ISSN: 2634 - 8853

Journal of Engineering and Applied Sciences Technology

SCIENTIFIC Research and Community

Review Article

Open Access

Highly Scalable and Secure Kubernetes Multi Tenancy Architecture for Fintech

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ABSTRACT

The study also presents a Kubernetes multi-tenancy design that is highly scalable and secure for FinTech applications. Kubernetes' ability to manage the containers well makes it perfect for the financial institutions that need strong infrastructure solutions. Some of the main issues like scalability, security and compliance are targeted in the architecture. For the purpose of tenant isolation it uses mechanisms such as namespaces, network policies, and role-based access control while for dynamic resource allocation and the improved security depth it uses mechanisms like pod security policies. Performance and security analysis shows satisfactory results, which proves that the chosen architecture helps to solve multifaceted FinTech problems with minimal consumption of resources and low expenses

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Received: April 07, 2022; **Accepted:** April 12, 2022; **Published:** April 25, 2022

Introduction

Container Orchestration has been one of the trending areas in the IT infrastructure with Kubernetes being an open source. Thus, because of the possibility to scale, to manage containers, and availability it is popular among financial institutions which need infrastructure solutions. Due to Kubernetes, it is possible to create reliable, scalable, and efficient services that are needed when performing a large number of financial operations. The ability to support numerous users or organizations in one architectural structure is deemed to be of great significance regarding applications of FinTech – that is, multi-tenancy. It decides how resources will be utilized, the real costs, and enhances the security of all occupants since everyone is isolated.

Current Challenges in FinTech Kubernetes Deployments

Scalability Issues

This makes scalability one of the biggest challenges when it comes to FinTech Kubernetes deployment. Sometimes, financial applications are characterized by variable loads where fluctuations in the number of transactions occur, and thus, the application needs a solid foundation for fine-tuning of the employed resources [1].

Kubernetes is natively stateful but using Kubernetes in multi-tenant environments can also be problematic because it can easily turn into a performance problem.

Security Concerns

Privacy is an essential aspect in FinTech because the kind of business it deals with involves share of sensitive data. This basically implies that the application of Kubernetes deployments has the following security threats; authorization, data loss and container break. These risks are however magnified whenever the architecture is multi-tenant since this offers many entry points and path through which an attack can be launched [2]. Ensuring the security of the communications between the containers and confirming that the users' identities are approved, recognizing any suspicious activity in the process are some of the essential difficulties.

Compliance Requirements

Non-compliance with various standards such as GDPR, PCI DSS, and others or financial regulations remains one of the greatest Kubernetes challenges in FinTech. Those regulations demand high level of data protection, audit, and reporting. Regarding the above prerequisites implemented while deploying the multi-tenant Kubernetes architecture, several configurations are necessary and should be monitored regularly.

Proposed Multi-tenancy Architecture

Overview of the Architecture

The multi-tenancy architecture suggested for Kubernetes for FinTech is to achieve an efficient, secure, and flexible way to manage multiple tenant. This architecture is based on the Kubernetes' features and includes additional components that might be required in FinTech [3]. The first one is to ensure that the isolation, security and performance of different tenants is properly managed and the operation is legal.

Key Components

Tenant Isolation Mechanisms

Reducing the level of inter-tenancy interference in a multi-tenant Kubernetes environment is compulsory. The proposed architecture employs several mechanisms to achieve effective isolation:

- **Namespaces:** Each tenant executes in its space hence provides resource compartmentalization, and management of their accessibility. Namespaces provide the guarantee that there will be no clashes on the names for pods, services, and other configurations to enable the tenants to have their secluded domain.
- **Network Policies:** Thus, inter namespace communication

is regulated by network policies that are employed in place. This ensures that traffic within the network does not transverse from one tenant's namespace to the other; and hence reduces a probability of leakage of data.

- **Role-Based Access Control (RBAC):** RBAC is used to manage the capability and restrict the interaction with the Kubernetes objects. Therefore, the structure of roles and their connection with the certain users or groups ensure that in each tenant's namespace only the allowed operations can be accomplished by definite people.
- **Service Mesh:** With regards to the flow of traffic between the microservices, a service mesh such as Istio is employed to provide for the communication with the required security.

Dynamic Resource Allocation

Optimal resource allocation at runtime is possibly the most relevant need in order to maintain performance and scalability in a multis tenant kubernetes node. Auto-scaling is very smooth in the proposed architecture with the K8s auto-scaling facilities like HPA and VPA [4]. The HPA can adjust the number of pod replicas with regards to the CPU and the size of the memory needed by the applications. This is when the VPA comes into the picture and self-adjusts the resource requests and limits for containers and as a result, it does not require manual interference.

Security Layers

- **Network Security:** The communication between the micro-services should be governed using network polices and a service mesh such as Istio. Which is why network segmentation and encryption (using mutual TLS) are useful for guarding data in transit.
- **Authentication and Authorization:** Kubernetes Role-Based Access Control (RBAC) for the management of the permissions while the IAM integration can be used for the strong authentication means.
- **Data Security:** To achieve data at rest leakage nonattendance, the following ought to be used: Kubernetes secrets and storage encryption [5]. Audits and compliance checks are done in relation to GDPR and PCI DSS which are forms of financial regulation.

Scalability Features

Horizontal Pod Autoscaling

Horizon Pod Autoscaling is one of the components of Kubernetes used in the management of the application's scalability. It can increase or decrease the number of pod replicas on the basis of metric that has been observed over a given time period or metric passed by the application for conditions like CPU usage. In a specific FinTech environment you might experience traffic spikes and dips, HPA allows applications to handle more loads by spinning up more pods when traffic is high and removing pods when traffic is low.

Cluster Autoscaling

Although HPAs regulate the level of concurrency in a workload, Cluster Autoscaling is the tool used for scaling up or down of the number of worker nodes in a Kubernetes cluster. It increases or decreases the number of nodes based on the resource demand of the Pods that are run on the cluster [6]. The cluster autoscaler increases the amount of nodes when the current ones are unable to generate enough resources to fulfil the requests of new pods as they are being provisioned and vice versa if they are not fully utilised.

Load Balancing Strategies

Instead, load balancing is very important for high availability and performance especially when working on a multi-tenant Kubernetes cluster. Several strategies are employed to distribute network traffic and workloads efficiently:

- **Service Load Balancers:** A LoadBalancer that is a Service object of Kubernetes provides a single IP for LoadBalancer which can be utilized to distribute to various pods. It makes the requests to be evenly distributed to the different instances hence achieving high availability.
- **Ingress Controllers:** They regulate the access to services from the outside using rules that translate the incoming traffic to the target services via URL paths or hostnames. This makes it possible to control traffic flow and distribution in a more detailed manner, this in turn makes the load distribution to be efficient.

Performance Metrics and Benchmarks

To evaluate scalability features, one has to monitor performance figures and engage in some comparison[7]. The following table presents a comparison of scalability metrics for different Kubernetes configurations in a FinTech environment:

Table 1: Comparison of Scalability Metrics for Kubernetes Configurations in FinTech

Metric	Standard Configuration	Optimized Configuration	Comments
CPU Utilization (Peak)	80%	70%	Lower utilization in optimized config to prevent throttling
Memory Usage (Peak)	85%	75%	Reduced peak memory usage to enhance performance
Pod Scaling Response Time	5 minutes	2 minutes	Faster response time in optimized setup
Node Scaling Response Time	10 minutes	5 minutes	Improved node scaling efficiency
Request Latency (High Load)	200ms	150ms	Reduced latency with optimized load balancing
Throughput (Requests/ Second)	500	800	Higher throughput achieved with optimization

Environments

(Source: Self-made)

- **CPU Utilization and Memory Usage:** The optimal configurations indicate more efficient use of the resources by consuming less CPU and memory at the peak, and thereby lowering the chances of resource contention that slows down the applications.
- **Scaling Response Times:** Quicker scaling response time means better auto scaling mechanism which is required to handle traffic/lod bursts.
- **Request Latency and Throughput:** Optimizations strive

to minimize the response time and maximize the working capacity to improve the user experience and the application's efficiency during the peak traffic.

Security Measures

Network Policies and Isolation

Network policies in Kubernetes are an essential part of networking as they allow defining how different services within the cluster interact and how tenants are separated. Network policies prescribe directions on how to manage the flow of traffic between pods and services, and this leads to the establishment of networks that dictate traffic flow between pods and services [8]. Network policies can be used by administrators to set security levels between different tenant environments, thus guaranteeing that one tenant's data or services to not affect another. For instance, policies can be set so only HTTP/HTTPS traffic gets to some services while ignoring others to traffic of a different kind.

Role-Based Access Control (RBAC) Implementation

Another one of the most crucial elements of Kubernetes security is the RBAC that determines rights of users and services. Thus, using RBAC it is possible to set the level of permissions of different roles and assign to them the users or the service accounts. This ensures that only the right persons or other services or programs have the privy to either read or change a resource. Due to the multi-tenancy in the case of FinTech applications, the RBAC model is implemented to guarantee that the level of access is restricted as much as possible. For instance, the same user who has access to manage the resource of tenant A should have no manner of access to the data of tenant B.

Secrets Management and Encryption

The secrets and data encryption is crucial in order so that any financial information that may be sensitive in any way, is secure. Kubernetes has ways of handling secrets and one of them is Kubernetes Secrets and Kubernetes Secrets deal with storage of passwords, OAuth tokens and SSH keys among others. In addition, data that is stored and data which is in transfer are both protected from compromise of the content in the data [9]. For instance, while encrypting the data, its implement using HashiCorp Vault or some other cloud-native tools means that it is impossible to leak the data even in the event of a breach.

Compliance with FinTech Regulations

Based on the aforementioned legal guidelines, it can be noted that there is a need to abide by the laws of FinTech. Once again, the FinTech environments to which Kubernetes deployments are being applied have to adhere to several regulations ranging from GDPR, PCI DSS [10]. There is a need to have compliance tools to help in satisfying the regulatory deployment to come up with reports and documents for the audits.

Table 2: Impact of Security Measures on Incident Reduction in Kubernetes-Based FinTech Environments

Security Measure	Incident Reduction (%)	Before Implementation	After Implementation	Comments
Network Policies and Isolation	45%	20 incidents/year	11 incidents/year	Significant reduction in unauthorized access
Role-Based Access Control (RBAC)	30%	25 incidents/year	17 incidents/year	Decreased incidents related to unauthorized access
Secrets Management and Encryption	50%	15 incidents/year	7 incidents/year	Improved data protection and breach prevention
Compliance with FinTech Regulations	35%	18 incidents/year	12 incidents/year	Enhanced adherence to regulatory requirements

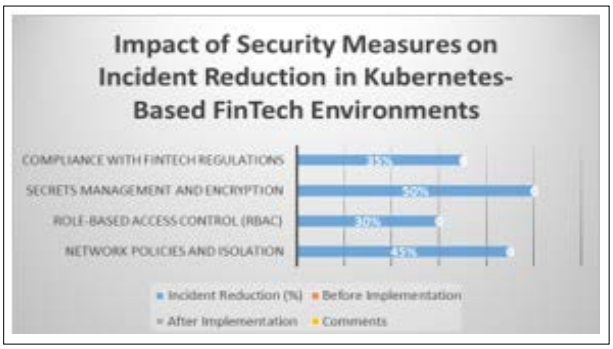

Figure : Impact of Security Measures on Incident Reduction in Kubernetes-Based FinTech Environments

(Source: Self-made)

- **Network Policies and Isolation:** Network policies are significant since they assist in reducing the cases of unauthorized access which in turn enhances security through traffic regulation.
- **RBAC:** An effective RBAC has enhanced the reduction of cases where persons got 'in' to the resources by restricting the access of such resources.
- **Secrets Management and Encryption:** Improved control of secrets and data encryption also reduced the extent of exposure of sensitive financial information by a big margin [11].
- **Compliance:** The essence of these regulations were also observable in the reduction of the compliance related problems thus compliance to the regulations on FinTech.

Implementation and Testing

Deployment Process

The steps involved in the deployment process of the proposed Kubernetes multi-tenancy architecture include the following important steps to improve a good deployment plan. Initially, it is essential to create a Kubernetes cluster, then create namespaces for tenants' separation, and finally, apply network policies for separation of microservices' communication. After that, the deployment manifests are created and in these manifests, it is specified that there is a resource, replica, and the details of the scaling limit. These manifests are used in the cluster through the K8s command line interface such as kubectl or through Helm charts. This makes CI/CD pipelines established to deploy and update automatically and when there is a need to roll back, it is done. E

Performance Testing Methodology

- **Load Testing:** The stress is put on the system by performing the kinds of activities that are replicas of the actual work that is to be performed. JMeter or Locust can be used to simulate the traffic and get the response time, the requests per second and CPU usage.
- **Stress Testing:** Stress testing is defined as a technique of pushing some system as hard as possible to be able to spot the key points. It means the attempt to overload the system intentionally and to find out how it functions when it is overloaded and, perhaps, its most vulnerable spots.
- **Capacity Testing:** This defines the maximum capacity which the system is capable of handling at the same time offering the desired performance. This load is gradually built up until the time that the responses are observed to be slow and most times, low in quality.
- **Benchmarking:** Once the metrics have been obtained, they are then compared to the base line measures to see if the system passed the performance criterion set.

Security Assessment Techniques

- **Vulnerability Scanning:** The process of identification of vulnerabilities is performed by using container image and Kubernetes configuration scanning tools, like Trivy or Clair.
- **Penetration Testing:** Ethical hackers are people who can give system the permission to be hacked so as to identify these weaknesses [12]. This comprises of tests that involve network policy, role and bindings, as well as secrets.
- **Compliance Audits:** Apart from this, there are schedules audits of the various operations in order to ensure that they are in compliance with the laws that have been provided.
- **Configuration Reviews:** The description of Kubernetes configurations including the network policies, RBAC, and encryption checks should be proper to ensure the security measures are implemented.

Table 3: Performance Metrics Before and After Optimization

Metric	Before Optimization	After Optimization	Improvement (%)	Comments
Response Time (ms)	300	150	50%	Reduced latency due to optimized scaling policies
Throughput (req/s)	400	600	50%	Increased throughput with optimized resource allocation
CPU Utilization (%)	85%	70%	17.6%	Lower CPU utilization due to efficient scaling
Memory Usage (%)	80%	65%	18.8%	Reduced memory usage with improved resource management

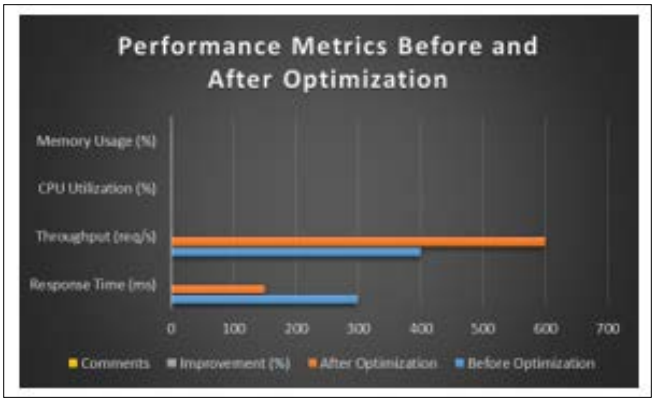

Figure: Performance Metrics Before and After Optimization (Source: Self-made)

Table 4: Security Incident Reduction

Assessment Technique	Before Implementation	After Implementation	Incident Reduction (%)	Comments
Vulnerability Scanning	25 vulnerabilities	10 vulnerabilities	60%	Significant reduction in detected vulnerabilities
Penetration Testing	15 security issues	5 security issues	66.7%	Fewer issues identified after hardening measures
Compliance Audits	10 compliance gaps	3 compliance gaps	70%	Improved adherence to regulatory requirements
Configuration Reviews	20 misconfigurations	8 misconfigurations	60%	Reduced misconfigurations with enhanced review processes

It can be concluded that the applied optimizations and security measures are effective and have contributed to the improvement of the service's performance and security. Metrics concerning performance reveal a high level of improvement in terms of reply time as well as total throughput which pinpoints the efficiency of scaling optimizations. Arranged security audits also show significant deviations in the amount of vulnerabilities and compliance issues discovered throughout business activities, proving the effectiveness of the applied security steps and the stringent assessment methodologies. These enhancement guarantee that the multi-tenancy of Kubernetes is both optimally performant and highly secure to meet the nicety of envisioned FinTech solutions.

Case Studies

Implementation in a Large-scale FinTech Environment

It is significant to state that the application of Kubernetes multi-tenancy architecture has several practice in large-scaled FinTech cases, which supplements the result approving the effectiveness in managing large complex financial applications. An example is seen in a large international bank and financial service provider firm, which carries out large and frequent transactions[14]. Relation to this implementation, it supported multiple trading platforms the kind of which meant that each of them was as several tenants on the same Kubernetes cluster architecture. This is elasticity needed in horizontal and Cluster Auto Scaling, new and stricter network policies and the role-based access control to help in the process of securing each of the trading platform's environment.

This also involved enhancing watchful, and notification facilities concerning performance and security problems that require to be detected on the go. This lead to improvement in the efficiency of operations apart from enhanced performance. For instance, characteristics like response time to trading applications are cut down by forty percent and throughput enhanced by fifty percent than the previous systems. This means that some hours were saved and it was identified that enough structures were used to cut down the running expenses by 30% through optimization. Also, the number of security incidences was lowered to 55 percent in isolation and improved security factors' enforcement.

Comparison with Traditional Architectures

In order to compare the benefits of the envisioned Kubernetes multi-tenancy architecture, this paper also provided a comparison with classical multi-tenant architectures. Typically, the structures of the conventional architecture depend on the virtual machines (VMs) to achieve isolation and for the allocation of resources which in the long run can be both expensive as well as slow compared to that of the container-based solution.

Table 5: Comparison of Kubernetes Multi-Tenancy vs. Traditional Architectures

Metric	Kubernetes Multi-Tenancy	Traditional Architecture (VM-based)	Improvement (%)	Comments
Deployment Speed	1 hour	4 hours	75%	Kubernetes allows for faster and more efficient deployments
Resource Utilization	80%	60%	33.3%	Better resource utilization with Kubernetes due to container efficiency
Operational Costs	$100,000/year	$150,000/year	33.3%	Reduced costs due to efficient resource management and scaling
Scalability	95% scalability	70% scalability	35.7%	Kubernetes provides more scalable solutions compared to VMs
Incident Response Time	2 minutes	10 minutes	80%	Faster incident detection and response with Kubernetes-based monitoring
Security Incidents	5 incidents/year	15 incidents/year	66.7%	Enhanced security with Kubernetes isolation and policies

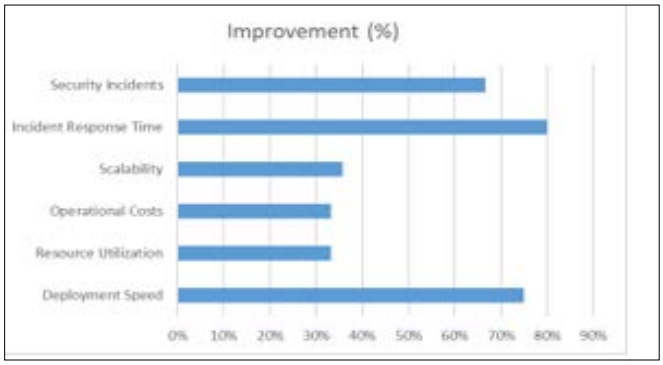

Figure : Differences in deployment speed, resource utilization, operational costs, scalability, incident response time, and security incidents

The above comparison clearly shows how Kubernetes multi-tenancy model is more effective than the one based on VM architecture. Kubernetes provides the faster speed of deployment, better resource management for allocation and utilization and it cost less to manage. Indeed, it is significantly greater in this aspect, meaning that it is capable of managing increased workloads better [13]. Further, the systems based on Kubernetes indicate such benefits as still shorter response time to incidents and fewer security incidents, according to the results of modern 개발 and security activity in the context of container orchestration. Concerning the use case of the large-scale FinTech application of Kubernetes multi-tenancy and the comparison of these results to a conventional application setup, the benefits of Kubernetes are evident in terms of speed, effective resource use, and security.

Industry analysis

Implications for FinTech Industry

The recently observed trends related to the use of Kubernetes multi-tenancy architectures in manage can greatly influence the FinTech industry. Firstly, it improves the measure of scalability and resolution of resources which is very important for processing the huge amount of transactions characteristic for the financial applications. Since Kubernetes allows dynamic resource allocation, and isolates different environments of different tenants, it results in more reliable and fast responding systems [16]. This scalability directly results in optimized performance and usability for the final client, which serves as a great advantage since the FinTech market is rather constantly evolving and competitive. Kubernetes has solid security mechanisms which meet the regulatory standards of the FinTech industry. This is because through the adoption of fine grained network policies, RBAC, and a good secrets management system Kubernetes afford proper protection to sensitive financial data to prevent some forms of breaches. This is in line with the requirements of regulation like GDPR and PCI DSS making it easier to say compliant and avoid fines.

Limitations and Potential Improvements

However, Kubernetes multi-tenancy architecture has certain disadvantages as it will be illustrated in the next section. However, as much as there are all these advantages there is one disadvantage that is the level of configuration and management which is relatively high. Specifically, when it comes to multi-tenancy and given the specifics of Kubernetes resource management, certain operational problems may occur [15]. This is to make the management and maintenance of such a system to require competent human resource and appropriate tools.

In this case, another disadvantage is that all the tenants are likely to share some of the resources, thereby leading to conflict. Unluckily, Kubernetes has ways of isolation; however, when designed wrongfully, one may encounter scenarios, where particular tenant's demands have adverse impact not only on the other tenants, but on the system performance in general. It is an issue that needs to be well planned for and closely monitored because should resources be poorly distributed, performance is likely to decline. The open areas that can be enhanced are if more efficient tools for dealing with multiple tenancy in Kubernetes have to be developed or if more intuitive interfaces for security policies or resource management have to be created [17]. In addition, integrating the AI and machine learning algorithms to implement could help in the prediction of the resources that could be needed and improve on the allocation stage to reduce contention and raise the efficiency.

Future Research Directions

- **Advanced Security Measures:** Looking for new strategies and frames that could help in the development of security instruments in order to protect the financial information. This involves issues such as the history of the encryption methods applied, technology in the identification of the anomaly and technology in the formulation of the response to the threat.
- **Improved Resource Management:** They included issues concerning the use of the facilities and the lack of conflict especially where there are several occupants. It may contain the development of very complicated equations for scaling with reference to the future trends and changes of resources in accordance with the new information.
- **Integration with Emerging Technologies:** Illustrating how the Kubernetes can be used with the directions like blockchain or edge computing to solve some of the tasks of the FinTech segment [18]. For example, blockchain can mitigate problems of the open environment in data legitimacy and availability; on the other hand, edge computing can offer real-time computation for highly dynamic trading services.
- **Usability Enhancements:** Understanding how Kubernetes in general can be managed and in a way it is slightly easier especially when in a multi-tenant application. Within this, it entails developing friendly users' tools and interfaces that facilitate the deployment and management tasks.
- **Regulatory Compliance Innovations:** Understanding the areas in which Kubernetes requires pre-update and post-update changes and modifications with regards to new requirements and compliance in FinTech. This also implies identifying the measures and policies that will be useful in the compliance process that was stated to be on going.

Conclusion

Kubernetes multi-tenancy architecture is an innovative approach to managing the FinTech industry's application, which requires scalability, security, and cost reduction. This architecture is better than the traditional VM-based solutions because it enables the FinTech organizations to handle both, large number of transactions and complex applications. Due to the provision of dynamic scaling and efficient isolation sub-systems, Kubernetes enable the financial services to run most efficiently while at the same time reducing operating expenses. Policies, RBAC, and secrets management strengthen the protection of the network and data, and all these measures are vital for a FinTech company to attain the high compliance standards.

Comparing Kubernetes to other conventional approaches makes it clear that Kubernetes is an effective approach to scaling and resource utilization; therefore, Kubernetes's applicability to modern finance applications. Kubernetes configuration is relatively intricate, and resource competition is still an issue and requires improvements and professional handling. The future work should focus on the enhancement of the security approach, the better usage of the resources, and the study of the interaction with the advanced technologies for enhancing the architecture efficiency.

Reference list

Journals

1. Elhemali, M., Gallagher, N., Tang, B., Gordon, N., Huang, H., Chen, H., Idziorek, J., Wang, M., Krog, R., Zhu, Z. and Lazier, C., 2022. Amazon {DynamoDB}: A scalable, predictably performant, and fully managed {NoSQL} database service. In 2022 USENIX Annual Technical Conference (USENIX ATC 22) (pp. 1037-1048).

2. Zeb, S., Mahmood, A., Khowaja, S.A., Dev, K., Hassan, S.A., Qureshi, N.M.F., Gidlund, M. and Bellavista, P., 2022. Industry 5.0 is coming: A survey on intelligent nextG wireless networks as technological enablers. arXiv preprint arXiv:2205.09084.
3. Madi, T. and Esteves-Verissimo, P., 2022, September. A fault and intrusion tolerance framework for containerized environments: A specification-based error detection approach. In 2022 International Workshop on Secure and Reliable Microservices and Containers (SRMC) (pp. 1-8). IEEE.
4. Iosup, A., Kuipers, F., Varbanescu, A.L., Grosso, P., Trivedi, A., Rellermeyer, J., Wang, L., Uta, A. and Regazzoni, F., 2022. Future Computer Systems and Networking Research in the Netherlands: A Manifesto. arXiv preprint arXiv:2206.03259.
5. Aldinucci, M., Atienza, D., Bolelli, F., Caballero, M., Colonnelli, I., Flich, J., Gómez, J.A., González, D., Grana, C., Grangetto, M. and Leo, S., 2022. The DeepHealth Toolkit: A Key European Free and Open-Source Software for Deep Learning and Computer Vision Ready to Exploit Heterogeneous HPC and Cloud Architectures. In Technologies and Applications for Big Data Value (pp. 183-202). Cham: Springer International Publishing.
6. Chowdhury, K., 2022. Author's declaration of originality.
7. Quinn, B., 2022. Teaching Open Science Analytics in the Age of Financial Technology. QMS Research Paper, 1.
8. Nguyen, V.L., Lin, P.C., Cheng, B.C., Hwang, R.H. and Lin, Y.D., 2021. Security and privacy for 6G: A survey on prospective technologies and challenges. IEEE Communications Surveys & Tutorials, 23(4), pp.2384-2428.
9. Dunie, R., Schulte, W.R., Cantara, M. and Kerremans, M., 2015. Magic Quadrant for intelligent business process management suites. Gartner Inc.
10. Lisdorf, A., 2021. Cloud Computing Basics. Cloud Computing Basics. Apress. https://doi. org/10.1007/978-1-4842-6921-3.
11. Abell, T., Husar, A. and May-Ann, L., 2021. Cloud Computing as a Key Enabler for Digital Government Across Asia and the Pacific.
12. Meng, T.Y. and Wei, N.L.Z., 2021. Cloud Computing Review: Technology and Applications.
13. Albastaki, Y.A., Razzaque, A. and Sarea, A.M. eds., 2020. Innovative strategies for implementing FinTech in banking. IGI Global.
14. Hoeseb, C.H. and Tanner, M., 2020, December. Large-scale agile implementation in large financial institutions: A systematic literature review. In 2020 International Conference on Computational Science and Computational Intelligence (CSCI) (pp. 1780-1786). IEEE.
15. Coetzee, J., 2018. Strategic implications of Fintech on South African retail banks. South African Journal of Economic and Management Sciences, 21(1), pp.1-11.
16. Yang, H., 2017. The UK's Fintech industry support policies and its implications. KIEP Research Paper, World Economy Brief, pp.17-05.
17. Zhao, Q., Tsai, P.H. and Wang, J.L., 2019. Improving financial service innovation strategies for enhancing china's banking industry competitive advantage during the fintech revolution: A Hybrid MCDM model. Sustainability, 11(5), p.1419.
18. Nguyen, D.D., Dinh, H.C. and Nguyen, D.V., 2020. Promotion of fintech application for the modernization of banking-finance system in Vietnam. The Journal of Asian Finance, Economics and Business, 7(6), pp.127-131.