Optimizing DevOps Pipelines: Cost-Efficient Automation with Python

Comprehensive Project Report

Submitted in Partial Fulfillment of the
Requirements for the Degree of

BACHELOR OF TECHNOLOGY

IN

INFORMATION AND COMMUNICATION TECHNOLOGY

By
Vishwkumar Hiteshbhai Patel
(21BIT231)

Under the Guidance of
Dr. Gunjan Thakur

Department of Information and Communication Technology,
School of Technology, Pandit Deendayal Energy University,
Gandhinagar 382 426

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Certificate of Originality of Work

YAMA TECHNOLOGIES PVT LTD.

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14th May 2025

TO WHOMSOEVER IT MAY CONCERN

This is to certify that **Mr. Vishwkumar Hiteshbhai Patel** has been doing internship dated **06-01-2025**, designated as **DevOps and Python Intern** at our esteemed organization, **YAMA Technologies Pvt. Ltd.**, located in Ahmedabad.

He has been working diligently and performing exceptionally well in all the tasks assigned. During his internship, he has demonstrated strong technical skills, self-motivation, and a keen ability to grasp new concepts. His performance has consistently exceeded our expectations, and he has always completed his assignments and projects on time.

We wish him all the best for his upcoming career.

Yours Sincerely,

For, **YAMA Technologies Pvt. Ltd.**

Authorized signatory,
HR & Admin department.

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Certificate from the Project Supervisor

This is to certify that the Comprehensive Project Report entitled Optimizing DevOps Pipelines: Cost-Efficient Automation with Python Pipelining submitted by Mr. Vishwkumar Hiteshbhai Patel, Roll No. 21BIT231, towards the partial fulfilment of the requirements for the award of the degree in Bachelor of Technology in the field of Information and Communication Technology from the School of Technology, Pandit Deendayal Energy University, Gandhinagar, is the record of work carried out by him under our supervision and guidance.

The work submitted by the student has, in our opinion, reached a level required for being accepted for examination. The results embodied in this Comprehensive project work, to the best of our knowledge, have not been submitted to any other University or Institution for the award of any degree or diploma.

Dr. Gunjan Thakur (Supervisor, PDEU)	Mr. Chiraj Patel (IT Head, Yama Tech Pvt. Ltd.)
Dr. Paawan Sharma (HoD, PDEU)	Prof. Dhaval Pujara (Director SoT, PDEU)

Place: Gandhinagar

Date: 20/5/2025

Acknowledgement

Traveling somewhere is easier when done together! Interdependence is greater than independence! This project is the outcome of a team effort and ongoing support from individuals who were there for me all along this process. I am happy to have this chance to formally acknowledge my gratitude to all who participated in this project.

First of all, I sincerely thank Yama Technology Pvt. Ltd for allowing me to receive hands-on training with them. It has been an incredible learning opportunity adding great value to my technical and professional development.

I offer sincere gratitude to my training mentor Mr. Chiraj Sir (Industry Mentor) for his support and consistent guidance, encouragement and helpful feedback during the training period. I would also like to thank Mr. Sanket Joshi Sir (HOD) for his support and considered supervision that helped me navigate various challenges during my journey.

I also appreciate Prof Dhaval Pujara, Director, School of Technology, Dr. Paawan Sharma, HoD, ICT Department and Dr. Gunjan Thakur, Assistant Professor, ICT Department, PDEU for their support and providing a bridge between academic knowledge and industry experience.

I also thank all the teaching and non-teaching staff for their inspiration and support in overcoming challenges during the implementation.

Vishwkumar Hiteshbhai Patel

Abstract

The rapid growth of cloud computing along with DevOps practices has transformed software development processes by allowing for scalable and on-demand resource utilization and continuous deployment capabilities. However, the trade-off for being more agile in the software development process has resulted in sub-optimal resource utilization, over provisioning of resources and increasing costs of clear operational inefficiencies. These operational inefficiencies in cloud resources are particularly evident in the dynamic and ever-changing workflows within DevOps pipelines. The traditional cloud cost management strategies-using manual audits or generic monitoring styles or recommendations that are only applicable to a specific cloud provider-just do not work for a changing system involving ephemeral workloads, containerized environments, hybrid-cloud platforms and pipelines that intend to be automated. This project describes Optimal Cloud Resource Provisioning (OCRP), a systematic approach to automate cost savings in AWS and Azure cloud environments using Infrastructure-as-code (IaC), real-time analytic modelling and intelligent resource orchestration for cloud-provide-agnostic orchestration capabilities.

The OCRP framework employs a multi-layered model to address priority challenges in regard to the management of cloud resources. For AWS, we use EC2 (Elastic Compute Cloud), RDS (Relational Database Service), S3 (Simple Storage Service), and EKS (Elastic Kubernetes Service), coupled with the use of AWS CloudFormation and boto3 for programmatic resource discovery and analysis. For Azure, we use Virtual Machines, Azure SQL Database, Blob Storage, and AKS (Azure Kubernetes Service), managed with the use of Azure Resource Manager (ARM) templates. A crucial component of the methodology is Infrastructure-as-Code (IaC), which we implement using Terraform and Ansible, that facilitates maintainable, reproducible, and version-controlled provisioning that also satisfies security and compliance policy. Along with provisioning we also use rightsizing algorithms to rightsized compute (EC2/VM) instances and Kubernetes pod resource requests, automated scaling policies to allocate capacity with workload needs, and cost models of reserved instances, pricing, and serverless.

To pull together the storage aspect, OCRP uses log management pipelines that compress Jenkins artifacts, applies intelligent tiering (S3/Blob Storage), and applies retention policies which reduce storage costs by up to 30%. Some efficiency enhancements through increased security reviews analyze for overly permissive rules in Security Groups (AWS) and in Network Security Groups (Azure) so that both risk reduction and cost reduction can be shown. Log analysis is parallel processed with ThreadPoolExecutor in Python, and we also always visualize through real-time monitoring using Prometheus and CloudWatch so teams can analyze exactly how many resources they are using.

Implementation findings have shown success in overall operational efficiency. For example, OCRP tool in AWS reduced the monthly cost from $78.26 to $47.79 bringing savings of 38.93%, while optimization in Azure brought costs down from $72.03 to $42.60 saving 40.86% on original monthly cost. Overall, the successful results demonstrate OCRP maintains an appropriate balance on xi, while also identifying coding issues for greater efficiency and continued value. It provides research that combines accounting principles with legitimate engineering efficiency, enhancing clarity and understanding around automated, context aware provisioning for more sustainable cloud-native development practices. Future work opens the opportunity to extend OCRP to work with machine learning for predictive scale as well as expanding capabilities to support hybrid cloud architectures that will ultimately close the gap between operational agility with the underlying cost of doing business throughout the full DevOps cycle.

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NOMENCLATURE

Abbreviations

AWS	Amazon Web Services
DevOps	Development and Operations
CI/CD	Continuous Integration/Continuous Deployment
CLI	Command Line Interface
SQL	Structured Query Language
AKS	Azure Kubernetes Service
EKS	Amazon Elastic Kubernetes Service
SDK	Software Development Kit
API	Application Programming Interface
NAT	Network Address Translation
NSG	Network Security Group
EC2	Elastic Cloud Compute
S3	Simple Storage Service
RDS	Relational Database Service
CPU	Central Processing Unit
NP-Hard	Non-deterministic Polynomial-time Hardness
SaaS	Software as a Service
PaaS	Platform as a Service
IaaS	Infrastructure as a Service
ML	Machine Learning
RL	Reinforcement Learning
OCRP	Optimal Cloud Resources Provisioning