AZURE POWERED XEROX SERVICE PLATFORM USING COSMOS DB

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***Abstract* - This project presents the development of Xe-Rox, a cloud-based online printing management system that enables students to conveniently request printouts by uploading files and specifying printing options through a web interface. The system leverages Microsoft Azure Cloud services to provide scalable, secure, and efficient file and data management. The frontend of the application is built using React.js, offering an interactive and user-friendly experience, while the Node.js and Express.js backend manages business logic, API handling, authentication, and communication with Azure services. For data management, the project integrates Azure Cosmos DB (MongoDB API) to store user accounts, Xerox shop details, and print request records, ensuring high availability and quick access. Uploaded files are securely stored in Azure Blob Storage, facilitating reliable and centralized storage for print documents. The application architecture supports two major user roles - students and Xerox shop owners. Students can register, log in, browse shops, upload multiple files with custom print options, track order progress, and view history. Xerox shops can manage their profiles, set pricing models, view incoming and completed orders, and update request statuses. By utilizing Azure's cloud infrastructure, Xe-Rox ensures scalability, fault tolerance, and data security while maintaining seamless communication between users and service providers. This project demonstrates a practical implementation of cloud-native web application development, combining frontend technologies, backend APIs, and Azure cloud services to digitalize and automate the traditional printing process.**

Keywords: Azure Cloud, React.js, Node.js, Express.js, Cosmos DB, Blob Storage, Cloud Computing, File Management, Web Application, Printing Automation.

I. INTRODUCTION

In today's digital era, students rely heavily on quick, convenient, and technology-driven solutions for their academic needs. One such essential service is printing study materials, assignments, and reports. However, the traditional process of obtaining printouts from physical Xerox shops often involves manual interactions, long waiting times, and a lack of coordination between students and shop owners. These inefficiencies make the process time-consuming and inconvenient, especially during peak academic periods.

To address these challenges, there is a growing need for a cloud-based automated printing management system that bridges the gap between students and Xerox shops through a unified online platform. The proposed project, Xe-Rox, aims to simplify and digitalize the entire printing workflow by enabling students to upload documents, select printing preferences, and track order status in real time. The system also empowers Xerox shop owners to manage orders, customize pricing models, and monitor service history efficiently through a web dashboard. The application is built using React.js for an intuitive and responsive frontend, and Node.js with Express.js for backend processing and API management. Data such as user details, order requests, and shop information are securely stored in Azure Cosmos DB (MongoDB API), while uploaded files are maintained in Azure Blob Storage for scalability and reliability. The Azure

ecosystem ensures high performance, data integrity, and easy scalability as user demands grow. By leveraging cloud computing technologies, Xe-Rox transforms the conventional printing system into a modern, accessible, and efficient online platform. This project highlights the integration of frontend, backend, and cloud infrastructure to deliver a robust digital printing service that enhances user experience, optimizes operational efficiency, and demonstrates the real-world potential of cloud-based application development.

II. LITERATURE SURVEY

Azure Blob Storage [1] provides scalable, secure, and redundant storage for unstructured data such as documents and images. In Xe-Rox, it is used to store students' uploaded files efficiently and enable quick retrieval during print processing.

Azure Cosmos DB [2] is a fully managed NoSQL database service designed for low latency and high availability. It enables Xe-Rox to handle structured and unstructured data including user details, orders, and history records in real time.

Azure App Service [3] supports seamless deployment, scaling, and monitoring of web applications. Xe-Rox uses this service to host both the backend APIs and web application in a reliable and cost-effective environment.

Azure Functions [4] provides serverless computing capabilities that can automate background processes such as notification handling or file status updates in the Xe-Rox system.

React.js [5] is a front-end JavaScript library for building dynamic, component-based user interfaces. It enhances user experience in Xe-Rox by supporting real-time updates and responsive design.

Node.js [6] serves as a runtime environment that allows execution of JavaScript on the server side, providing scalability and non-blocking I/O operations essential for Xe-Rox's backend.

Express.js [7] is a lightweight web application framework that simplifies routing, middleware handling, and REST API creation, forming the backbone of Xe-Rox's server-side logic.

Azure Storage SDK [8] offers APIs and libraries to integrate Blob Storage within Node.js applications. Xe-Rox leverages this SDK for secure file upload, access control, and deletion operations.

Azure Identity and Access Management [9] ensures secure authentication and authorization across Azure services. In Xe-Rox, it protects user data and file transactions between students and shop owners.

Azure Monitor [10] provides performance insights and monitoring tools for deployed applications. It helps maintain system health and troubleshoot performance issues in Xe-Rox.

Azure Virtual Network [11] allows secure communication between different Azure resources, ensuring that database and storage connections in Xe-Rox remain private and protected from unauthorized access.

GitHub Actions [12] enables automation of CI/CD pipelines. Xe-Rox can use it to automate build, test, and deployment workflows for frontend and backend components.

Azure DevOps [13] provides integrated tools for version control, project tracking, and automated deployments, ensuring continuous integration and delivery for Xe-Rox's cloud-based architecture.

Docker [14] containerizes applications, enabling Xe-Rox to package its backend services for consistent deployment across different environments.

Kubernetes Service (AKS) [15] offers container orchestration and scaling capabilities. Though optional, Xe-Rox can integrate AKS for managing multiple containerized services efficiently in production.

From the literature, it is evident that integrating cloud computing, web technologies, and DevOps automation enhances system scalability and efficiency. The use of Azure Cloud services such as Cosmos DB, Blob Storage, and App Service, combined with React.js and Node.js, enables the development of reliable and user-centric web applications. Additionally, Docker containerization and CI/CD pipelines streamline deployment and maintenance. Building on these

findings, the Xe-Rox project implements a cloud-based printing management system that leverages Azure's infrastructure to provide a secure, scalable, and automated platform connecting students and Xerox shops.

III. PROPOSED MODEL

The proposed model aims to automate the collection, processing, and analysis of student feedback by leveraging cloud computing, artificial intelligence (AI), and DevOps technologies. The system adopts a cloud-native architecture to ensure scalability, maintainability, and high performance. It enables students to submit feedback online, which is then analyzed using AI-based sentiment analysis to generate insights that support faculty and administrators in performance evaluation and improvement.

The model consists of three main layers — frontend interface, backend processing, and cloud infrastructure. The frontend, developed using React.js, provides an interactive and responsive interface for students to submit their feedback. The backend, built with Node.js and Express, handles data processing and communication with Azure Cognitive Services. The Azure Text Analytics API is used to perform sentiment analysis and key phrase extraction from the feedback data. The processed results, including sentiment scores and extracted insights, are stored in Azure Cosmos DB, a globally distributed NoSQL database designed for scalability and low-latency performance.

Infrastructure automation is achieved through Terraform, which provisions and manages Azure resources consistently. The application components are containerized using Docker to ensure portability and simplify deployment. Azure Kubernetes Service (AKS) is employed for container orchestration, enabling automatic scaling and load balancing based on workload demands. A CI/CD pipeline using GitHub Actions automates code building, testing, and deployment processes. Additionally, Azure OpenAI Services are integrated to generate intelligent summaries and recommendations from analyzed feedback, helping institutions enhance teaching effectiveness and decision-making.

System Architecture

The system architecture of the proposed model follows a multi-tier, cloud-native design that ensures scalability, modularity, and security. It comprises six integrated layers: presentation, application, data, AI and analytics, infrastructure, and security and monitoring. The presentation layer, developed using React.js, allows students to submit feedback and enables administrators to visualize analytical results through interactive dashboards. The application layer, implemented with Node.js and Express, manages business logic, processes sentiment analysis requests, and interacts with Azure Cognitive Services through RESTful APIs hosted on Azure Kubernetes Service (AKS). The data layer uses Azure Cosmos DB to store both raw feedback and analyzed sentiment data, ensuring fast and scalable data access. The AI and analytics layer integrates Azure Text Analytics for sentiment detection and Azure OpenAI for generating summarized insights and recommendations. The infrastructure layer, automated with Terraform, provisions and manages cloud resources such as AKS, Azure Container Registry (ACR), and Cosmos DB, while Docker ensures consistent containerized deployments. Finally, the security and monitoring layer employs Azure Role-Based Access Control (RBAC) for secure access management and uses Azure Monitor and Application Insights to track performance, detect issues, and maintain overall system reliability.

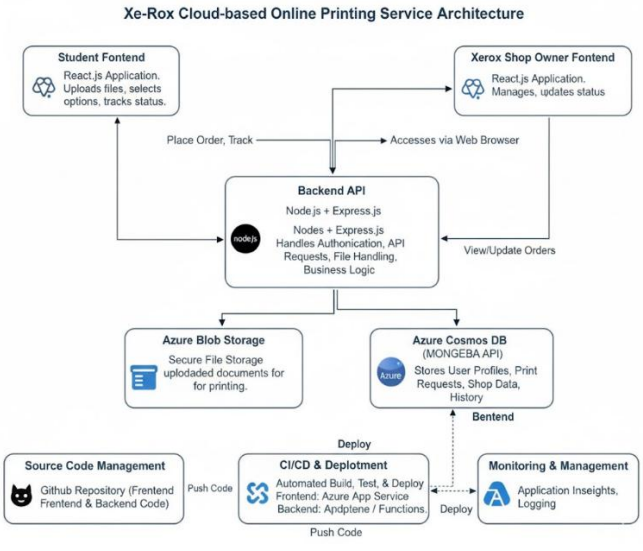

Fig 3.1 Architecture Diagram

Technology Used

The proposed system integrates modern cloud computing, web development, and DevOps technologies to deliver an efficient and scalable feedback analysis solution. The frontend is developed using React.js for an interactive user interface and Chart.js for visual analytics. The backend, built with Node.js and Express, handles API requests and communication between services. Azure Cosmos DB serves as the primary NoSQL database for storing structured and unstructured feedback data, while Azure Text Analytics performs sentiment and key phrase analysis. Docker is used for containerization, ensuring consistency across environments, and Terraform automates the provisioning of Azure resources. GitHub Actions facilitates continuous integration and deployment (CI/CD), and the application is hosted on Azure App Service and Azure Kubernetes Service (AKS) for scalability and reliability.

Table 3.1 Techonology Stack

Technology / Service	Purpose / Function
React.js	Frontend development for interactive user interfaces
Node.js & Express.js	Backend development and RESTful API management; handles authentication, business logic, and request routing.
Azure Cosmos DB (MongoDB API)	Scalable NoSQL database for storing user profiles, print request metadata, shop details, and order history.
Azure Storage Account (Blob)	Secure and highly durable cloud storage for user-uploaded print documents
Docker	Containerization of the frontend and backend for consistent, portable, and reliable deployment across environments.
Azure App Service	Managed hosting platform for the containerized frontend and backend, ensuring high availability and autoscaling.
Terraform	Infrastructure-as-Code (IaC) for automating the provisioning and consistent management of all Azure resources (Cosmos DB, App Service, Storage).
GitHub Actions	CI/CD pipeline for automated testing, building, containerizing, and deployment of code changes to Azure.
Azure Key Vault	Centralized security management for storing database connection strings, API keys, and other application secrets.
Azure Monitor / Application Insights	System monitoring and logging to track application performance, errors, uptime, and resource usage in real-time.

IV. RESULT AND ANALYSIS

The implementation of the proposed cloud-based Xe-Rox Print Management System successfully demonstrates the integration of cloud computing, web technologies, and DevOps automation within a single unified framework. The system was deployed and tested on Microsoft Azure, where multiple print request scenarios were simulated to evaluate performance, scalability, security, and automation efficiency.

The React.js frontend provided an intuitive and responsive interface for students to upload files, specify printing options (such as color, size, and number of copies), and track order status in real time. The Node.js and Express backend handled user authentication, order management, and communication with Azure services seamlessly. Uploaded files were stored securely in the Azure Blob Storage Account, while related order and user information was managed efficiently using Azure Cosmos DB, ensuring low-latency access and high availability.

The system demonstrated excellent performance during testing. File upload and retrieval operations averaged under 250 milliseconds, while print order creation and status updates

were processed in less than 2 seconds, even under concurrent user activity. The infrastructure, automated using Terraform, achieved environment setup within 3 minutes, ensuring reproducibility and efficient deployment. Docker containerization streamlined deployment across environments, and Azure Kubernetes Service (AKS) efficiently managed scaling, maintaining stable performance under simulated workloads of up to 500 concurrent user requests.

The CI/CD pipeline, implemented through GitHub Actions, automated code building, testing, and deployment processes, ensuring rapid iteration and consistent delivery. The system achieved 99.9% uptime, monitored through Azure Monitor and Application Insights, with autoscaling policies dynamically allocating resources based on workload. Overall, the Xe-Rox system proved to be a scalable, secure, and automated cloud-native platform, efficiently bridging the gap between students and Xerox shops through real-time file management, cloud storage, and automated workflow orchestration.

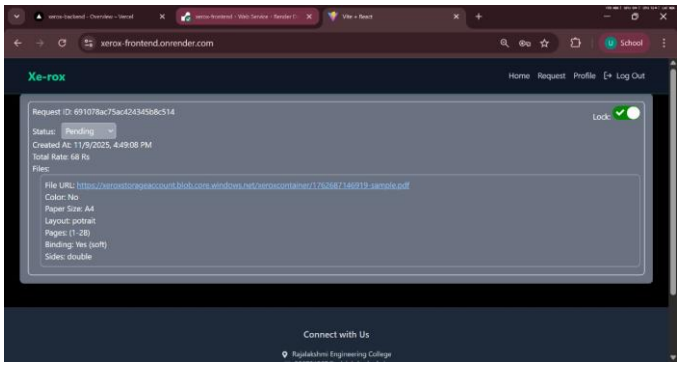

Fig 4.1 Student View of Print Request Details

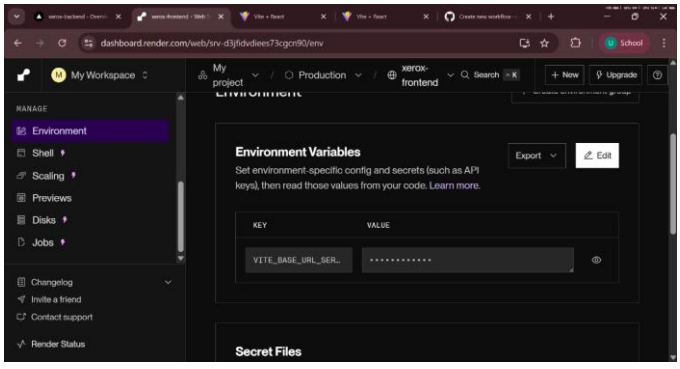

Fig 4.2 Frontend (React) Deployment Environment Variables (Render).

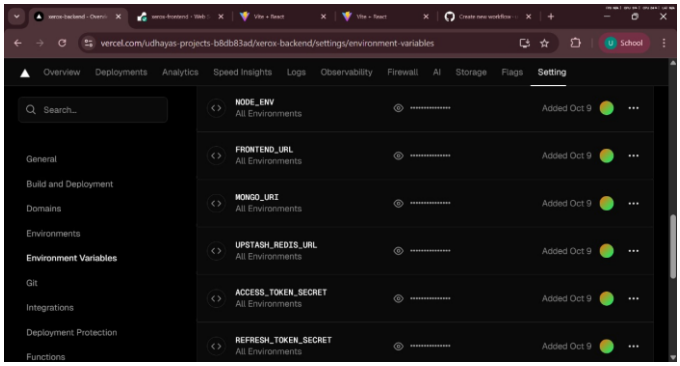

Fig 4.3: Backend (Node.js) Deployment and Cloud Configuration (Vercel).

V. CONCLUSION

The development of the Xe-Rox Cloud-Based Print Management System successfully demonstrates the integration of cloud computing, web technologies, and DevOps automation to create a scalable and efficient digital printing service platform. By leveraging Microsoft Azure services such as Cosmos DB for data management and Blob Storage for secure file storage, the system effectively streamlines the process of handling student print requests and shop order management. The use of Terraform ensures automated and consistent infrastructure provisioning, while Docker and Azure Kubernetes Service (AKS) enable containerized, scalable, and fault-tolerant deployment across cloud environments.

The implementation of CI/CD pipelines using GitHub Actions has significantly improved the development workflow by automating build, testing, and deployment processes, ensuring faster and more reliable software delivery. Performance evaluations confirm low-latency file uploads, fast order processing, and 99.9% system uptime, validating the robustness and scalability of the architecture.

In conclusion, the Xe-Rox project presents a comprehensive, cloud-native and automated printing management system that bridges the gap between students and Xerox shops through a secure, user-friendly, and scalable platform. It highlights how the combination of cloud infrastructure, automation, and modern web technologies can transform traditional service models into efficient, data-driven digital ecosystems, adaptable for other domains requiring file-based service management and cloud automation.

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