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# Multi-Cloud DevOps Adoption - Tools and Techniques

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**Abstract:** We belong to a world that rapidly upgrades itself in terms of innovation and technology. Organizations have to keep up with the changing times and thereby started using agile and lean development techniques in their operations for increased process pace and quality. The umbrella term used to describe the portmanteau of development and operation is called DevOps. In this paper we shall delve into the various Multi-cloud adoption tools and techniques. We initially summarized the results of a Systematic Literature Review to explore the advantages of DevOps. Then we described the results of an exploratory survey based study involving eight devops tools and how they contribute to various technologies in the organization. We observed Multi-Cloud DevOps adoption is accepted all over the world as it posed very few challenges against the wide array of services it offers.

**Keywords:** Multicloud, DevOps, Tools, Techniques, Adoption

## I. INTRODUCTION

It was observed that various lines of business (LOBs) needed certain specific types of support that IT couldn't provide as its budget was entirely utilized in running everyday operations. The main areas in an organization included sales force automation, CRM, human resources, marketing automation, and supply chain management services. In order to upgrade the systems ad hoc outsourcing accelerated to an extent where it would not be known by the enterprise. LOBs were the first to drive the business into a multi-cloud environment. Soon after IT organizations also began implementing multi-cloud infrastructure.[13] To improve software development and testing the coupled compute and storage services from infrastructure-as-a-service (IaaS) providers and simultaneously explored PaaS offerings from early public cloud services.

## II. THEORY OF RESEARCH

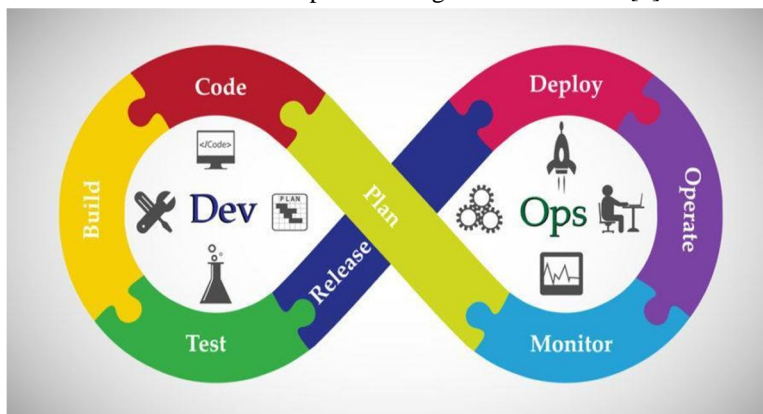
In order to achieve the best execution in every workload venue, the exploration and comparison of various cloud services in terms of pricing and performance.[8] This led to the adoption of multi-cloud configurations as it ensured the workloads were migrated to its best venue for execution and at an appropriate price.[11]

## III. METHODOLOGY

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- 1) Study the various DevOps tools and technologies.
- 2) Map the results through an online survey conducted.

The various DevOps technologies are as follows[1]:



*A. Continuous Delivery*

The built artifacts are made deployment ready with the due consent of a the human.

Popular tools : TravisCI, Atlassian Bamboo

*B. Continuous Integration*

The laborious workflows are seamlessly automated. This helps developer save time and reduces human error.

Popular tools used: Jenkins, CircleCI

*C. Communication and Collaboration*

Communication allows teams to make rapid changes to an application through real-time feedback while keeping a stable and robust environment. [4]On the other hand Collaboration which brings together Development and Operations teams, Popular tools: Slack and Basecamp

*D. Infrastructure As A Code*

It is the management of infrastructure (networks, virtual machines, load balancers, and connection topology) in a descriptive model. [7]It evolved to solve the problem of environmental shift in the release pipeline.

Popular tools: Ansible and JuJu

*E. Microservices*

They can be conceptualized as a newer way to create corporate applications. They involve the breaking down of applications into smaller, independent services independent upon a specific coding language.[3] The development teams use the language tools they are most comfortable with and achieve synergy in the process of application development

Popular tools: Swarm and Kubernetes

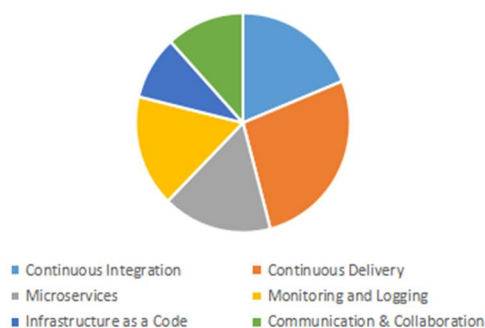
*F. Monitoring and Logging*

This forms a crucial part in a project.[6] There is a need for increased awareness at every stage in the delivery pipeline.

Monitoring targets fall into the following primary categories namely application log output, server health development milestones, vulnerabilities, deployments and user activity

Popular tools: Prometheus and Logstash

According to the survey



**Analysis**

The most adopted DevOps practice is Continuous Delivery at 27.05%.

Closely followed at 18.82 we have the continuous integration as a service.

Following suit is microservices and monitoring at 16.47%. The task breakdown and monitoring and logging aid in the improved performance of an organization.

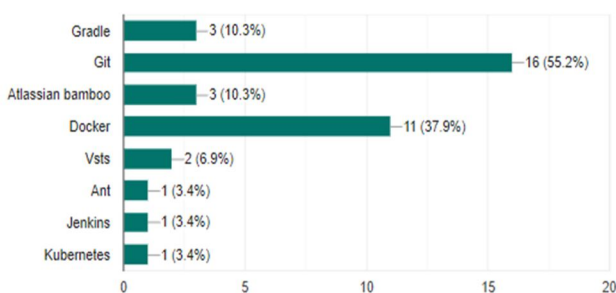
At 11.76% we have communication and collaboration which plays a key role in an organization

IaC at 9.41% follows next focusing on the management of all infrastructure

These are the following DevOps tools that we have decided to study.[10]

TOOL	FEATURES	PRICING
GRADLE	<ul style="list-style-type: none"> <li>Rich API</li> <li>Mature ecosystem of plugins</li> <li>Fast delivery due to the lightning fast builds</li> <li>A build tool that accelerates the developer's productivity</li> </ul>	FREE
GIT	<ul style="list-style-type: none"> <li>Allows tracking of the development work</li> <li>Allows experimentation as the users can fork and merge as per convenience</li> <li>Different versions of the source can be saved and reviewed.</li> <li>A distributed source code management tool(SCM)</li> </ul>	FREE for basic version \$7 per month for unlimited personal repository creation on GitHub \$9 per month Organizational account on GitHub
ATLASSIAN BAMBOO	<ul style="list-style-type: none"> <li>Intuitive UI</li> <li>Pre-defined functionalities</li> <li>Easy integration with Jira and Bitbucket</li> <li>Tool that allows automation of the delivery pipeline - from the build to the deployment</li> </ul>	\$10 - Basic version  \$880 for full version
DOCKER	<ul style="list-style-type: none"> <li>Works with any stack</li> <li>Isolates apps in containers for enhanced security</li> <li>Package dependencies with the app to make it portable</li> <li>Used to build, ship, and run distributed applications anywhere,</li> </ul>	Community Edition: FREE Enterprise Edition \$750 - \$2000 per year \$2,000/year
AZURE VSTS	<ul style="list-style-type: none"> <li>Automatic builds to test code</li> <li>Easy integration with Microsoft Azure</li> <li>Allows organized planning through the Boards section</li> <li>Simplifies software development</li> </ul>	FREE - Open source and small projects(5 users)  \$30-\$6150 - larger teams
ANT	<ul style="list-style-type: none"> <li>Flexible</li> <li>Can pilot any kind of software explained as tasks and targets</li> <li>Number of built in tasks for compiling, assembling and testing</li> <li>Used as a build automation tool</li> </ul>	FREE
JENKINS	<ul style="list-style-type: none"> <li>Multi-platform</li> <li>Numerous Plugins</li> <li>Easy Configuration</li> <li>Used for monitoring execution of repeated jobs</li> </ul>	FREE
KUBERNETES	<ul style="list-style-type: none"> <li>Portable cloud platform</li> <li>Microservice platform</li> <li>Flexible</li> <li>Used for managing containerized workloads</li> </ul>	\$2880 - hosting on AWS and Azure \$1648 - hosting on GCP

According to the survey



**Analysis**

It is evident that Git is preferred by maximum number of users (55.2%) due to its source code management facility where the users can closely track the progress of their work

We find that 37.9 % opted for Docker due to its enhanced security and portability

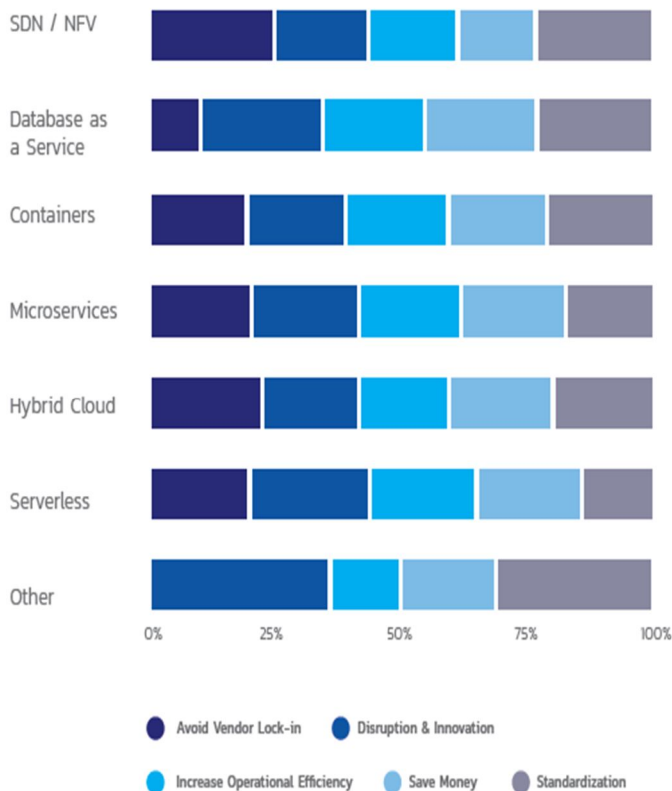
Gradle and Bamboo follow suit with 10.3%. Both have a wide variety of features. However, the high pricing for Bamboo poses a challenge.

Vsts (6.9%) is used organized planning feature and the integration with the reputed tech giant Microsoft

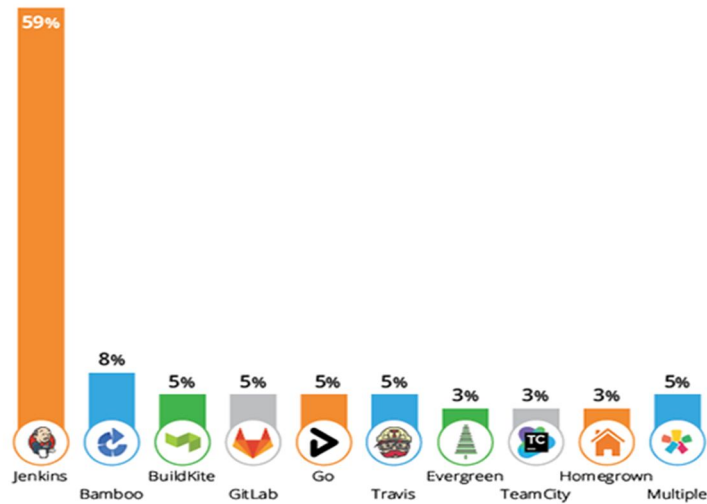
Ant, Jenkins and Kubernetes closely follow with a 3.4%. They offer Build Automation, Configuration Management and Microservices

**IV. ADOPTION IN THE INTERNATIONAL MARKET**

The Business drivers correlated with various enterprises are as follows:



The avoiding of vendor lock-in and standardization are both important factors when assessing which emerging enterprise ops technologies are of interest.[5] It has been observed that DBaaS is the only emerging technology where these drivers are less of a concern, as they have been standardized.[12]



In accordance with the survey in the US market by Apple, the following statistics were obtained pertaining to the different DevOps tools used:

Jenkins tops the list at 59% due to its free pricing and open source feature

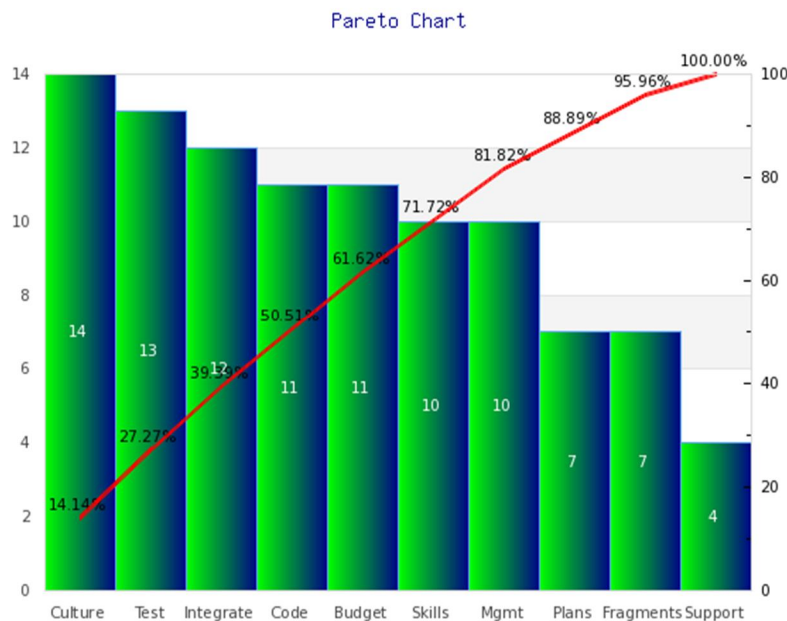
Bamboo is second with 8%

BuildKite, Git, Go, Travis and Multiple at 5%

Evergreen, TeamCity, and Homegrown at 3%

### V. CHALLENGES FACED

DevOps is still emerging and not completely accepted by all due to some cons. Overcoming these issues will subsequently increase its Adoption [16]



#### A. Analysis

It is observed that 80 % of the problems are caused by more than 20% of the causes.

Culture, Test Automation, Integration, Complexity of Code, Budget, Skillset and Management are found to be the causes Awareness, organized scheduling planning and continuous improvement of skills can help alleviate these problems.

## VI. OVERALL FINDINGS

The survey also investigated how IT looks at cloud application management and solutions in that category. Two key points came up. DevOps practitioners have yet to see cloud application management as a category separate from configuration management and cloud provider services. [10]One reason for that is because cloud infrastructure providers have been continuing to invest in capabilities that enable management of workloads and applications that sit further up the stack.



Performance and storage scoring the highest user rating at 25 % followed by 23% of availability. With the usage of a hybrid model new and innovative public cloud features are obtained. Security accounts for 16% of the chart. One of the most attractive features of a cloud-phone for large and small businesses is its scalability and it accounts for 18% of the chart making it quite desirable.



## VII. RECOMMENDATIONS

We see a plethora of services offered through Multi-Cloud DevOps Adoption [16].It serves as a solution to various fields such as Construction, Electronics and Communication, Agriculture, Nanotechnology, Bioengineering etc.

The little challenges can be overcome by focusing on the following:

- Increasing the code throughput metrics
- Increasing the code and change deployment velocity
- Reducing the marketing time for new products and services.
- Quickening the mean time to recovery (MTTR)
- Improving the reliability metrics
- Enhancing the collaboration and productivity.
- Eliminating the work in progress and technical debt.
- Enhancing the overall platform and tool chain

## VIII. CONCLUSION

DevOps seeks to create a culture of collaboration and an “IT value stream” by combining trusted principles and practices ranging from physical manufacturing to software [15]development with a goal to bring software development, quality assurance (QA), IT operations ,information security (InfoSec) under a strategic business asset.

Continuous Delivery is most sought after DevOps practice.

We also concluded that GIT is the most used DevOps tool in the Indian market and Jenkins in the US Market.

More awareness about the DevOps features will facilitate in the collaboration of tech-enthusiasts. This will lead to the transition of technology to a whole new level.

## IX. ACKNOWLEDGEMENTS

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