rice2023 Proceedings of the Eighth International Conference on Research in Intelligent Computing in Engineering pp. 23–27
DOI: 10.15439/2023R51
ISSN 2300-5963 ACSIS, Vol. 38

A Review on Software Engineering: Perspective of Emerging Technologies & Challenges

Kulashekar Inkollu
University College of Engineering and Technology, Krishna University
Rudravaram, Machilipatnam, India
kulashekarinkollu@gmail.com

Sai Kiran Gorle
University College of Engineering and Technology, Krishna University
Rudravaram, Machilipatnam, India
saikirangorle909@gmail.com

Sai Ram Kondabattula
University College of Engineering and Technology, Krishna University
Rudravaram, Machilipatnam, India
kondabattulasairam@gmail.com

Pagalla Bhavani Shankar
University College of Engineering and Technology, Krishna University
Rudravaram, Machilipatnam, India
ORCID - 0000-0001-5935-7758

M. Babu Reddy
University College of Arts & Sciences
Krishna University
Rudravaram, Machilipatnam, India
m_babureddy@yahoo.com

***Abstract*—Software Engineering is constantly evolving to meet the demands of emerging technologies. In this paper, we explore the challenges and perspectives of software engineering in the context of emerging technologies like blockchain, cloud computing, deep learning, game development. This paper discusses these challenges and provides insights into the software engineering practices that can adapt to meet the demands of these rapidly evolving fields. Each of these domains presents unique challenges and opportunities for software developers, necessitating adaptive approaches to software engineering. This abstract offers a comprehensive overview of the key challenges inherent to each technology and explores the evolving perspectives, methodologies, and best practices essential to tackle them effectively. Emphasizing the interplay between these technologies and the demand for cross-disciplinary collaboration, this paper serves as a valuable resource for altogether varieties of participants, offering enhanced insight into the challenges encountered by software engineers in the realm of emerging technologies.**

***Index Terms*—Software Engineering, blockchain, cloud computing, deep learning, game development.**

I. Introduction

The rapid advancement of technology has led to the emergence of several disruptive and transformative domains, each posing distinct challenges to software engineering. By comprehending these challenges, developers can better navigate the complexities of these domains and deliver successful software solutions.

Deep Learning (DL), a subset of artificial intelligence, has witnessed remarkable progress in areas like CV (Computer Vision) and NLP(Natural Language Processing). Yet, the development and deployment of deep learning models are fraught with challenges related to data quality, model complexity, and ethical considerations. Prearrange of the current developments in ML, we are also keen-sighted the trades starting to increasingly take benefit of the cited practices, expressly in the large technology firms such as Google, Apple, and Facebook. Google had spread over DL techniques to the enormous volumes of data collected in services such as the Google Translator, Android's voice recognition & depiction, Google's Street View, and their Search service [10]. Apple's virtual personal assistant Siri offers a variety of services such as weather reports, update of sports news, and generic question-answering by utilizing techniques such as DL [11].

Blockchain technology has disrupted traditional paradigms of trust and decentralized systems. However, building secure, scalable, and interoperable blockchain applications remains a formidable challenge for software engineers. In the ancient years, a lot of kindness has been paid to the incipient concepts of blockchain and smart contract. Some spectators are even talking of the dawn of a new era [5] and about the likely of reforming the contemporary financial services, technical infrastructure [6,7]. Ever in the meanwhile digital currencies started to represent a real monetary value, also hacks and attacks started. The key was the MtGox attack and another amazing exploit was that sustained by the DAO organization in June 2016. Concerning software development, the scenario is that of a sort of competition first-come-first-serve (FCFS) which does not pledge neither software quality, nor that all fundamental perceptions of software engineering are taken into the predefined account and liable to the justification.

Cloud computing, on the other hand, has revolutionized the way businesses deploy and manage IT resources. But with its widespread adoption comes the complex task of ensuring data security, efficient resource management, and seamless scalability in the cloud environment. For eras, when officialdoms needed to upsurge their computer systems' data and the capacity of computation, the organization faced a choice between purchasing additional hardware or improving the efficiency of their IT operations. Cloud computing offers a distinct alternative by providing resources to organizations without the need for them to worry about maintaining computing resources [8]. The field of cloud computing engineering disciplines that pertain to cloud computing . within this domain, a systematic approach is adopted to tackle standardization, commercialization, and governance concerns [9].

Game development, a thriving industry in the digital era, pushes the boundaries of software engineering with demands for realism, performance optimization, and multiplayer net-

working. These challenges require innovative solutions to craft engaging and immersive gaming experiences. The gaming industry requires effective engineering practices that can accommodate its diverse characteristics, such as multimedia asset management and captivating gameplay. The video game industry is faced with the challenge of adapting its software engineering methods to keep up with the escalating complexity of games and the heightened expectations of consumers. There are many ways for game developers to improve their processes. Despite the inherent difficulty and flexibility of established software engineering processes, their application to video game development holds promise for improved project management and risk mitigation. This study examines current game development practices to identify specific challenges and the corresponding SE principles that can help developers overcome them.

In this exploration of software engineering challenges, we delve into the intricacies of each domain, dissecting the hurdles that software engineers encounter as they strive to create robust and innovative solutions. By understanding these challenges and developing strategies to address them, software engineers can navigate the complexities of these cutting-edge fields and pave the way for the next generation of technology solutions.

II. Literature Review

In the realm of software engineering, various challenges and evolving paradigms have emerged, necessitating a comprehensive understanding of the field's dynamics. This literature review synthesizes key insights from a selection of relevant papers to shed light on the software engineering challenges associated with emerging technologies and paradigms.

Deep Learning and Software Engineering (Arpteg, et al., 2018 [1]): In recent years, deep learning, a branch of machine learning, has seen a remarkable increase in popularity. Arpteg et al. (2018) highlight the unique challenges posed by integrating deep learning into software engineering [14,15]. Their work underscores the importance of adaptability and specialized knowledge to effectively incorporate deep learning techniques into software development processes.

Blockchain-Oriented Software Engineering (Porru, et al., 2017 [2]): Blockchain technology [16] has garnered considerable attention, especially in the context of software engineering. Porru et al. (2017) investigate the challenges and new directions in blockchain-oriented software engineering. They emphasize the necessity for innovative development methodologies and tools tailored to blockchain applications, addressing issues of security, scalability, and consensus mechanisms.

Cloud Environment Challenges (Kashfi, 2017 [3]): Kashfi (2017) delves into the software engineering challenges within the cloud environment. From a software development lifecycle view, the paper identifies complexities associated with cloud adoption, such as managing scalability, data privacy, and service orchestration. Understanding these challenges is vital for efficient cloud-based application development.

Game Development Challenges (Kanode & Haddad, 2009 [4]): Kanode and Haddad (2009) explore software engineering challenges in the context of game development. This niche domain presents unique challenges, including real-time rendering, physics simulations, and content creation. The paper underscores the necessity for specialized SE(Software Engineering) practices to ensure the successful development of complex games.

Blockchain in Finance (Swan, 2015 [1]; Unicredit, 2016 [6]; Aymerich et al., 2009 [7]): Blockchain technology's impact on the financial sector has been studied extensively. Swan (2015), Unicredit (2016), and Aymerich et al. (2009) offer insights into blockchain's financial applications [16]. They emphasize the need for security, scalability, and regulatory compliance in blockchain-based financial systems.

Cloud Computing in Software Engineering (Grundy et al., 2012 [8]; Shan, 2011 [9]): Grundy et al. (2012) discuss the implications of cloud computing on software engineering, highlighting the importance of adapting software engineering practices for cloud environments. Shan (2011) presents the concept of "Smart Cloud Engineering" and its significance in achieving optimal cloud-based solutions.

Deep Learning and its Practical Application (Jones, 2014 [10]; Efrati, 2013 [7]): Deep learning's practical application, as discussed by Jones (2014) and Efrati (2013), demonstrates the real-world relevance of deep learning techniques. Apple's use of deep learning showcases its potential for enhancing software applications, thereby contributing to the broader field of software engineering.

Software Development Life Cycle Models (Bhuvaneswari & Prabaharan, 2013 [13]): Bhuvaneswari and Prabaharan (2013) provide a comprehensive survey of software development life cycle models. Understanding various SDLC models is crucial for software engineers to select and adapt methodologies that suit specific project requirements.

Software Engineering Body of Knowledge (Swebok) (Abran et al., 2004 [8]): Swebok, as presented by Abran et al. (2004), serves as a guide to the software engineering body of knowledge. It offers a structured framework to understand the core principles and concepts underpinning software engineering.

In conclusion, the reviewed literature demonstrates the evolving landscape of software engineering [14], shaped by emerging technologies like deep learning, blockchain [16], cloud computing, and specific application domains such as finance and gaming. These insights will inform the development of comprehensive and adaptive software engineering practices in the face of evolving challenges and opportunities.

III. The Software Development Life Cycle

The primary aim of software engineering [14] is to establish models and processes that enable the production of the software with comprehensive documentation and effortless maintainability. A software life cycle is a series of identifiable stages that a software product undergoes during its development. Within the realm of software engineering, there are multiple software development lifecycle models[13]. Various levels of the lifecycle are:

Fig. 1. The Software Development Life Cycle (SDLC)

A. Planning

This is a primary level plays a vital role in the life cycle. Planningleads to determine the requirements gathering of a predefined or defined project. It undergone by the experts of the fellow members of the project. It gives the well-defined pre planned guidelines to the fellow members in a specified manner.

B. Defining

Once the planning and requirement analysis have been completed, the subsequent phase involves precisely outlining and documenting the product requirements, seeking approval from either the customer or the market analysts. Throughout the project lifecycle, a comprehensive software requirement specification(SRS) document is utilized to ouline and define all the product requirements that will be designed and developed.

C. Designing phase

In this phase the design of the software is created. Based on the requirements specified in SRS document the team will develop the design for the software

D. Building

Also known as implementation in this phase the design is implemented in code.It is essential that developers abide by the coding standards and guidelines outlined by their organization.

E. Testing

This phase includes the testing of the software thoroughly for errors and bugs and to ensure that it meets the requirements and functions correctly.

F. Deployment

After successful testing, the software is released into the market and made available to end-users.post-launch maintenance is essential for products once they hit the market.

IV. Emerging Domains

Software Engineering is a well bound creator in the all fields of the engineering aspects. It vary in the different domains as per the expertise based on the challenges and based on the consumption of the engineering process. Deep Learning, Blockchain, Cloud Computing and Game development are the emerging technologies were successfully adopted the software engineering techniques in as per the needs of domain knowledge.

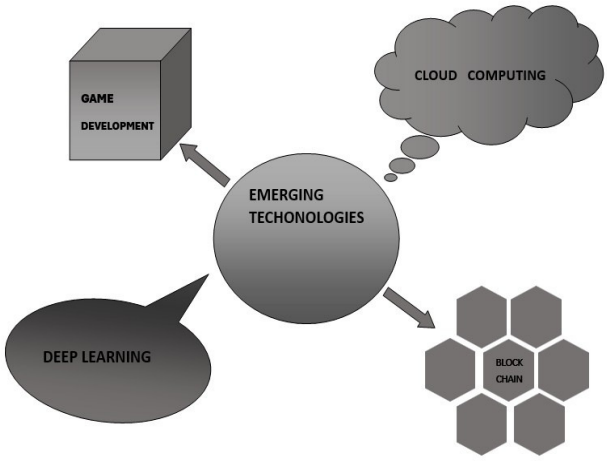

Fig. 2. Emerging Domains In the field of Software Engineering

V. Deep Learning

With its capability to handle complex tasks like image recognition, natural language processing, and decision making, deep learning the branch of machine learning, has gained extensive recognition. Many fields and research domains have embraced the extensive use of deep learning technology [17]. Nevertheless, the development of deep learning models is far from straight forward. Challenges in this domain are categorized into three types [1].

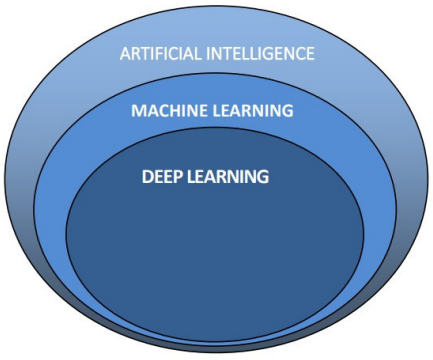

Fig. 3.Intranet Classification of Deep Learning

A. Deep Learning Challenges

The authors [1] conducted the experiment on seven real world Machine Learning (ML) projects, the successful execution of these ML projects in conjunction with companies of various sizes and types has facilitated valuable learning experiences and various challenges. These challenges are categorized into three types: development, production, and organizational challenges. The most commonly occurring challenges are stated below with the help of a pie chart. The

given below pie chart shows the scope of each challenge that can occur in the project.

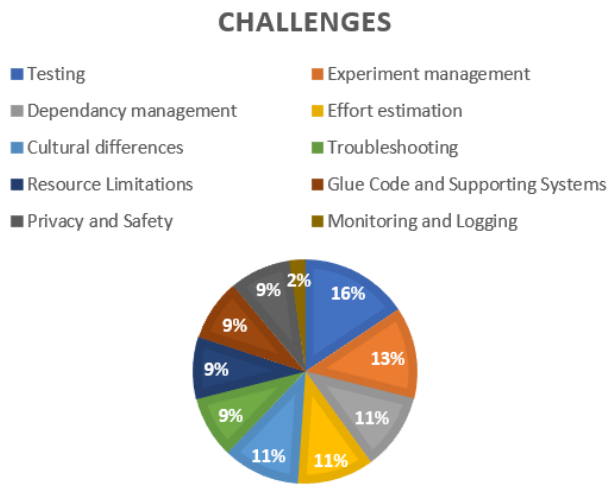

Fig. 4. Pie Chart of Various Challenges in Machine Learning projects

VI. Blockchain

Blockchain technology[16] has gained immense popularity for its transformative potential in areas like finance, supply chain management, and healthcare, blockchain technology has seen a skyrocketing rise in popularity.. In simple words it is like a mathematical structure that stores data or digital transactions, the utilization of blockchain involves an unalterable and distributed digital ledger, comprising interconnected blocks that are safeguarded by virtually unhackable cryptographic signatures, thereby minimizing the risk of tampering or disruption solutions. However the implementation of blockchain solutions comes with a unique set of challenges:

A. Blockchain Challenges

The key elements define a blockchain as a data structure [2]. The authors [2] identify the most relevant Blockchain-Oriented Software Engineering (BOSE) and the consequent issues that arise. To effectively address these challenges, they refer to relevant excerpts from the SWEBOK [8]. to provide a comprehensive understanding of the related problems. The challenges in the blockchain-oriented Software Engineering are listed in the tabular form given below.

Table I. List Of Blockchain Technology Challenges In The Realm Of Software Engineerings

CHALLENGE	EXPLANATION
New Professional Roles	The increasing importance of blockchain has led to the emergence of new professional roles [2], such as intermediaries bridging the gap between business-focused individuals and IT experts, requiring expertise in finance, law, and technology.
Security And Reliability	Blockchain-based systems (BOS) must prioritize security and reliability throughout the software development lifecycle, with a focus on testing suites for smart contracts (SCT) and blockchain transactions (BTT) to ensure trustworthiness and integrity.
Architecture Of The Software	In BOS development, software architects should define selection criteria for blockchain implementations and consider advanced data representations like Object Graphs to improve operational efficiency.
Modelling Languages	In BOS development, specialized graphical modelling languages and adaptations of existing models, such as UML diagrams, are often needed to accurately represent the unique characteristics of the BOS environment, as traditional diagrams may fall short.
Metrics	For BOSE Systems, specialized metrics are needed, and the Goal/Question/Metric (GQM) method can be adapted to measure complexity, communication, resource consumption (e.g., gas in Ethereum), and overall performance in the distributed blockchain environment.

VII. Cloud Computing

Cloud computing has become a fundamental component of modern software engineering. It offers agility, scalability, and cost-efficiency, enabling software engineers to focus on building innovative applications while relying on cloud providers for infrastructure management and support.

However, engineers must also address security, resource management, and vendor-related considerations [3] when adopting cloud solutions.

Customers can avail the services offered by the cloud computing models in three ways:

- Software as a service (SaaS): This model delivers on solicit claims over the internet (network).
- Platform as a service (PaaS): It supplies a framework.
- Infrastructure as a service (IaaS): This archetypal offers solicit infrastructure possessions, often in the form of virtual machines.

Depending on the service models offered, software development encounters may be associated with various roles. On Par with challenges cloud computing also has its own security threats and risks [19].

A. Cloud Computing Challenges

Cloud computing has revolutionized the way software is developed and deployed. However, it introduces its own set of challenges:

Table Ii. List Of Challenges And Considerations In The Cloud Computing Environment

Challenge	Considerations
Software Requirements	Functional Requirements: Prioritizing specific requirements
	Non-Functional Requirements: Security and Privacy, Reliability, Delay, Scalability, Availability
	Other Requirements: SLA, Vendor Lock-in, Lack of Standards for development, Cloud Evaluation, Consumption patterns
Design	Choosing an appropriate design pattern, Platform problems, Parallel design, Design for Errors
Implementation	The cost of data transmission to the cloud, Topological dependencies problems, Implementation risks, Virtual machine's communications, Billing strategies
Testing	Security test, Expandability and performance test, Integrity related test, Innovation in testing, Testing tools
Maintenance and Support	Development support, Service Level Agreement, Resource and cost optimization

VIII. Game Development

Game development is a multidisciplinary field that requires collaboration among artists, designers, programmers, and testers. It combines technical expertise with creativity and innovation to create interactive experiences that captivate players.

The Video game industry, with its unique characteristics like managing multimedia assets and creating engaging gameplay experiences, requires tailored engineering practices [4]. As games become more intricate and players expectations rise, game developers must adapt by enhancing their software engineering methods. This involves implementing proven software engineering processes and prac-

tices that are both rigorous and adaptable to effectively manage projects and minimize risks in game development. This research explores the specific challenges in game development and how sound software engineering practices can assist developers in addressing these challenges effectively. The main challenge that all the game developers faces on the testing and the testing should be automated, as it helps the game developers[18], including the all types of stakeholders.

TABLE III. THE CHALLENGES AND EFFECTS IN THE DOMAIN OF GAME DEVELOPMENT

Challenge	Software Engineering Practice	Effects
Diverse Assets	Asset Management and Integration	Increased complexity and overhead
Scope of the project	Requirements Engineering and Scope Control	Delays, missed milestones, feature creep
Game Publishing	Contract Management and Agile Methodologies	Market-driven changes, communication issues
Project Management	Effective Management and Training	Poor communication, missed issues
Team Organization	Cross-functional Teams and Communication	Communication barriers, “us vs. them” mentality
Development Process	Agile Methodologies and Project Planning	Challenges in translating GDD to project plan, iteration management
Third-Party Technology	Third-Party Integration and Engine Selection	Compatibility issues, limitations

IX. CONCLUSION

The rise of cutting-edge technologies like blockchain, cloud computing, deep learning, and game development has brought exciting opportunities, but also significant challenges, to enterprise software development. This paper delves into these challenges throughout the software development lifecycle (SDLC), examining each stage individually

Given below table provides the different types of challenges that all the domains will face in the software development process. This includes various challenges some of the challenges are commonly faced by all the domains of software development, these are mainly testing and maintenance challenges.

TABLE IV. THE DIFFERENT TYPES OF CHALLENGES THAT ALL THE DOMAINS WILL FACE IN THE SOFTWARE DEVELOPMENT

Challenge	Deep Learning	Block Chain	Cloud Computing	Game Development
Testing	✓	✓	✓	✓
Maintenance	✓	✓	✓	✓
Security	✓	✓	✓	✓
Scalability	-	✓	✓	✓
Regulatory Compliance	-	✓	✓	✓
Resource Optimization	✓	-	✓	✓
Cost Management	✓	-	✓	✓

The above Table IV shows the comparison between the different challenges that occur in the emerging technologies in the domain of software engineering.

X. FUTURE WORK

The objective of examining challenges from this particular standpoint is as follows:

- Categorizing the encounters to offer an optimal solution based on the advance phases of future work.
- Advising a new-fangled tactic for software developers to face the tests.

Clear benefits can be observed in utilizing emerging technologies for software development, despite the presence of challenges. Hence, forthcoming work will aim to propose an appropriate approach to effectively address these existing challenges.

REFERENCES

[1] Arpteg, Anders, et al. "Software engineering challenges of deep learning." 2018 44th euromicro conference on software engineering and advanced applications (SEAA). IEEE, 2018.

[2] Porru, Simone, et al. "Blockchain-oriented software engineering: challenges and new directions."2017 IEEE/ACM 39th International Conference on Software Engineering Companion (ICSE-C). IEEE, 2017.

[3] Kashfi, Hanieh. "Software engineering challenges in cloud environment: Software development lifecycle perspective."International Journal of Scientific Research in Computer Science, Engineering and Information Technology 2.3 (2017): 251-256.

[4] Kanode, Christopher M., and Hisham M. Haddad. "Software engineering challenges in game development."2009 Sixth International Conference on Information Technology: New Generations. IEEE, 2009.

[5] M. Swan, Blockchain: Blueprint for a new economy. O’Reilly Media, Inc., 2015.

[6] Unicredit, “Blockchain technology and applications from a financial perspective,”2016.

[7] F. Aymerich, G. Fenu, and S. Surcis, “A real time financial system based on grid and cloud computing,” in Proceedings of the ACM Symposiumon Applied Computing, 2009, pp. 1219-1220.

[8] Grundy, J., Kaefer, G., Keong, J., and Liu, A., “Guest Editors' Introduction: Software Engineering for the Cloud”, IEEE Software, vol. 29, pp. 26-29, 2012.

[9] Shan, T., “Smart Cloud Engineering, Nomenclature, and Enablement”, In Proceedings of the 1st International Conference on Cloud Computing and Services Science, Noordwijkerhout, Netherlands, 7-9 May, 2011.

[10] N. Jones, “The learning machines,” Nature, vol. 505, no. 7482, p. 146, 2014.

[11] A. Efrati, “How deep learning works at apple,”2013.

[12] A. Abran, J. W. Moore, P. Bourque, R. Dupuis, and L. Tripp, “Swebok: Guide to the software engineering body of knowledge 2004 version,” IEEE Computer Society, Los Alamitos, California, 2004.

[13] Bhuvaneswari, T., Prabaharan, S., “A Survey on Software Development Life Cycle Models”, International Journal of Computer Science and Mobile Computing, Vol. 2, Issue.5, pp. 262 – 267, May 2013.

[14] Pagalla Bhavani Shankar, et al. “Effort Estimation of Software (EEOS) Using Machine Learning Approached Algorithms”, International Journal for Innovative Engineering and Management Research, Vol.12, Issue.02, pp.162-165.

[15] Pagalla Bhavani Shankar, M. Babu Reddy, “Significant Strategies to Assess Software Effort Estimation: A View of Functional Point”, I-manager's Journal on Software Engineering, Vol. 17, No. 3, pp. 33-37.

[16] Pagalla Bhavani Shankar, "Blockchain: The Essential Future of Modern Internet", International Journal for Modern Trends in Science and Technology, 6(10): 60-64, 2020.

[17] Dong, Shi, Ping Wang, and Khushnood Abbas. "A survey on deep learning and its applications." *Computer Science Review* 40 (2021): 100379.

[18] Politowski, Cristiano, Yann-Gaël Guéhéneuc, and Fabio Petrillo. "Towards automated video game testing: still a long way to go." *Proceedings of the 6th International ICSE Workshop on Games and Software Engineering: Engineering Fun, Inspiration, and Motivation*. 2022.

[19] Alouffi, Bader, et al. "A systematic literature review on cloud computing security: threats and mitigation strategies." *IEEE Access* 9 (2021): 57792-57807.