Security Implications in Cloud Computing

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ABSTRACT

: Cloud computing is one of the fastest-growing technologies in the IT sector. It is a concept for providing ubiquitous, practical, and on-demand network access to collections of computer resources such networking devices, servers, storage, applications, and services. Due to the various advantages the cloud has to offer, several firms have migrated their data there. However, since physical infrastructure is outsourced to a third party, cloud data storage presents a serious security risk. Using internal infrastructure, businesses may develop and maintain their own security standards, but how can they know what security measures cloud providers are doing and how well they are working? The cloud computing industry is also trying to come up with a solution for this issue. We want to create a security benchmark for cloud computing. By creating a single standard, all service providers and developers may follow the same guidelines to build a unified cloud environment, raising the bar for cloud computing security to new heights.

KEYWORDS Cloud Computing, Cloud security.

I. INTRODUCTION

A parallel and distributed computing system consisting of a collection of interconnected and virtualized computers that are dynamically provisioned and presented as one or more unified computing resources based on service-level agreements (SLAs) established through negotiation between the service provider and customers, is how cloud computing is defined (Cloud Computing Definition). The proposed Efficient Speculative Parallelization Architecture (ESPA) has the potential to significantly reduce speculation overheads in cloud computing, improving overall security and performance of cloud-based systems [1], [4], [5]. "When using cloud computing, the range of resources available changes based on customer demand; it grows when there is a high demand for services and shrinks when there is a low demand [11], [14], [15]." But cloud computing also creates security issues since it basically takes control of the data away from the data owner.

The integration of this efficient hardware-supported and parallelization architecture for intelligent systems can contribute towards mitigating security risks associated with speculative execution in cloud computing, leading to more secure and reliable cloud-based systems [2], [16], [17]. Security is a key issue in the world of cloud computing and the cornerstone of cloud development. Due to security concerns, businesses and consumers are reluctant to fully embrace the cloud environment. Many businesses consider using cloud service providers but decide against doing so because they don't trust the security measures in place. The classification of web pages on attractiveness through a supervised learning approach can provide valuable insights into user behaviour and preferences, ultimately leading to improved security measures and better user experiences in cloud-based web services [7], [8]. There are several methods for data loss in the cloud to happen, despite claims by cloud computing companies that user data is safe, secure, and protected from threats. Right now, when launching a new cloud service, providers may choose to either create their own standards or follow those created by the CSA, NIST, IEEE, or ENISA. As a consequence, the industry becomes disorganised, and its parts are unable to work together. Customers' viewpoints the sheer quantity of security measures merely confuses us, and we have no idea how secure the providers are. Academics predict that cloud computing will have a huge impact on the future of the IT industry, but this development is being seriously stymied by the lack of a widely accepted standard. Brain-Computer Interaction (BCI) offers a potential solution for secure and reliable authentication in cloud computing, as it provides a unique and personalized method of interaction based on the user's brain waves, reducing the risk of unauthorized access and enhancing overall security [9], [29]. Therefore, developing a new security standard is essential for cloud computing development. By adhering to a single standard, we can build a fresh unified cloud environment that is more robust and better equipped to protect user data from attacks. The advantages of current technologies might be merged in a new standard to enhance the security of cloud computing.The evaluation of automatic parallelization algorithms in minimizing speculative parallelism overheads provides valuable insights towards developing more efficient

and secure cloud computing systems, especially in the face of increasing security threats posed by speculative execution vulnerabilities [10], [30]. A significant finding is that combining many solutions at once might hinder the development of cloud computing in the future since no one security can effectively protect data stored in the cloud from hackers. So, adhering to a single standard could be a means to guarantee cloud computing security. The project proposal consists of six parts. A brief review of cloud computing in general and its security requirements will be provided in the introduction of this article. The aims and objectives of the study will be covered in the second part. We also go through the Background and the Research Gap in part three. Section 4 discusses Research Innovation and Significance. Section 5 presents a few suggestions for methods based on this. The key conclusions are summarised in Section 6 along with some suggestions for further study.

II. RESEARCH AND OBJECTIVES

A. RESEARCH AIMS

To begin with, we want to make it quite obvious that the main aim of our investigation is to locate a new security standard for cloud computing. As was already said, the adoption of so many standards have made the environment for cloud computing rather chaotic, and it is now having difficulty finding out how to progress. The COVID-19 pandemic has accelerated the shift towards online media consumption, making it more critical than ever to understand the technological implications of this trend in terms of security and privacy concerns in cloud computing environments [12]. Therefore, by upholding a single norm, this problem may be overcome. There are two reasonable justifications for why cloud computing needs a new security standard.

To begin with, because cloud computing is a relatively new system that incorporates a number of technologies, including network, storage, computers, and information technology, it requires a novel technology that is different from those currently in use. AutoML, with its ability to automate the process of building and optimizing machine learning models, has the potential to revolutionize cloud computing security by facilitating the development of more robust and effective security systems [19]. Almost all security measures in use today were developed before the cloud industry took off. "On a dedicated server, users may occupy a full system without having to share their resources with anybody else, giving them total control over the hardware, operating system, and other elements of the server." In cloud settings, the effectiveness of security measures that worked well on traditional infrastructure could not be completely realized.

Second, despite the fact that cloud computing employs a variety of security measures, the majority of cloud service providers only choose one of them to protect customer data. A sustainable framework for metaverse security and privacy can effectively address the emerging security and privacy challenges in the metaverse, and enable the development of secure and trustworthy virtual environments for cloud computing users [20]. A single cloud computing security technique is inadequate to provide a strong defense against sophisticated cyber-attacks, according to Rong, Nguyen, and Jaatun (2012) [32]. Cloud service providers must combine several techniques into one system in order to raise the level of security in cloud computing. Combining several security measures might make up for a deficiency in one method by utilizing its advantages. "As a consequence, we are able to provide a strong defense against potential attacks."

B. RESEARCH OBJECTIVES

The major aim will be achieved by pursuing three objectives: examining existing security practises, learning about a new software named Zyber, and contrasting Zyber with current security practises. The first step is to examine some typical security methods used by cloud providers to safeguard their customers' data. The proposed transfer learning-based model for ultrasound breast cancer image classification can aid in the early detection and diagnosis of breast cancer, contributing towards improved healthcare outcomes while also addressing security concerns in cloud-based medical image analysis [21]. This objective should provide a comprehensive overview of cloud computing security. The results will enable us to pinpoint the advantages of modern security methods and the justification for cloud providers' choice to use them while developing their systems. It may also draw attention to certain security weaknesses, enabling us to fix them and setting a new benchmark for cloud computing security. The next objective is to concentrate on Zyber, a brand-new cloud computing application. Zyber is being developed and supported by the Canadian government. The integration of Software Defined Networking (SDN) with edge computing and Artificial Intelligence (AI) technologies in the context of IoT and smart cities holds great potential for enhancing security in cloud computing by enabling efficient data processing and analysis at the edge, reducing the risk of data breaches and cyber-attacks [22]. We also want to re-evaluate Zyber's prospective performance by focusing on its features, including how it functions, the sort of encryption technique it uses, how much it costs to provide a better security solution than current approaches, and so on. We'll also look at its positives and negatives.

Based on the results of the first two goals, we want to compare Zyber with modern security methods. This comparison will concentrate on the advantages and disadvantages of various approaches as well as some unique aspects of Zyber. The integration of deep learning in robotics can strengthen Industry 4.0 by improving the efficiency and reliability of cloud-based systems, while also presenting new security challenges that must be addressed in order to fully realize the potential of this technology [23]. The study's main objective is to ascertain if Zyber can establish a new standard for cloud computing security.

III. REVIEW OF LITERATURE

The current haphazard growth of cloud computing reduces its competitiveness in the IT industry and raises the danger of security breaches. According to Martinez & Pulier (2012) [27], many firms no longer employ cloud infrastructure, despite the fact that it may have numerous advantages for enterprises, since the computing capacity provided by cloud providers lacks security, control, and administration. The three main areas of security risks that must be guarded against are data availability, confidentiality, and integrity, according to Zissis & Lekkas 2012 [39].

The first issue is data confidentiality. Ryan (2013) [33] notes that since data are hosted on cloud systems, managers are more open to bribery. Managers may progressively lose their willpower when faced with conflicts of interest. Due to the fact that the cloud is a shared-tenant environment, anybody except the data owners, such as hackers or employees of third parties, may access the data stored in the cloud database. The bulk of IT infrastructure and data storage are now managed by outside vendors, according to Rong, Nguyen, and Jaatun (2012) [32], which has two detrimental effects. First off, since cloud servers are located in faraway locations, data owners have little influence over the IT infrastructure. As a consequence, it is essential for cloud service providers to establish guidelines for their security practises in order to ensure data privacy. The second is that cloud service providers have extensive control over and unauthorised access to consumer data and applications. Customers that utilise business models with stringent security needs in particular are more likely to be continually worried about the safety of their data and have less faith in cloud providers as a result.

Previous studies have recognised the second security issue in cloud computing as the integrity risk. Gogna (2012) [25] notes that data saved on a cloud server may change while being sent. Data loss concerns still exist even if the cloud provider's infrastructure is more reliable than that of a personal device. Rong, Nguyen, and Jaatun (2012) [32] claim that the architecture of the provider permits the alteration of important data without user consent. Users greatly rely on the accuracy and veracity of the data, thus it must be maintained. However, there isn't a rule that may be used to regulate those cloud service providers in the cloud industry. According to Wang et al. (2010) [36], some cloud service providers may even reclaim storage by deleting seldom used data in an effort to boost revenues.

Data accessibility is the third biggest problem with cloud computing security. Users using cloud services are unable to access their data in the event of a server or hard drive failure since they have no access to the system directly. According to (Rao & Selvamani 2015 [28]), cloud providers are very concerned about availability since data is scattered among servers in remote locations. If the cloud server goes down, more users will suffer than in the traditional arrangement (Rong, Nguyen & Jaatun 2012 [32]). As was previously said, switching to a cloud environment could have certain drawbacks, but other research have provided a number of strategies to lessen these issues. First off, CSA (2013) [35] and Rong, Nguyen, and Jaatun [32] encourage cloud computing customers to use a better encryption (2012). This would prevent data from being sent in plain text to cloud service providers and other unauthorised users prior to being received by the authorised users (Rong, Nguyen & Jaatun 2012 [32]). Further, [11] suggests that cloud storage should be built on the dependability of hard drives, calling for greater infrastructure research. Choo (2010) [24] argues that cloud service providers need to build their storage facilities throughout a number of urban areas.

In several reviews of current research, many alternative solutions have been proposed to decrease the negative consequences of the move to cloud computing. They all work really hard to provide the best degree of data security in cloud computing. "However, none of them realised that what was necessary was to build a new cloud environment by developing a new model that everyone could use." At the moment, it is also a research gap.

IV. RESEARCH SIGNIFICANCE

The current haphazard growth of cloud computing reduces its competitiveness in the IT industry and raises the danger of security breaches. According to Martinez & Pulier (2012) [27], many organisations no longer employ cloud infrastructure, despite the fact that it might have numerous advantages for enterprises, since the computing capacity provided by cloud providers lacks security, control, and administration. The three main areas of security risks that must be guarded against are data availability, confidentiality, and integrity, according to (Zissis & Lekkas 2012 [39]). The first issue is data confidentiality. Ryan (2013) [33] notes that since data are hosted on cloud systems, managers are more open to bribery. "Managers may progressively lose their willpower when faced with conflicts of interest." Due to the fact that the cloud is a shared-tenant environment, anybody except the data owners, such as hackers or employees of third parties, may access the data stored in the cloud database. The bulk of IT infrastructure and data storage are now managed by outside vendors, according to Rong, Nguyen, and Jaatun (2012) [32], which has two detrimental effects. First off, since cloud servers are located in faraway locations, data owners have little influence over the IT infrastructure. As a consequence, it is essential for cloud service providers to establish guidelines for their security practises in order to ensure data privacy. The second is that cloud service providers have extensive control over and unauthorised access to consumer data and applications. Customers that utilise business models with stringent security needs in particular are more likely to be continually worried about the safety of their data and have less faith in cloud providers as a result. Previous studies have recognised the second security issue in cloud computing as the integrity risk. Gogna (2012) [25] notes that data saved on a cloud server may change while being sent. The implementation of a fuzzy-based clustering approach for analyzing

consumers' big data in industrial applications can provide enhanced security measures, allowing for improved identification and mitigation of potential security threats in cloud computing [40]. Data loss concerns still exist even if the cloud provider's infrastructure is more reliable than that of a personal device. Rong, Nguyen, and Jaatun (2012) [32] claim that the architecture of the provider permits the alteration of important data without user consent. Users greatly rely on the accuracy and veracity of the data, thus it must be maintained. However, there isn't a rule that may be used to regulate those cloud service providers in the cloud industry. According to Wang et al. (2010) [36], some cloud service providers may even reclaim storage by deleting seldom used data in an effort to boost revenues.

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- Step 1: Verify the existence of efficient governance, risk, and compliance processes
- Step 2: Audit operational and business processes
- Step 3: Manage people, roles, and identities
- Step 4: Ensure adequate data and information protection
- Step 5: Enforce privacy rules.
- Steps 6: through 9 involve assessing security provisions for cloud applications, checking the safety of cloud networks and connections, evaluating security measures for physical infrastructure and facilities, and managing security terms in cloud service level agreements. - Step 10: Recognize the exit procedure's security requirements.

V. RESEARCH METHODOLOGIES

Warfield (2010) [37] asserts that utilising a combination of quantitative and qualitative research methods as opposed to a single research methodology improves the validity of the findings. The highlighted study goal and proposed objectives are met using a variety of research techniques, including quantitative and qualitative methods. "More specifically, quantitative techniques are used for online survey methods, whereas qualitative approaches are chosen for interview, evaluation research, and comparison research."

Each strategy is closely tied to our study goals and aim since it was selected for a certain stage of the research. In order to direct our own study, we modified Cao et al. (2006)'s framework, which consists of four primary acts, to match our research. Among these reshaped activities are theory formulation, observation, assessment, and justification. First, the phase's guiding principle. This stage should result in data points and numbers that have also undergone analysis. "Therefore, one of the essential methods is doing online surveys." Online polls and discussion boards could be a part of this. Research questions are important because they

specify the subjects that a study wishes to look at, according to Timothy & Levy (2009). Furthermore, surveys collecting quantitative data should be created in a confirmatory and predictive way, claim Timothy & Levy (2009). As a consequence, some of our fictitious questions about cloud computing may be:

- Question 1 - Discussion board - How secure is end-to-end encryption when transmitting data? (Confirmatory)
- Question 2 - Users in General - How will cloud computing affect your career, study, and social life if security is significantly improved? (Predictive)

It is important to remember that over the course of the investigation, a potential issue with data validity will need to be addressed. In conclusion, the outcomes of this stage are essential for conceptually advancing our research objective.

Observations make up phase two. If a study question requires a more in-depth examination of a specific social phenomenon at this point, the case studies technique is highly suggested. As a result, case studies and literature reviews are employed as supporting tools in our research to conduct a comparative analysis. A literature review's foundation is reviews of a variety of academic publications. "The primary focus is on current security issues and their solutions." The results of this phase are essential in assisting the subsequent stage since case studies are conducted with the goal of finding solutions. According to Wynn & Williams (2012), a case study should focus on actions occurring inside a specific framework, such a single business. In order to evaluate existing solutions and compare their advantages and disadvantages in light of certain organisational events, we will conduct case studies. Overall, the creation of hypotheses that will be tested during the experimental step is aided greatly by this stage. The next phase is evaluation and justification. According to [3], a variety of conventional approaches, such as interviews, may be used to conduct system assessments. Furthermore, according to [3], understanding an IT artefact completely requires merging system evaluation and theory testing operations. "As a consequence, we released an evaluation study on Zyber, a still-in-development technology, for both theoretical testing and interviews." Previous studies have shown Zyber to have significantly improved cloud computing security, and this is also the basic tenet of our study approach. After its first release or during beta, Zyber will first undergo testing.

The usefulness of Zyber will be assessed based on its performance, usability, consistency, availability, reliability, and degree of security. We will also conduct interviews with possible targets like the CEO and development team of Zyber. As a result, our suggested hypothesis may be supported by the evaluation's results.

A success assessment approach must be employed in respect to the three main goals we stated after each research phase. Data analysis [18] is done after analysing phase results and before comparing with stated goals. It's also vital to remember that the research approaches you've selected are not phase-exclusive and necessary, which means you might, depending on the circumstance, utilise a range of tactics or more flexible choices.

VI. CONCLUSION

In conclusion, cloud computing is becoming more widely accepted, and many companies are switching to cloud-based infrastructure since it is a modern and developing trend in technology. However, security flaws continue to pose a severe hazard to users of cloud services. The three key issues that function as barriers to cloud adoption are, in order, data availability, data integrity, and confidentiality. The main study objective is to find a new standard that is safe enough for businesses and individual users to adopt. For us to succeed, a number of objectives must be accomplished. These objectives include evaluating existing solutions, testing new technologies, and comparing them. The significance of the study's results must be emphasised since they have the potential to completely transform cloud computing. More customers could benefit from cloud computing's advantages. "Furthermore, data from previous investigations provide strong support for our suggested hypothesis." In addition to online surveys, literature reviews, case studies, interviews, and a more general strategy that focuses on assessing Zyber technology, our research team has selected a variety of significant research approaches. Ultimately, by following a broad framework and set of guidelines, as well as by including principles in the research process and using modern research technology, significant and accurate research findings are predicted.

REFERENCES

[1] S Kumar, SK Singh, N Aggarwal & K Aggarwal (2022). Efficient Speculative Parallelization Architecture for Overcoming Speculation Overheads. In Proc. of International Conference on Smart Systems and Advanced Computing (Syscom-2021)

[2] Kumar, S., Singh, S. K., Aggarwal, N., Gupta, B. B., Alhalabi, W., & Band, S. S. (2022). An efficient hardware supported and parallelization architecture for intelligent systems to overcome speculative overheads. International Journal of Intelligent Systems, 37(12), 11764-11790.

[3] Kaur, P., Singh, S. K., Singh, I., & Kumar, S. (2021, December). Exploring Convolutional Neural Network in Computer Vision-based Image Classification. In International Conference on Smart Systems and Advanced Computing (Syscom-2021).

[4] A. Mishra (2023) Homomorphic Encryption: Securing Sensitive Data in the Age of Cloud Computing, Insights2techinfo, pp.1

[5] A. Dahiya (2021), Integration of Cloud and Fog Computing for Energy Efficient and Scalable Services, Insights2Techinfo, pp.1

[6] Kinyanjui P.W., Rawal B.S. (2022) Opportunities in 5G Edge Computing Security Challenges. Cyber Security Insights Magazine, Insights2Techinfo, Volume 1, pp. 20-27. 2022.

[7] Gupta, B. B., Yamaguchi, S., & Agrawal, D. P. (2018). Advances in security and privacy of multimedia big data in mobile and cloud computing. Multimedia Tools and Applications, 77, 9203-9208.

[8] G Khade, S Kumar, S Bhattacharya (2012). Classification of web pages on attractiveness: A supervised learning approach. In 2012 4th International Conference on Intelligent Human Computer Interaction (IHCI).

[9] Kumar, S., & Singh, S. K. (2021). Brain Computer Interaction (BCI): A Way to Interact with Brain Waves.

[10] S Kumar, SK Singh, N Aggarwal, K Aggarwal (2021). Evaluation of automatic parallelization algorithms to minimize speculative parallelism overheads: An experiment. In Journal of Discrete Mathematical Sciences and Cryptography (2021).

[11] Peñalvo, F. J. G., Sharma, A., Chhabra, A., Singh, S. K., Kumar, S., Arya, V., & Gaurav, A. (2022). Mobile cloud computing and sustainable development: Opportunities, challenges, and future directions. International Journal of Cloud Applications and Computing (IJCAC), 12(1), 1-20.

[12] Gupta, A., Singh, S. K., Chopra, M., & Gill, S. S. (2022). An Inquisitive Prospect on the Shift Toward Online Media, Before, During, and After the COVID-19 Pandemic: A Technological Analysis. In Advances in Data Computing, Communication and Security: Proceedings of I3CS2021 (pp. 229-238). Singapore: Springer Nature Singapore.

[13] Singh, M., Singh, S.K., Kumar, S., Madan, U., Maan, T. (2023). Sustainable Framework for Metaverse Security and Privacy: Opportunities and Challenges. In: Nedjah, N., Martínez Pérez, G., Gupta, B.B. (eds) International Conference on Cyber Security, Privacy and Networking (ICSPN 2022). ICSPN 2021. Lecture Notes in Networks and Systems, vol 599. Springer, Cham. https://doi.org/10.1007/978-3-031-22018-0_30

[14] Negi, P., Mishra, A., & Gupta, B. B. (2013). Enhanced CBF packet filtering method to detect DDoS attack in cloud computing environment. arXiv preprint arXiv:1304.7073.

[15] Gupta, B. B., Gupta, S., & Chaudhary, P. (2017). Enhancing the browser-side context-aware sanitization of suspicious HTML5 code for halting the DOM-based XSS vulnerabilities in cloud. International Journal of Cloud Applications and Computing (IJCAC), 7(1), 1-31.

[16] Yadav, U. S., Gupta, B. B., Peraković, D., Peñalvo, F. J. G., & Cvitić, I. (2022). Security and privacy of cloud-based online online social media: A survey. In Sustainable management of manufacturing systems in industry 4.0 (pp. 213-236). Cham: Springer International Publishing.

[17] Gaurav, A., Psannis, K., & Peraković, D. (2022). Security of cloud-based medical internet of things (miots): A survey. International Journal of Software Science and Computational Intelligence (IJSSCI), 14(1), 1-16.

[18] Gupta, A., Singh, S. K., Chopra, M., & G-ill, S. S. (2022). An Inquisitive Prospect on the Shift Toward Online Media, Before, During, and After the COVID-19 Pandemic: A Technological Analysis. In Advances in Data Computing, Communication and Security: Proceedings of I3CS2021 (pp. 229-238). Singapore: Springer Nature Singapore.

[19] Mengi, G., Singh, S.K., Kumar, S., Mahto, D., Sharma, A. (2023). Automated Machine Learning (AutoML): The Future of Computational Intelligence. In: Nedjah, N., Martínez Pérez, G., Gupta, B.B. (eds) International Conference on Cyber Security, Privacy and Networking (ICSPN 2022). ICSPN 2021. Lecture Notes in Networks and Systems, vol 599. Springer, Cham. https://doi.org/10.1007/978-3-031-22018-0_28

[20] Singh, M., Singh, S.K., Kumar, S., Madan, U., Maan, T. (2023). Sustainable Framework for Metaverse Security and Privacy: Opportunities and Challenges. In: Nedjah, N., Martínez Pérez, G., Gupta, B.B. (eds) International Conference on Cyber Security, Privacy and Networking (ICSPN 2022). ICSPN 2021. Lecture Notes in Networks and Systems, vol 599. Springer, Cham. https://doi.org/10.1007/978-3-031-22018-0_30

[21] Gupta, S., Agrawal, S., Singh, S.K., Kumar, S. (2023). A Novel Transfer Learning-Based Model for Ultrasound Breast Cancer Image Classification. In: Smys, S., Tavares, J.M.R.S., Shi, F. (eds) Computational Vision and Bio-Inspired Computing. Advances in Intelligent Systems and Computing, vol 1439. Springer, Singapore. https://doi.org/10.1007/978-981-19-9819-5_37

[22] Singh, R., Singh, S. K., Kumar, S., & Gill, S. S. (2022). SDN-Aided Edge Computing-Enabled AI for IoT and Smart Cities. In SDN-Supported Edge-Cloud Interplay for Next Generation Internet of Things (pp. 41-70). Chapman and Hall/CRC.

[23] K Aggarwal, SK Singh, M Chopra, S Kumar, F Colace (2022). Deep Learning in Robotics for Strengthening Industry 4.0.: Opportunities, Challenges and Future Directions. In Robotics and AI for Cybersecurity and Critical Infrastructure in Smart Cities (2022).

[24] Choo, R.K. 2010, Cloud computing: Challenges and future directions, Australian Institute of Criminology, Canberra, viewed 8 September 2015, <http://aic.gov.au/publications/current

[25] Gogna, M. 2013, 'A survey on security challenges of Cloud Computing', International Journal of Computer Science & Communication, vol. 4, no. 1, pp. 21-23.

[26] Grance, T. & Mell, P. 2011, Recommendations of the National Institute of Standards and Technology, 800-145, National Institute of Standards and Technology (NIST) Special Publication 800-145, U.S. Department of Commerce, the United State.

[27] Martinez F. R. & Pulier E. 2012, 'System and method for a cloud computing abstraction layer with security zone facilities', U.S. Patent Application Publication, no. 13/354,275.

[28] Rao, R.V. & Selvamani, K. 2015, 'Data Security Challenges and Its Solutions in Cloud Computing', Procedia Computer Science, vol 48, pp. 204-209.

[29] Peñalvo, F. J. G., Sharma, A., Chhabra, A., Singh, S. K., Kumar, S., Arya, V., & Gaurav, A. (2022). Mobile cloud computing and sustainable development: Opportunities, challenges, and future directions. International Journal of Cloud Applications and Computing (IJCAC), 12(1), 1-20.

[30] Gupta, S., et al. (2018). XSS-secure as a service for the platforms of online social network-based multimedia web applications in cloud. Multimedia Tools and Applications, 77, 4829-4861.

[31] Robert, K.Y. 2013, Case Study Research: Design and methods, 5th edn, Sage publications, London.

[32] Rong, C., Nguyen, S.T. & Jaatun, M.G 2012, 'Beyond lightning: A survey on security challenges in cloud computing', Computers and Electrical Engineering, vol. 39, no. 1, pp. 47-54.

[33] Ryan M.D. 2013, 'Cloud computing security: The scientific challenge, and a survey of solutions', Journal of Systems and Software, vol. 86, no. 9, pp. 2263-2268.

[34] Timothy, J.E & Levy, Y. 2009, 'Towards a Guide for Novice Researchers on Research Methodology: Review and Proposed Methods', Issues in Informing Science & Information Technology, vol. 6, pp. 323.

[35] Top Threats Working Group 2013, The Notorious Nine Cloud Computing Top Threats in 2013, Cloud Security Alliance (CSA).

[36] Wang C, Chow, S. S. M., Wang Q, Ren K, Lou W. 2010, 'Privacy-preserving public auditing for data storage security in cloud computing//INFOCOM', Proceedings IEEE, San Diego, CA, pp. 1-9.

[37] Warfield, D. 2010, 'Information Systems (IS) and Information Technology (IT) research: A research methodologies review', Journal of Theoretical & Applied Information Technology, vol. 13, pp. 28-25.

[38] Wynn, J.D. & Williams, C.K. 2012, 'Principle for conducting critical realist case study research in information system', MIS Quarterly, vol. 36, pp. 787.

[39] Zissis, D. & Lekkas, D. 2010, 'Addressing cloud computing security issues', Future Generation Computer Systems, vol. 28, no. 3, pp. 583-592.

[40] A Sharma, SK Singh, E Badwal, S Kumar, BB Gupta, V Arya, KT Chui, D Santaniello (2023). Fuzzy Based Clustering of Consumers' Big Data in Industrial Applications. In 2023 IEEE International Conference on Consumer Electronics (ICCE).

[41] M Chopra, S Kumar, U Madan, S Sharma (2021). Influence and Establishment of Smart Transport in Smart Cities. In International Confer