly suitable for independent or educational projects (Foxman, 2019).

**Asset Store** – The Unity Asset Store provides resources such as models, scripts, and tools that developers can use or commercialize, accelerating the development process and reducing the need to create all assets from scratch (Nicoll & Keogh, 2019).

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**Strong presence in the indie market** – Unity dominates a significant portion of the independent games market due to its versatility, support for multiple operating systems, and an active support community (Foxman, 2019; Abramowicz & Borczuk, 2024).

**Independent success cases** – Games such as *Among Us* and *Valheim* were developed using Unity, demonstrating its ability to support indie projects with extensive global reach (Foxman, 2019; Abramowicz & Borczuk, 2024).

### 6.2 Unreal Engine

Developed by Epic Games, Unreal Engine originated in 1998 as internal technology for the game *Unreal* and evolved into one of the most powerful engines available, particularly in terms of photorealistic graphics and advanced physical simulation (Abramowicz & Borczuk, 2024).

**Languages (C++ and Blueprints)** – Unreal is based on C++ for high-performance programming and also offers the visual Blueprints system, which allows game logic to be created without writing code, facilitating use by designers and artists (Abramowicz & Borczuk, 2024).

**Graphical quality** – The engine is widely recognized for its graphical power and advanced tools that support visual realism in AAA games and cinematic applications (Abramowicz & Borczuk, 2024; Nieborg, 2016).

**Royalty-based model** – Unreal adopted licensing models that include royalty payments after a certain revenue threshold, encouraging larger studios and high-budget projects while still offering free access for prototyping (Nieborg, 2016).

**Use in indie and AA projects** – Although more commonly associated with large-budget productions, Unreal Engine is also used in independent projects that aim to leverage advanced graphics and physics, expanding its reach within the creative market (Abramowicz & Borczuk, 2024).

### 6.3 Other Relevant Engines

**Godot** – Godot is an open-source engine released in 2014, free of charge and without licensing fees, widely used by independent developers due to its flexibility and collaborative community, which continuously contributes improvements (Zolotov, 2024).

**GameMaker** – Primarily focused on 2D games since its creation in 1999, GameMaker simplifies development through a drag-and-drop interface and its own scripting language, making it one of the preferred engines for beginners and 2D projects (Politowski et al., 2021).

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**Construct** – An engine focused on visual 2D game development, ideal for beginners as it does not require advanced programming knowledge, featuring an active community and support for exporting to multiple platforms (Sumner et al., 2024).

**RPG Maker** – A specialized engine for RPG development with an intuitive interface and a visual event system, particularly suitable for interactive narratives and indie titles focused on storytelling and world design (Politowski et al., 2021).

## 7. Democratization of Game Development

### 7.1 Operational Dimensions of Democratization

In this study, "democratization of game development" is operationalized through four analytical dimensions that allow the concept to be examined beyond a purely descriptive or technological framing (Nieborg & Poell, 2018; van Dijck et al., 2018):

**Reduction of Entry Costs** – availability of free or low-cost engines, absence of upfront licensing fees, and broad access to learning resources, which collectively lower financial and technical barriers to entry (Parker et al., 2016; Srnicek, 2017).

**Diversity of Creators** – increased participation of solo developers, small studios, and creators from non-traditional geographic regions, reflecting a partial expansion of cultural participation within digital production ecosystems (Lipkin, 2013; Whitson, 2018).

**Infrastructural Access** – availability of multiplatform deployment, asset marketplaces, and increasingly standardized development pipelines, which shape both creative possibilities and forms of dependency on platform infrastructures (Nieborg & Poell, 2018; O'Donnell, 2014).

**Economic Distribution** – degree of revenue concentration, visibility asymmetries, and reliance on platform-controlled marketplaces, which condition how economic value is captured and distributed within the indie ecosystem (Langley & Leyshon, 2017; Parker et al., 2016).

Democratization is therefore analyzed as a relative expansion of access, rather than as an egalitarian outcome or a redistribution of market power, emphasizing the coexistence of increased participation with persistent structural inequalities (Srnicek, 2017; van Dijck et al., 2018).

### 7.2 Reduction of technical barriers

Traditionally, game development required advanced technical knowledge in programming and software engineering, which created significant barriers for aspiring developers without formal technical training. In recent years, tools focused on accessibility—including game engines with visual programming systems and visual development models—have been created to enable individuals with different levels

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of experience to develop games without directly writing code, thereby reducing dependence on highly specialized technical skills (Sumner et al., 2024).

### 7.3 Free or low-cost access

One of the central pillars of development democratization is free or low-cost access to tools that were previously exclusive to large studios. Open-source engines or those offering free versions—such as engines that allow export to multiple platforms without initial fees—have expanded the capacity of new developers to create games without prohibitive costs, fostering a broader ecosystem of creators (Universidade Federal de Goiás [UFG], 2026).

### 7.4 Visual tools (low-code / no-code)

Tools that provide low-code or no-code development enable game creation through graphical interfaces and event-based logic, eliminating the need for in-depth knowledge of programming languages. Such platforms facilitate rapid prototyping of ideas and increase the inclusion of individuals with little or no background in traditional software development (Sumner et al., 2024).

### 7.5 Availability of tutorials, courses, and documentation

The wide availability of online tutorials, free or low-cost courses, and detailed engine documentation has been fundamental in enabling beginners to learn game development. Platforms such as video-sharing websites, online learning environments, and community forums have facilitated self-directed learning and fostered the global growth of independent developers (Denisova et al., 2024).

### 7.6 Online communities and forums

Online communities, specialized forums, and developer groups create collaborative environments in which technical questions can be resolved and resources shared. These spaces function as informal support networks, accelerating the learning process and encouraging the exchange of experiences between beginners and professionals (Parker et al., 2018; Denisova et al., 2024).

## 8. Impact of Game Engines on the Indie Market

### 8.1 Growth of independent studios

The popularization of game engines and digital distribution platforms has transformed the landscape for independent studios, enabling small teams to enter markets previously dominated by large publishers. Indie development has evolved from a niche activity into a global phenomenon, with studios achieving international success and visibility without requiring substantial financial investment (Crogan, 2018; Parker et al., 2018).

### 8.2 Solo development (solo devs)

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Access to affordable tools has enabled the emergence of solo developers ("solo devs"), whether professional or amateur, who create games individually or in very small teams. This shift has expanded the diversity of voices and ideas in the game market, as game creation is no longer exclusive to large multidisciplinary teams (Whitson, 2018; Crogan, 2018).

### 8.3 Access to multiple platforms (PC, consoles, mobile)

With engines that allow games to be exported to multiple platforms—such as PCs, consoles, and mobile devices—without major changes to the source code, independent developers can reach broader audiences with reduced effort and cost. This multiplatform support enhances the reach and relevance of indie titles in the global market (Nieborg & Poell, 2018; Parker et al., 2016).

### 8.4 Simplified publishing on digital storefronts

Digital distribution platforms have further democratized market access by allowing developers to publish their games directly to consumers without traditional intermediaries. This has reduced entry costs and created opportunities for indie games to reach millions of players worldwide (Nieborg & Poell, 2018; Parker et al., 2016).

### 8.5 Examples of successful indie games

Several indie games have achieved both commercial and critical success in recent years, illustrating the impact of modern engines on the market. Titles such as **Minecraft**, **Stardew Valley**, and **Undertale** have become global phenomena, demonstrating that games developed outside major studios can compete with large-scale productions in terms of quality, creativity, and popularity (Crogan, 2018; Lipkin, 2013).

## 9. Economic and Market Aspects

### 9.1 Reduction of production costs

The use of robust game engines has drastically reduced game production costs, particularly for small studios and independent developers. Today, teams can release commercially viable titles with significantly lower budgets than in the past, when it was necessary to develop tools from scratch or pay high licensing fees for proprietary technologies. In addition, complementary technologies such as AI-based tools have further reduced costs related to asset creation and repetitive tasks (Keogh, 2023; Politowski et al., 2021).

### 9.2 New business models (royalties, marketplaces)

Business models based on royalties and asset marketplaces have a significant economic impact on both developers and engine providers. Many engines charge a percentage of revenue or adopt subscription-based structures, which may be advantageous for some studios but burdensome for others, thereby influencing

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strategic decisions related to game development and distribution. Internal marketplaces, such as asset stores, generate income for content creators and facilitate resource acquisition for developers (Nieborg, 2016; Keogh, 2023).

### 9.3 Competition among engines

Competition among different game engines has intensified with the popularization of free, open-source, and freemium options. This competitive environment drives providers to innovate and offer more attractive conditions, which can benefit developers but also creates uncertainty regarding long-term support and future costs. Moreover, competition encourages market diversification through regional engines and specialized alternatives (Foxman, 2019; Nicoll & Keogh, 2019).

### 9.4 Influence on the labor market and professional training

The widespread adoption of game engines and the global expansion of game development have increased demand for professionals specialized in specific tools, such as Unity, Unreal, or Godot. At the same time, professional education has undergone significant transformation, with technical courses, undergraduate programs, and bootcamps focusing directly on development using game engines. Nevertheless, there remains a shortage of entry-level positions and increasing pressure for advanced skills in programming and design (Whitson, 2018; O'Donnell, 2014).

## 10. Limitations and Challenges

## 10.1 Study Limitations

This analysis is subject to several limitations. First, the discussion primarily reflects conditions observed in the Global North, where access to computational resources, high-speed internet, and formal education infrastructures is comparatively higher. In many regions of the Global South, persistent economic, institutional, and infrastructural constraints continue to limit effective participation in digital game development ecosystems (Graham, 2019; Heeks, 2017).

Second, the study focuses on access to production tools rather than on consumption patterns or monetization outcomes, which restricts claims regarding economic democratization and revenue redistribution. Finally, as a narrative bibliographic review, the analysis does not provide original empirical measurement but instead synthesizes existing literature to identify structural trends, conceptual tensions, and unresolved debates within platform-mediated creative industries (Grant & Booth, 2009; Webster & Watson, 2002).

### 10.2 Technological dependence on engines

Although game engines make development more accessible, they can also create significant technological dependence. Unexpected changes in business models or in the practices of companies that develop these tools can directly affect ongoing or

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planned projects, imposing unforeseen costs and requiring migration to alternative solutions (Foxman, 2019; Nicoll & Keogh, 2019).

### 10.3 Licensing changes

Modifications to licensing policies, such as usage fees or changes in royalty percentages, can have a drastic impact on studio budgets, particularly for independent developers, who operate with narrower revenue margins and have fewer resources to absorb additional costs (Nieborg, 2016; Keogh, 2023).

### 10.4 Optimization and performance

Ensuring that games run efficiently across different platforms and devices represents a major technical challenge. The current market, characterized by a wide variety of hardware-from high-end PCs to resource-constrained smartphones-forces developers to invest additional time and resources in performance optimization, increasing project complexity and costs (Panourgias et al., 2014; Orlikowski, 2007).

### 10.5 Indie market saturation

While accessible engines have significantly lowered barriers to entry, they have also contributed to **market saturation**, particularly on digital distribution platforms. Existing platform-oriented studies indicate a sharp increase in the volume of independently released games since the early 2010s, transforming digital storefronts into highly competitive attention economies (Nieborg, 2016; Parker et al., 2016). For instance, publicly available data from the Steam platform indicate that the annual number of game releases increased from fewer than 1,000 titles in the early 2010s to over 14,000 in recent years (e.g., 12,277 in 2022 and 14,070 in 2023; SteamDB, 2026). This surge has been accompanied by an extremely skewed revenue distribution: estimates suggest that the top 10 games released in a given year often account for over 60% of total revenue generated by all new titles that year, while the remaining thousands contribute only a small fraction (Sensor Tower, 2024; Nieborg, 2016; Parker et al., 2016).

This expansion has intensified competition for visibility, resulting in a **highly skewed revenue distribution**, in which a small fraction of titles captures the majority of economic returns. Consequently, democratization at the level of production does not necessarily translate into democratization of economic success or audience reach, reinforcing structural inequalities embedded in platform-mediated cultural markets (Langley & Leyshon, 2017; Nieborg & Poell, 2018).

### 10.6 Actual learning curve versus initial expectations

The promise of simplified development through accessible engines may obscure the reality of a still-steep learning curve, particularly when aiming to create more complex games or meet high technical requirements. Mastering advanced tools, scripting languages, and complete production workflows still demands time, study, and

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practice, which can frustrate beginner developers expecting rapid results (Politowski et al., 2021).

## 11. Future Trends

### 11.1 Open-source engines

An important trend in game development is the growth of open-source game engines. Free and open-source engines attract developers by enabling full customization, transparency, and community collaboration, further reducing entry barriers and fostering shared innovation among professionals from different regions (Zolotov, 2024).

### 11.2 Integration with AI

Recent industry and academic literature suggests that artificial intelligence tools may increasingly assist game development tasks, particularly in areas such as asset generation, automated testing, and procedural content creation. However, estimates indicating that a substantial proportion of programming tasks could be partially automated should be interpreted as **speculative projections**, grounded in forward-looking models rather than empirically consolidated evidence (Elish & Boyd, 2018; Kiran et al., 2015).

Rather than replacing developers, current research indicates that AI primarily functions as a **productivity-enhancing support technology**, whose effectiveness varies significantly depending on project scale, genre, organizational structure, and technical complexity. Consequently, the long-term impact of AI on creative labor, employment relations, and skill requirements in game development remains uncertain and requires cautious, context-sensitive interpretation (Autor, 2015; Orlikowski, 2007).

### 11.3 Increasingly accessible tools

The game engine market continues to grow while incorporating tools that further simplify development, including visual interfaces, cloud-based collaboration, and low-code modules. As a result, even developers with limited technical experience can create complex games with reduced effort, reflecting a continuing trend toward lowering technological barriers (Foxman, 2019; Panourgias et al., 2014).

### 11.4 Engines tailored to specific niches

In addition to large, general-purpose engines, there is a growing number of specialized tools aimed at specific niches—such as engines optimized for web-based, casual, or educational games—that address the needs of particular audiences and markets, offering more focused and potentially more efficient solutions (Panourgias et al., 2014; Orlikowski, 2007).

### 11.5 Potential standardization of pipelines

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Another emerging trend is the standardization of development pipelines, with more integrated workflows between engines and external tools, native support for multiple platforms, and automated export processes that eliminate repetitive tasks. This tendency is expected to reduce development time and improve collaboration among distributed teams (Panourgias et al., 2014; Orlikowski, 2007).

## 12. Final Considerations

Game engines play a fundamental role in the democratization of game development by reducing technical and financial barriers. Accessible tools supported by strong communities enable individuals and small studios to create innovative games without the need for extensive resources or large teams. This technological transformation has been one of the main drivers behind the continuous expansion of the global indie market (Crogan, 2018; Parker et al., 2018).

The popularization of engines and the availability of accessible tools have fueled an explosion of independent titles, increasing the diversity of games and styles available to players. The indie market, once restricted to smaller niches, has become competitive and integrated into widely accessible digital distribution platforms, contributing to a more vibrant and creative ecosystem (Panourgias et al., 2014; Orlikowski, 2007).

The impact of game engines extends beyond the indie sector, influencing the global landscape of game development by creating professional opportunities and reshaping career paths. Emerging developers can learn, prototype, and publish games with lower initial investment, while companies benefit from more efficient workflows and powerful tools that accelerate production (Autor, 2015; Elish & Boyd, 2018).

Future research may further explore the ethical and legal implications of AI integration into game engines, the environmental impact of automated pipelines, and the evolution of business models based on collaborative software. It is also relevant to investigate how engines can adapt to emerging trends such as extended reality (XR), cloud gaming, and interactive experiences beyond traditional entertainment (Panourgias et al., 2014; Orlikowski, 2007).

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