**Introduction**

In a rapidly evolving technological environment, the processes that support software development are constantly transforming to meet the demands of on-time and budget-conscious project completion while maximizing product quality. Despite the critical role of these processes, the complexity and dynamic nature of software development projects create significant challenges in effectively measuring and rewarding the contributions of developers. Traditional methods are often inadequate in assessing these contributions fairly and transparently, thus negatively impacting project productivity and quality of results (Hann et al., 2002). This study aims to design an innovative system that leverages blockchain technology and tokenomics concepts to measure and reward developers' contributions in software development processes, overcoming existing challenges and initiating a transformative wave in the software development industry.

The success of software development processes is at the heart of today's technology ecosystems, and completing projects on time and within budget constraints requires maximizing product quality. Effective management of these processes is vital for organizations to remain competitive and innovative, especially in large-scale software development projects. Researchers such as Wang et al. (2019) stated that the success of software development processes depends on the scope and complexity of the projects and that the efficient management of these processes has a direct impact on software quality.

The current paradigm for measuring and rewarding the contributions of developers in software development projects is based on various metrics such as code quantity, code quality, defect rates, and contribution time to the project. However, the measurement of these metrics is often based on subjective assessments and lacks consistency across projects (Nicolette, 2015). Furthermore, current systems do not sufficiently encourage collaboration and knowledge sharing between developers, potentially hindering the overall success of projects.

In this context, incentive systems that increase the motivation and engagement of developers are of great importance in order to continuously improve the success and performance of software development processes. Motivational factors are known to directly affect developers' productivity and job satisfaction, and in this context, it is often emphasized in the literature that incentive mechanisms can significantly improve the overall success rates of software projects (Mahaney & Lederer, 2001), These incentive systems, usually by providing financial or non-monetary rewards, create a positive competitive environment among software developers, which can increase overall productivity.

Innovative incentive systems are becoming increasingly important in the field of software development. In particular, incentive systems combined with more effective use of metrics used to measure success in projects (such as code quality, defect rates, and project delivery times) can encourage developers to work to high standards. These metrics provide an objective measurement, avoiding subjective evaluations, and facilitate the fair distribution of incentives. Kogon et al. (2015) detail the impact of such innovative incentive systems on managing software development processes more effectively and increasing the success rates of projects.

Blockchain technology is a promising solution in this context, characterized by its transparency, fair measurement capabilities and tamper-proof records. A blockchain-based system can record developers' contributions in real time and facilitate a fair reward mechanism based on these records (Nakamoto, 2008). However, tokenomics offers economic models and mechanisms that incentivize deeper participation and contribution from developers.

Tokenomics refers to the economic models and mechanisms that govern the creation, distribution, acquisition, and use of tokens in a blockchain ecosystem. This concept helps to understand how tokens gain value, motivate user behavior within the ecosystem, and support the overall economic soundness of a project (Au & Power, 2018). As defined by the researchers, tokenomics is crucial to the success of a project; it offers a set of strategies and principles used to increase engagement, reward users and developers, and thus ensure the sustainability of the ecosystem.

The application of tokenomics to software development processes suggests an innovative approach to measuring and rewarding developers' contributions. Specifically, in a blockchain-based system, developers' contributions can be directly measured, and rewards can be distributed in the form of tokens based on these contributions. This aims to motivate developers to contribute more significantly and provide high-quality inputs, thus increasing the overall success of software development projects. In this context, tokenomics serves as a mechanism to increase developer motivation and engagement while underpinning the economic model and sustainability of the project. This approach represents a paradigm shift in evaluating and rewarding developer contributions and exploring the potential of blockchain and tokenomics in software development processes.

Blockchain and tokenomics-based incentive systems, when applied in software development, can significantly improve the performance of developers and the overall success of projects. These systems use metrics to objectively and fairly measure developers' contributions, while at the same time rewarding those contributions with economic values. This two-way approach increases the motivation of developers as well as encourages the completion of projects on time and within budget (Luo & Zheng, 2023). This work is based on the integration of blockchain technology and tokenomics concepts to revolutionize the measurement and rewarding of developer contributions in software development processes. This integration aims to introduce an innovative model that has the potential to significantly transform project management and developer motivation.

Consequently, this study aims to design a blockchain and tokenomics-based incentive system that can reshape software development processes. This system will be designed to objectively measure the contributions of developers and, based on these measurements, distribute tokens based on their performance. The methodology of the study will include a detailed literature review and the development of a prototype of the system, and the effects of these systems on software development performance will be examined in detail. This research is expected to have a transformative impact on the industry by providing innovative solutions to the current challenges in software development.

**The Importance of Quality and Developer Incentives in Software Development**

Software development processes have evolved significantly over the last few decades, moving from waterfall models to more agile and iterative methodologies (Sidky & Smith, 2009). This evolution is driven by the increasing demand for faster delivery times, higher quality products, and development practices that are more adaptable to changing requirements (Stellman & Greene, 2017). Agile methodologies have revolutionized software development by emphasizing flexibility, customer collaboration, and the ability to quickly adapt to changes. Despite these advances, challenges in measuring and rewarding developer contributions persist, underscoring the need for innovative solutions that can adapt to the dynamic nature of modern software development (Kalliamvakou et al., 2009).

Software development processes are complex activities that are critical for completing projects on time and within budget constraints while maximizing product quality in a rapidly evolving technological environment. Effective management of these processes is directly related to increasing developer motivation and engagement. Motivational factors can significantly increase the overall success rate of software projects by influencing developers' productivity and job satisfaction. Therefore, the design and implementation of effective incentive systems have become an integral part of software development processes, and the correct design of these systems can lead to more successful and efficient projects (Blau et al., 2011).

Open software development projects are particularly challenging because they are often carried out by developers from various locations and with different skill levels. This can lead to problems such as low participation rates, inconsistent code quality, and failure to complete on time. Open-source projects encourage innovation and are supported by a broad community by offering a wide network of collaborators and a high level of transparency. However, as noted by Hann et al. (2002), the high rate of voluntary participation in these projects further increases the importance of incentive systems. In this context, developer incentives have a critical role in improving quality and productivity, especially in open software development projects.

In software development processes, the successful completion of projects and the maintenance of high-quality standards are directly related to the effective measurement and management of developers' performance. In modern software development environments, the integration of incentive systems offers great potential for objective and transparent performance measurement. These systems evaluate the contributions of developers based on defined metrics and reward these contributions with appropriate incentive mechanisms. Studies by Laird & Brennan (2006) have shown that effective measurement of developers' contributions significantly improves the overall success of software development projects.

Methods for incentivizing developer contributions have also evolved, from traditional compensation models to more complex systems that incorporate performance metrics and contributions (Wang et al., 2019). In the past, developer incentives were primarily based on output metrics such as lines of code. However, these metrics often failed to accurately reflect the quality or impact of the contribution, leading to the search for more qualitative evaluation methods (Fenton and Bieman, 2014).

Recent trends have focused on creating more holistic and fair systems that take into account various aspects of developer contributions such as code quality, collaboration, and innovation (Besker et al., 2022). In this framework, various metrics used to measure developer contributions in software development projects can directly affect the success of the project. These metrics include methods such as code quality, defect rates, amount of code contributed, and active participation in peer review processes. These metrics are vital for objectively assessing the performance of developers and ensuring consistency across projects. Moreover, the correct application of these metrics minimizes subjective evaluations and makes software development processes fairer and more transparent (De Bassi et al., 2018). Studies on these metrics in the literature show that ensuring objectivity and consistency in developers' performance measurement has a direct positive impact on the overall productivity and success of projects.

Developer incentives, which are one of the methods that can be used in this field and can increase the quality of software development and prevent problems and motivation problems, can be provided in various ways. Financial incentives can increase the motivation of developers in cases of achieving certain goals or showing exceptional performance in the project. Non-monetary incentives include elements such as career development opportunities or professional recognition and can increase developers' long-term commitment and satisfaction. An effective incentive system should harmoniously combine these various methods (Heroux, 2016). The use of innovative incentive systems can improve the management of developer incentives through technology-enabled solutions, especially by automating data collection and analysis processes across projects. By providing real-time feedback, these systems can facilitate developers' access to continuous learning and development opportunities (Besker et al., 2022).

On the other hand, non-monetary incentives are also critical to increase developers' long-term commitment and professional satisfaction. These incentives can include career development opportunities, professional recognition, rewarding working conditions or flexible working hours. For example, providing developers with ongoing training and learning opportunities or encouraging leadership roles in projects can contribute to their personal and professional development, which in turn can increase overall motivation and job satisfaction (Krishnamurthy, 2006).

An effective incentive system should combine these various methods in a coherent and holistic approach. In particular, the management of developer incentives can be modernized and improved by using technology-enabled solutions. In this context, automation of data collection and analysis processes in projects can be used to assess developers' performance in an objective and continuous manner (Atal & Shankar, 2015). For example, continuous integration and continuous delivery systems provide real-time feedback on critical metrics such as code quality and bug rates, allowing developers to make immediate corrections and engage in continuous learning processes.

Such innovative incentive systems can make it easier for developers to access continuous learning and development opportunities, while at the same time improving the efficiency and effectiveness of software development processes. By receiving continuous and meaningful feedback, developers have the chance to evaluate and improve their own performance, which contributes to the overall success of the project (Storey et al., 2019). As a result, these integrated and technology-enabled incentive systems can play a transformative role in solving motivation and engagement issues in software development projects and continuously improving quality.

**Blockchain and Tokenomics**

Blockchain technology, introduced by Nakamoto (2008), provides a new way to record transactions securely and transparently by providing a decentralized and immutable ledger. Its core principles of decentralization, transparency, and immutability make it an attractive solution for a variety of applications beyond cryptocurrencies, including software development processes (Zheng et al., 2017). Blockchain's potential to increase transparency and fairness in developers' incentive systems is particularly noteworthy as it enables immutable recording Automation of contributions and rewards through smart contracts (Yilmaz et al., 2019).

In other words, a blockchain is a data structure that is distributed among all participants in the network and requires each transaction to be verified by the entire network. This structure ensures the accuracy and integrity of transactions without the need for any central authority or intermediary institution. In addition, since each block contains a cryptographic summary of the previous block, changing the content of one block will affect the entire chain and will be noticed immediately (Zheng et al., 2017). This makes the blockchain highly resistant to manipulation.

Over time, the use cases of blockchain technology have expanded beyond the financial sector to many different areas such as healthcare, education, supply chain management, and especially software development. In the field of software development, blockchain technology is being used to perfect the processes of project management, version control, and code verification. By making the entire development process more transparent and reliable, this technology has the potential to reduce error rates and improve software quality (Almeida, Albuquerque & Silva, 2019).

The integration of blockchain technology into software development enables the development of decentralized applications (dApps) and the implementation of transparent governance models (Mougayar, 2016). This integration plays a critical role in change management, code revisions, and verification of intellectual property. Moreover, each transaction on the blockchain leaves an irreversible trace, which increases the accuracy of software releases and the traceability of developer contributions (Hammad et al., 2023). In particular, projects designed to encourage code reuse and collaboration in open-source projects can benefit from these unique advantages of blockchain (Canidio, 2018).

Blockchain technology has the potential to revolutionize areas such as project management, version control, and code verification through its applications in software development processes. As noted by Hammad et al. (2023), this technology increases transparency and integrity in software projects by providing time-stamped and immutable records of changes and updates. In particular, blockchain's contribution to version control and code verification processes significantly improves software quality by maintaining code integrity and reducing error rates and enables secure rollback to earlier versions (D'mello & González-Vélez, 2019). Furthermore, blockchain-based incentive systems proposed by Tapscott and Tapscott (2016) have the potential to increase collaboration and motivation among software development teams by using them to objectively measure and reward developers' performance. These characteristics make blockchain technology a critical tool for reshaping software development processes.

Smart contracts, as an application of blockchain technology, are contracts that are automatically enforceable upon fulfillment of predefined conditions (Buterin, 2014). These contracts express agreements between parties in the form of blocks of code, which are stored on the blockchain so that the terms of the agreement cannot be changed and are transparently enforced. In software development processes, smart contracts can be used as an effective tool, especially in incentive management. A framework developed by Singi et al. (2020) proposes a token-based system for measuring and rewarding the performance of software engineers. In this system, smart contracts can automatically trigger the distribution of tokens when set performance targets are achieved, thus creating a powerful incentive mechanism to increase developers' motivation and improve software quality.

As an example of this work, Król et al. (2018) suggest that smart contracts can also be used in areas such as collaboration and resource sharing in software development processes. In the system called “ChainSoft”, processes such as code sharing between developers, version control, and bug management are managed through smart contracts. In this way, cooperation in software development projects is encouraged, while the accuracy and reliability of all stages of the project are recorded on the blockchain. Smart contracts thus contribute to the successful execution of projects by making each stage of the development process more transparent and effective.

Tokenomics, as defined in different studies, refers to the set of economic models and mechanisms that regulate the creation, distribution, acquisition, and use of tokens within blockchain ecosystems (Cong et al., 2021). This concept provides a comprehensive understanding of how tokens function and how they can drive user and developer behavior. Tokenomics is designed to incentivize users to exhibit certain behaviors, support the long-term sustainability of projects and platforms, and deliver value to participants (Wandmacher, 2019).

In software development projects, tokenomics can be used as a strategic tool to measure, evaluate, and reward developers' contributions. Particularly in areas such as open-source projects and complex software development environments, tokenomics-based incentive systems encourage high-quality software deliverables by increasing developer motivation and engagement. These systems provide token rewards if developers complete certain tasks or make certain contributions to the project, thus encouraging collaboration and the creation of innovative solutions (Tanniru et al., 2021).

Tokenomics can also be used in software development projects to manage intra-project dynamics and facilitate the transfer of value between projects. This encourages collaboration and efficient use of resources, especially in large-scale projects and where several teams are working together. Project managers should set rules on the distribution and use of tokens to ensure that developers use them fairly and efficiently. Thus, tokenomics has the potential to transform software development processes and, when integrated with blockchain-based incentive systems, can radically improve the management of software development projects and developer engagement (Tapscott and Tapscott, 2016).

Blockchain technology, smart contracts and tokenomics, when combined to transform software development processes, offer innovative and effective solutions, especially in the area of developer incentives. The decentralized nature of blockchain enables developers' contributions and interactions to be recorded in an immutable, time-stamped and transparent manner, which significantly improves project management, version control and code verification (Liu, 2019). Smart contracts automate and conditionalize these processes, evaluating and rewarding developer contributions based on set criteria. For example, if a developer completes a specific bug fix or successfully enhances a software module, token rewards can be provided that are automatically triggered by smart contracts. This structure promotes transparency and fair measurement in software development processes, while also increasing trust and cooperation among developers (Drasch et al., 2020).

In a study by Luo and Zheng (2023), tokenomics plays a critical role in this ecosystem to reward and measure developers' contributions with economic values. Token-based reward systems for developers increase developers' motivation and commitment to the project through tokens awarded for specific achievements and contributions. The tokens can be used in a variety of ways, for example, they can be spent to gain access to tools within the platform, to access training materials or to take advantage of other professional development opportunities. This incentive system encourages developers to maintain high quality standards and continuous improvement, while also helping to ensure that software projects are completed on time and within budget. Thus, the integration of blockchain, smart contracts, and tokenomics could radically improve the way software development projects are managed, ushering in a new era for efficiency and innovation in the software industry (Freni, Ferro, & Moncada, 2022).

**Improving Software Development Processes and Blockchain-Based Incentive System**

The management of software development processes poses significant challenges in an ever-evolving technological world. As the complexity of projects and the diversity of teams increase, the importance of effective project management and quality control mechanisms becomes more evident. Success in these processes is closely related not only to the application of technical skills but also to interdisciplinary interactions such as project management, defect management, and process optimization. However, the uncertainties and technical challenges inherent in software development processes can prevent projects from being completed on time and within budget, increasing the risk of project failure (Fournier, 2017). To overcome these problems and continuously improve software quality, it is imperative to develop sustainable and effective solutions for projects.

In addition to traditional methods, various new techniques and methodologies in software development have emerged to address these challenges. For example, agile methodologies such as Agile and Scrum increase team collaboration and flexibility, enabling projects to progress faster and more efficiently. In addition, the practices of Continuous Integration and Continuous Deployment enable code changes to be automatically integrated and rapidly deployed to the production environment, speeding up software development processes and reducing error rates. In addition, a DevOps culture strengthens collaboration between development and operations teams, making processes more transparent and efficient (Fitzgerald and Stol, 2017).

In addition, a structure powered by smart contracts can make significant contributions in this area, which are programmable contracts executed on blockchain networks that are automatically executed according to predetermined conditions (Kr'ol et al., 2018). On platforms such as Ethereum, Turing-complete smart contracts support many financial and business functions as well as complex organizational and governance protocols (Buterin, 2014). In software development processes, smart contracts can be used to provide a more direct and fair incentive to developers by combining performance-based reward mechanisms with real-time monitoring and auditing. For example, the quantity and quality of a developer's contributions can be assessed using specific code metrics and peer review processes, and tokens can be automatically distributed based on these contributions (Tonelli et al., 2018). Unlike traditional incentive systems, this approach improves the overall quality of software projects by encouraging collaboration and quality-oriented work among developers instead of competition (Miraz & Ali, 2020).

In addition, the use of blockchain in this area can also contribute to the appropriate allocation of these incentive mechanisms and offer an innovative perspective, especially in software development. Incentive mechanisms in blockchain ecosystems are reward systems designed to enable participants to make valuable contributions to the network. These systems typically provide token rewards in exchange for actions such as mining, staking or performing certain tasks. The goal of incentive mechanisms is to improve the security, transparency, and overall performance of the network, as well as to incentivize participants to further invest in and participate in the network (Malinova and Park, 2023). Incentive mechanisms in the token economy in software development projects can incentivize developers to provide high-quality contributions and actively participate in the development of the project (Luo and Zheng, 2023).

Tokenomics models designed for developer incentives that can strengthen this approach include reward systems that are customized according to the needs and goals of the project. These models use complex metrics and algorithms to measure developers' contributions and distribute tokens fairly based on these contributions. For example, in the context of a software development project, factors such as the quality of developers' contributions, the quantity of contributions, code reviews, and interactions within the project can be evaluated to create a scoring system for token rewards (Canidio, 2018).