



VAASAN AMMATTIKORKEAKOULU  
UNIVERSITY OF APPLIED SCIENCES

Naimul Hassan Noor

**AFFORDABLE CLOUD EMPOWERMENT:  
REVOLUTIONIZING SMALL BUSINESS  
OPERATIONS WITH COST EFFECTIVE  
CLOUD SOLUTIONS**

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## ABSTRACT

Author	Naimul Hasan Noor
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This research problem focuses on the significant gap between the financial limitations faced by small businesses and this study can offer a change by cloud technology. Currently, the available solutions that are on the market are costly for small businesses such as start-ups. The objective of the study is to offer a cost-effective solution based on cloud computing that is specially designed to meet the distinct requirements of Small and Medium-sized Enterprises (SMEs).

The methodology employs a mixed-methods approach, utilizing surveys, interviews, and case studies, to specifically focus on addressing the technological needs of SMEs. The goal of this study is to develop an affordable, customized solution that promotes the utilization of cloud computing that SMEs can easily reach. This solution was developed with a focus on highlighting the utilization of open-source components to create a cost-effective and efficient cloud solution.

The findings of this thesis are that this study achieves its goal successfully, it minimizes the cost of the server for SMEs. As SMEs continue on their journey through the challenges of the digital landscape, this particular project contributes a really valuable and resourceful asset for organizations hoping to pursue a more cost-effective and simply sustainable trip to the cloud

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Keywords                      Affordable cloud solutions, cloud adoption, cost-effective solutions, cloud empowerment, scalability, SMEs

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**APPENDIX 1:** Comparing Current Configuration with Typical Cloud Resources for Cost and Feature.

## 1 INTRODUCTION

In a time of lightning-fast technological progress, small enterprises are confronted with balancing innovation with budgetary limitations. Integrating cloud technology can significantly improve competitiveness, scalability, and operational efficiency. The revolutionary potential of cloud technologies and the financial constraints that many small firms encounter, however, differ significantly. In the industrialized world, cloud computing is being used by businesses and governments to enhance service delivery and performance. Though the situation is dire in some developing nations, the cloud computing concept has enormous promise due to its revolutionary nature. (Adam et al., 2014). Despite being aware of the advantages of cloud computing, a lot of SMEs are afraid to adopt it as a method of handling their information due to its high cost (Alijani et al., 2014).

Historically, Cloud Computing Technology (CCT) has been distinct from other technologies because it prioritizes service delivery over technology in general. Technology components like storage, CPUs, and network working gear are more like the building blocks of the service in CCT than the actual product. The phrase "cloud computing" refers to any activity that uses the Internet to supply hosted services (Attaran & Woods, 2018). The industrial market is unable to deal with a delay of six to eight weeks for supply.; hence it is critical for SMEs to act swiftly (Dillon et al., 2010). Consequently, SMEs had to embrace a fresh approach based on technology that might boost creativity, cut costs, and expedite implementation. Massive processing power and business insights can be leveraged in this global information technology era to create a competitive advantage. (Liu & Dan, 2010). In a study by Alijani et al. (2014) shows that 55% of the SMEs agreed that cloud computing is cost-effective in addition only 34% of the small businesses indicated that cloud computing can be considered as reliable information management. Industry research and worldwide trends indicate that small enterprises have challenges when implementing cloud technologies. Small businesses' financial constraints prevent cloud computing from being widely used, despite its demonstrated

advantages, which include increased scalability, efficiency, and competitiveness. The goal of the thesis is to present a thorough analysis of small businesses' existing cloud adoption situation while highlighting the critical need for accessible and tailored solutions.

Despite seeing the potential benefits of cloud technology, small firms frequently discover that their budgetary limitations prevent them from utilizing cloud computing solutions. The extant literature underscores the obstacles encountered by small enterprises when attempting to navigate the intricate environment of cloud solutions, resulting in a critical deficiency in the efficient application of cloud technology in this industry. For this crucial sector of the economy, small businesses have unique operational and financial challenges that must be overcome to fully realize the transformative promise of cloud computing.

In recent years, the number of SMEs has been increasing rapidly but it also closing down very soon for so many reasons. Especially in portions of Latin America, Africa, and Southeast Asia, infrastructure and financial barriers frequently result in higher-level obstacles, so that SMEs cannot expand their business (Parthasarathy & Kumar, 2016; Rai, 2024). One of the many reasons is their tight budget for adopting cloud for their business. So, the purpose of this thesis is to minimize the cost of cloud technologies but This thesis also has a diverse study purpose that aims to accomplish several broad objectives.

1. To identify operational and financial barriers.
2. To examine present cloud adoption patterns.
3. Cost-effective cloud solution framework development.
4. Empirically proving the solutions.
5. To offer realistic perspectives and suggestions.

The thesis is motivated by an understanding of an important challenge addressed by many small businesses. limited financial resources that hamper the acceptance of cloud technology. The objective is to study the potential of cloud computing to

have a major effect on these enterprises by promoting innovation and productivity. This study seeks to make use of open-source tools to provide cost-efficient solutions personalized for the requirements of small businesses. Using inexpensive open-source tools and technology, this thesis aims to investigate how economical cloud empowerment may transform small business operations. This study looks at whether these tools can help SMEs satisfy their logistical requirements while cutting expenses and preserving or increasing efficiency. The desire to explore this subject is not entirely based on academic expertise but also originates from practical involvement in implementing cloud applications. The goal is to enhance the accessibility of cloud technology for small- and medium-sized businesses, enabling them to prosper in the rapidly developing digital environment.

## 2 NEEDS ANALYSIS AND DESCRIPTION OF THE PRESENT STATE

In many nations especially in third-world countries, small and medium-sized businesses (SMEs) play a significant economic role (Cajamarca-Palomo et al., 2019). According to some authors, 79% of enterprises globally are SMEs (Solano & Tobar-Pesántez, 2018). SMEs are crucial to the nation's economy because, in addition to creating jobs, they support regional economic recovery and technical advancement. Their ability mainly depends on the manager's or owner's willingness to make investments in technology, intangible goods, and adaptive development. (Cajamarca-Palomo et al., 2019). Cloud computing has been recognized by authors as one of the most significant technical advancements of the last several years. The efficiency advantage of automating routine processes through a large network that functions on demand through a collection of virtual appliances that are configured between themselves and the rapid establishing of information to any location in the world are among the many prospective advantages of these technologies. (L.F. & Assis, 2016) (Ramachandra et al., 2017). In this context, many authors note that cloud computing works via the Internet and requires payment for service usage through a subscription. Among the services it provides, the company manages three key service models: Infrastructure as a Service (IaaS), which offers traditional hosting services from a data center; Platform as a Service (PaaS), which combines IaaS with additional services; and Software as a Service (SaaS), where applications are provided by a vendor (Cajamarca-Palomo et al., 2019). Regarding the previous points, cloud computing provides many features that are prepared to satisfy business requirements. These functionalities can be applied to the company's administrative procedures, including billing, accounting, and hiring personnel, among others. (Vafamehr, 2018; Ratten & Vanessa, 2016).

In recent years, there has been a significant rise in the usage of cloud computing, as numerous organizations are enthusiastic about migrating their IT infrastructure and applications to the cloud. Based on a recent IDG survey, 92% of businesses have adopted cloud technology, and 64% of their workloads are running on the

cloud (Cognixia, 2023). The study predicts a significant 20.4% increase in global end-user expenses on public cloud services by 2024, highlighting the essential role of cloud technology. (Wallace, 2024). But for SMEs pursuing cloud could be costly. Let's go through this table that shows the approximate cost for SMEs to pursue cloud in three different providers.

Service Type	AWS	Azure	Google Cloud
Compute	\$50 - \$500+ /month (EC2 instances)	\$50 - \$500+ /month (Virtual Machines)	\$50 - \$500+ /month (Compute Engine instances)
Storage	\$20 - \$200+ /month (S3, EBS)	\$20 - \$200+ /month (Blob, Disk Storage)	\$20 - \$200+ /month (Cloud Storage)
Database	\$30 - \$300+ /month (RDS)	\$30 - \$300+ /month (SQL Databases)	\$30 - \$300+ /month (Cloud SQL)
Basic Networking	Usually included or low additional cost	Usually included or low additional cost	Usually included or low additional cost

**Table 1.** Potential Cost Range for SMEs on AWS, Azure, and Google Cloud

From this table, it's very clear that this cost for SMEs is a bit high, and it will be tough for them to afford the cloud for their business. There are some hidden fees for data transfer, migration costs, and vendor-lock-in, these things cause cost

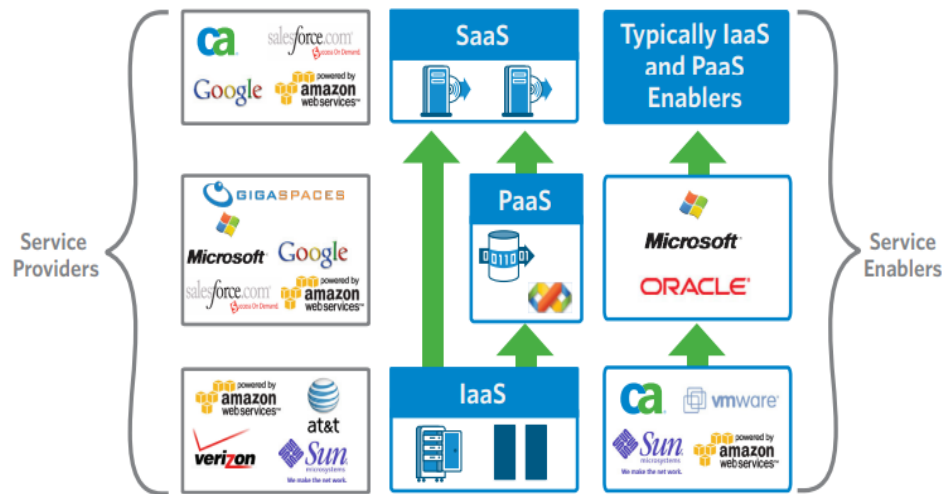
concerns for SMEs. On average, SMEs' cloud costs range from \$600,000 to \$1.2 million annually (Slingerland, 2023) and might spend between \$100-\$300 per month on cloud, with variations due to specific services (Kurkina, 2023). So, it is crucial to recognize that the cost of cloud computing is intrinsically variable and affected by the distinct characteristics of each task. This understanding encourages a more sophisticated and deliberate approach to adopting cloud technology, encouraging choices that align with a company's financial well-being and long-term viability (Rai, 2024). Considering that small and medium-sized enterprises (SMEs) can effectively implement cloud-based business intelligence (BI) systems, it is logical to expect that these solutions will enhance their competitiveness and offer a more efficient approach to managing information.

### **3 THEORETICAL BACKGROUND**

The following section explores the literature on cloud technology fundamentals and services to explore the implementation of its affordability in small and medium-sized enterprises (SMEs). This section has been structured into three distinct components. The initial section represents the introduction to cloud technology and the conceptual foundations of cloud adoption. The second section focuses on the adoption of cloud technology in SMEs and explains its various forms. This section briefly discusses the Benefits and Challenges of Cloud Computing for SMEs.

#### **3.1 Introduction to Cloud Technology**

The cloud-based system has been recognized as one of the most effective techniques in the field of information technology. The concept of cloud computing is fundamentally based on existing concepts such as virtualization, grid computing, and distributed computing. While not a recent area of research, it can be distinguished by the originality of the concept of providing computing services to everyone as a utility. This technology approach enables users to effortlessly incorporate internet connectivity into a computer resource system, allowing them to freely adjust their demands with minimal involvement from external entities. (Alam, 2020). It is important for all organizations, especially SMEs, to have a clear understanding of the fundamental features of cloud computing to effectively implement its services (Mikkonen & Imran , 2016). Both internal and external clouds form the basis for many cloud computing service models. The industry has effectively implemented three types of cloud computing service models. Infrastructure-as-a-Service (IaaS), Platform-as-a-Service (PaaS), and Software-as-a-Service (SaaS) are three types of cloud computing services ( Somashekar, 2010).



**Figure 1.** Cloud Models ( Somashekar, 2010)

In Figure 1, the service providers are those who offer cloud computing services for example AWS, Azure, and Google Cloud. As for the Service enablers, they are companies that allow the cloud to work. As for the models, their details are described below.

Software as a Service (SaaS) delivers ready-to-use software accessible via web browsers (Singh et al., 2021; Rai, 2024). It is a system of distribution in which service providers or vendors host applications and distribute them to clients as a service over the Internet. It is also known as on-demand software because solutions are licensed on a subscription basis. This computing service is highly advantageous for SMEs since it is based on the concept of "plug and go". This means that SMEs may easily obtain IT resources from public cloud or other service providers and then supply those resources to their customers ( Lawton, 2008).

PaaS, or Platform as a Service, provides a compelling solution for SMEs in the IT industry who are engaged in application development. PaaS provides SMEs with a hosted environment that allows them to utilize a web-based platform and develop apps online (Lawton, 2008). PaaS offers consumers the necessary infrastructure, including development software, hardware, and operating systems, to facilitate the development of new applications without requiring a major financial commitment. In PaaS models, the service provider is responsible for delivering and overseeing the back-end resources. Nevertheless, PaaS models encompass all the necessary software capabilities and tools required for designing applications.

Infrastructure as a Service (IaaS) is the least disruptive technological offering that SMEs adopt. SMEs can access virtualized computing infrastructure over the web by utilizing IaaS. This service is built on IT layers and servers, and it also facilitates the delivery of Software as a Service (SaaS) and Platform as a Service (PaaS) (Peng et al., 2009). IaaS is appealing since the conventional method of obtaining computer resources for running programs or storing data involves a significant investment of time and cost. Organizations are required to acquire technology through purchasing processes that can span several months. To meet their needs, they must allocate resources towards the acquisition of physical spaces, which are usually designated rooms equipped with power and cooling systems. Once the systems are deployed, IT specialists are required to oversee and sustain them.

### **3.2 Cloud Adoption by SMEs**

SMEs adopting cloud is accelerating due to the benefits of scalability, cost-effectiveness, and enhanced flexibility. Cloud computing allows SMEs to access robust IT infrastructure and cutting-edge software without the hefty upfront investments and maintenance costs associated with traditional on-premises

solutions. This pay-as-you-go model aligns expenses with usage, making cloud services particularly attractive for SMEs with fluctuating resource needs. Furthermore, cloud-based collaboration tools and remote access capabilities promote business agility and resilience (Parthasarathy & Kumar, 2016). Cloud-based solutions enable SMEs to scale their IT infrastructure easily in response to fluctuating business needs. This obviates the necessity of excessive provision facilities to accommodate peak loads, hence reducing superfluous expenditures.

The use of cloud technology is distinct from other computer technologies. It provides assistance for creating web applications that are interactive and easy for users to navigate. Individuals will possess their own unique viewpoints. Cloud computing is often seen as the utilization of virtualized computer resources for dynamic development and software deployment. Cloud computing has become crucial in the modern day, particularly in the realm of business ( Si Xue & Wee Xin, 2016). It has so many benefits, for example, it provides flexibility of the work and it mostly reduces cost; organizations can pay for what they use. It also has automatic software and hardware upgrades. A drawback, especially faced by SMEs, are costs for small organizations, sometimes their budget is exceeded. A cloud attack is also a major issue as well as data loss, and data security. This study mainly focuses on cost reduction, to provide an affordable cloud solution for SMEs.

## 4 DESCRIPTION OF THE DEVELOPMENT PROCESS

The development method for this project consists of multiple stages aimed at ensuring the effective execution of the proposed remedy. Before initiating development, the project scope, requirements, and timeframe had to be carefully anticipated. Two servers needed to be configured as part of the environment setup: one for development tools and the other for the application and database.

### 4.1 Environment Setup

Two types of servers were needed in this project. Their specifications are given below:

1. Tools Server:
  - a. CPU: 8 vCPU Cores
  - b. RAM: 24 GB
  - c. Storage: 300 GB NVME
2. Application & Database Server
  - a. CPU: 8 vCPU Cores
  - b. RAM: 24 GB
  - c. Storage: 300 GB NVME

### 4.2 Technology

Some open-source tools and applications were used to maintain project timelines for developing tool servers.

1. Jenkins was used to automate the pipeline for constant development and deployment (CI/CD).
2. Grafana was used to keep an eye on system measures along with performance data and show them visually.
3. Nexus Repo was used as a repository for objects and project requirements to store and manage them.

4. Git is a version control system that keeps track of changes to the source code.
5. Docker is a containerization platform used to set up separate environments for publishing and packaging apps and their dependencies.
6. Certbot was used to handle and set up SSL certificates.
7. Python was used in the development environment for scripting
8. Laravel Framework was used to build the application's backend system, which makes it reliable and scalable.
9. React Framework was used for building a frontend interface for interacting with users.

Following standards, coding includes writing clean, well-structured code and testing it thoroughly in both unit and integration mode to make sure the application works well and is reliable. By encapsulating the program and its dependencies into Docker images, containerization expedites the deployment process while assuring platform compatibility and consistency. While Jenkins pipelines handle the entire deployment cycle, including necessary operations like image generation, testing, and production updates, the Nexus repository is critical for managing artifacts. Error risk is reduced when configurations are effectively managed across many environments, ensuring scalability and consistent settings. Grafana dashboards provide proactive monitoring and maintenance by providing insightful real-time information on the health, performance, and resource usage of applications. This integrated strategy improves efficiency and reliability in handling contemporary apps while also simplifying deployment. Regularly deploying fixes and updates keeps the system safe and stable. The success of a project depends on people working together, talking to each other, and constantly reviewing the process to get the best results.

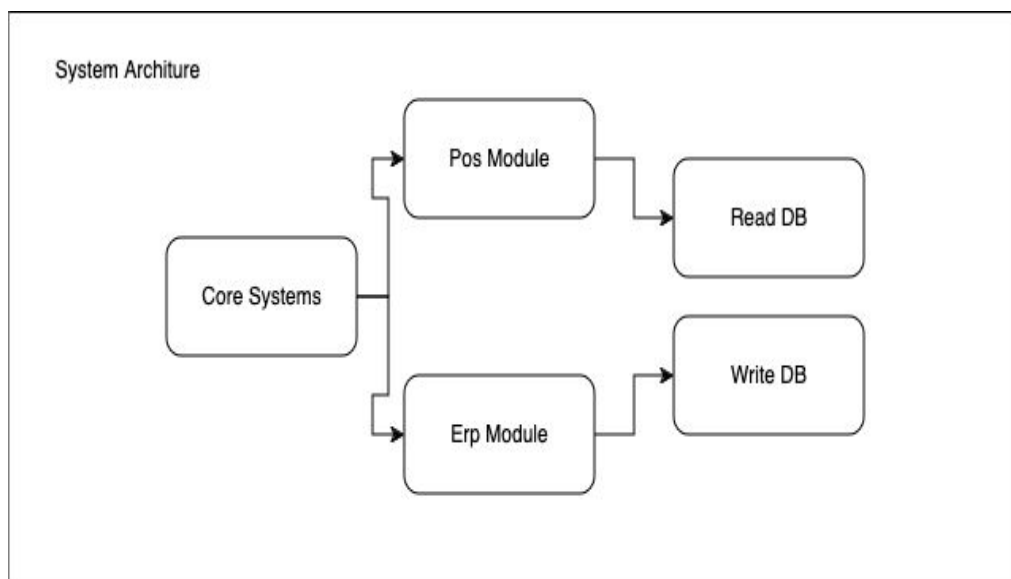
## 5 DESCRIPTION OF THE DEVELOPMENT OPERATIONS

The development operations include an organized manner of planning, setting up the environment, building the infrastructure, and deploying, which makes sure that the process runs smoothly and quickly during the project's lifecycle. After careful planning, the team looks at the technology stack and gathers a lot of needs to make sure they are in line with the project goals. This first step sets the stage for the next steps, making sure that the growth process is clear and logical.

As soon as the needs are made clear, the attention turns to preparing the environment for the application. To do this, two separate servers need to be set up. One will hold the development tools, and the other will host the program and database. The right amount of CPU cores, RAM, and storage space are set aside on each computer to meet the needs of the project. Both servers have 8 vCPU cores, 24 GB of RAM, and 300 GB of NVME storage, which ensures the best speed and scalability. Once the criteria are evident Jenkins, Nexus, Docker, Docker Compose, and Grafana are installed to establish the infrastructure. The setting up of a Git repository provides a location for the source code of the project, integrating tools for development with the Git, and automated build and deployment processes that are activated by changes in the code become likely. It contains a database, a local installation of the Laravel framework, and the code editor/IDE for coding. For a simple deployment and to assure consistency across environments, development employs Docker images. The Laravel version, PHP, database, and any other critical dependencies are encapsulated within these images.

Figure 2 shows the system architecture of this thesis, a cloud-based web application framework that is made to be reliable and scalable. The application is the main way that users connect with the system. Load Balancers make sure that user requests are sent to all of the Web Servers in a network evenly so that no one server gets too busy. These Web Servers handle the requests and often talk to a Database and Database Server to get or store data that is important to the program. For

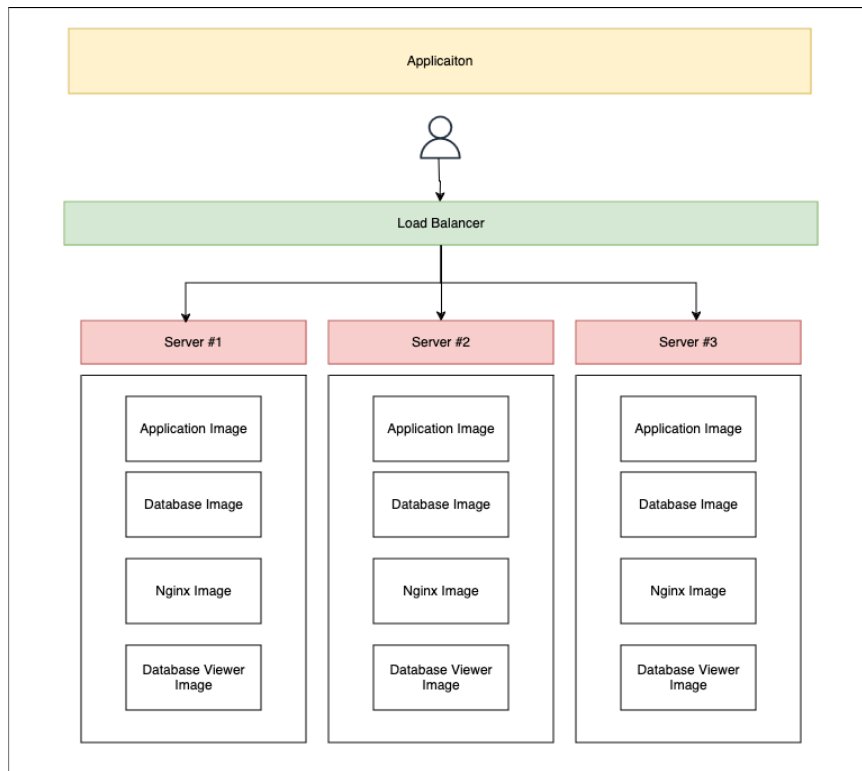
material that is not used very often, cloud storage could be used to add to this. A Security Group keeps the whole system safe by following rules that stop people who are not supposed to be there from getting in. Scalability is one of the best things about this cloud-based setup. It is easy to add more computers or storage to handle more users or shifting application demands.



**Figure 2.** System Architecture

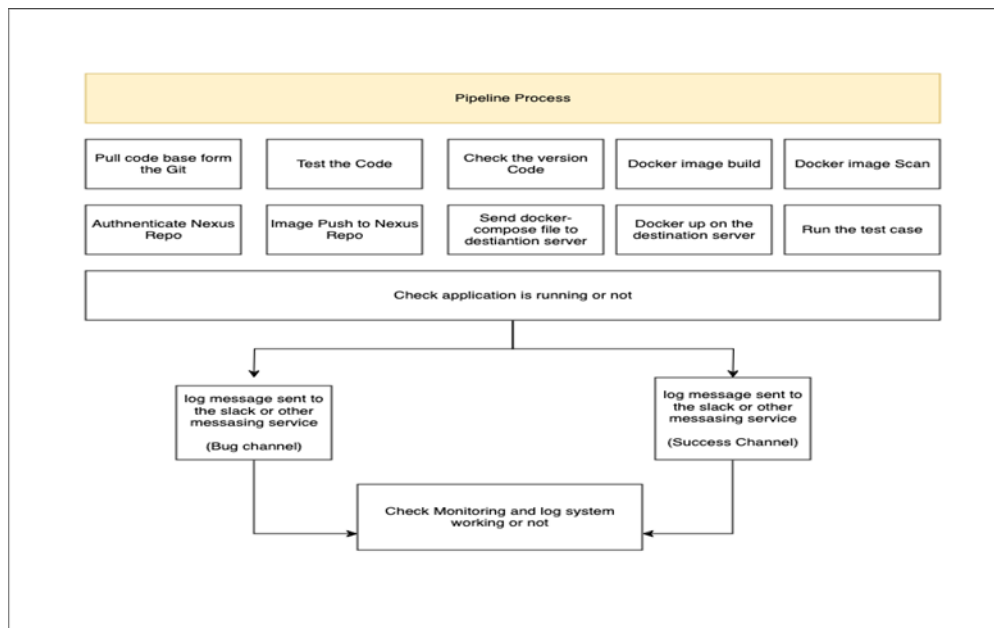
Figure 3 shows the workflow of a cloud computing system in the application and it shows how different components are working together. Here the application represents the software that a user will interact with which can be a web application or mobile application, each user will start with the load balancer, which will distribute incoming traffic among multiple servers, these servers will store the data, and prevent any single server becoming overloaded and it will keep the application responsive. The application image is the configuration of the application, the Nginx image represents the configuration of the web server, database images

represent the database and the database viewer image represents the software that allows the user to interact with the database.



**Figure 3.** The Workflow of the Cloud Computing System

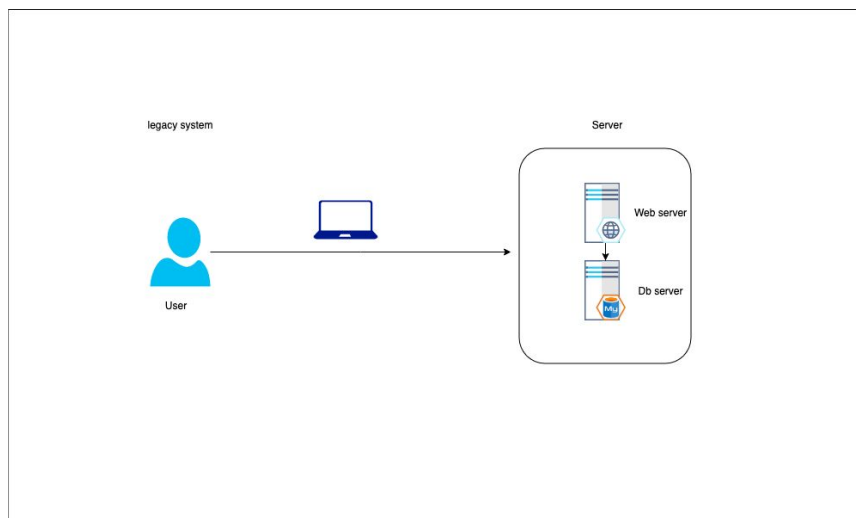
In a nutshell, the image represents the workflow of the entire application. for example, a user wants to look at a webpage. Their request is sent to the load balancer, which then pairs it with a computer. The request is handled by the server, which may get data from a database, make the webpage, and send it back to the load balancer. The load balancer then gives the webpage to the user. This well-organized process makes sure that resources are used well and that everything goes smoothly. This process makes better use of resources by dividing activities and preventing any single server from being overcrowded.



**Figure 4.** App Deployment Pipeline Process

For this application deployment, we need to follow a pipeline process that is shown in Figure 4. For the deployment process, several on-premises tools are used by this pipeline method to make sure that deployments are quick and easy. First, Jenkins, Nexus, Docker, Docker Compose, and Grafana are set up to begin with. The Continuous Integration and Delivery (CI/CD) workflow is made easier to use when these tools work together. Git, the version control system, is at the heart of it all. When a coder pushes changes to the code to the Git repository, the CI/CD pipeline starts, which starts the automated release process. The process starts by getting the most recent code from Git. After being downloaded, the code is put through a series of automatic tests to make sure it works and is of good quality. It is used to make a Docker image if the code passes the tests. This image contains the program code and all of its dependencies, making a portable, self-contained unit that can work the same way in a variety of settings. Docker Compose is the

next part that is used. It combines the newly formed application image with other Docker images, which could be for databases or other services. This creates a network of tools that are all connected to each other and interact in order to run the application. The image is shared to the Nexus repository once it is finished being made. Nexus is a central location where Docker files can be stored, managed, and shared. It keeps track of all versions of the picture, making it easy to find and use whenever needed. Now that the web server, Nginx, is set up, the app is finally ready to run. With this, users can now view the deployed app, which means that the CI/CD pipeline process is complete. This method has a number of benefits: Automation speeds up deployments and cuts down on mistakes. Docker images make sure that applications behave the same way in all environments, and Nexus is the central location for handling Docker images.



**Figure 5.** Legacy System

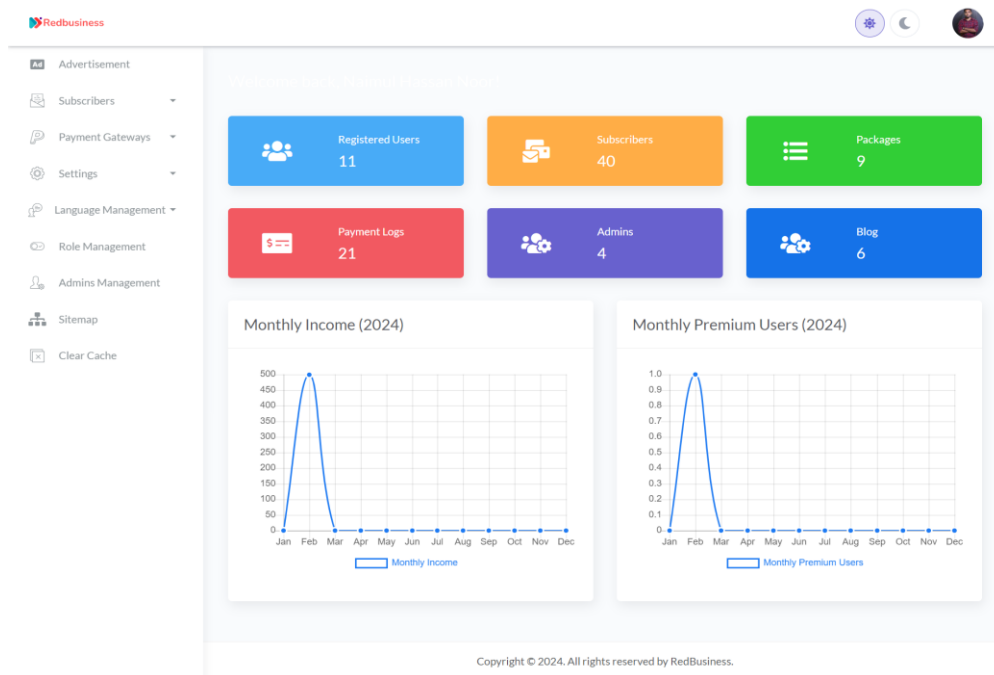
In the Figure 5 shows user interaction with the web application. Here, the user represents the person using the system. The web server responds to the user request and the db server stores the information of the web server. For example,

the user opens a web browser to look for information online. As they type the website address and press "Enter," a procedure that they cannot see starts. A strong computer called a web server gets their request. The web server is like a digital library; it is ready to help users find what they need. It could get the information it needs from a database server, which is a huge collection of data. There are times when it may even talk to an outdated computer system, also known as a legacy system, to get more information. The web server then carefully packs up everything it found and quickly sends it back to the user's browser, where it is shown on the monitor.

Finally, once Nginx is set up, the site goes live and people can interact with the application directly. However, the process of growth does not end here. Grafana is a key part of continuous analysis and tracking. It has dashboards that show important data such as how well an application is running, how healthy the server is, and how resources are being used. This data gives developers useful information that helps them find slow spots, find places to improve things, and deal with possible problems before they happen. The information received is used again and again in the development process, which lets developers make small changes over and over to make the app better. This closed-loop method makes sure that cloud app does not just get deployed; it also keeps changing to give users a better experience.

### **5.1 Project Development Strategy and Execution**

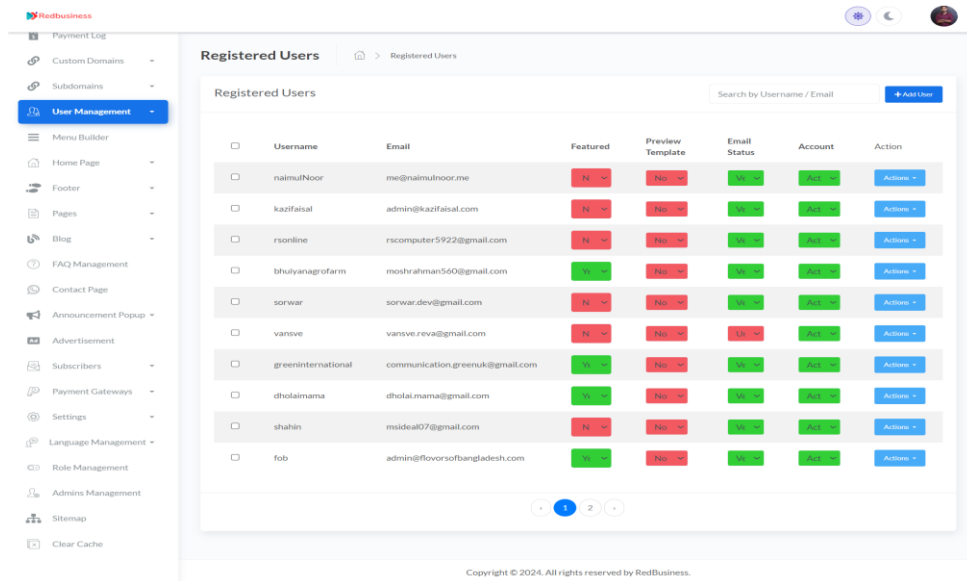
This sub section will describe the graphical user interface of the project admin panel. The admin panel gives administrators an easy-to-use interface and acts as a central location for managing the backend features of the application. Features such as content restriction, user management, and system monitoring are included. In order to simplify administrative operations, the graphical interface will provide easy navigation, a user-friendly design, and access to important metrics and controls.



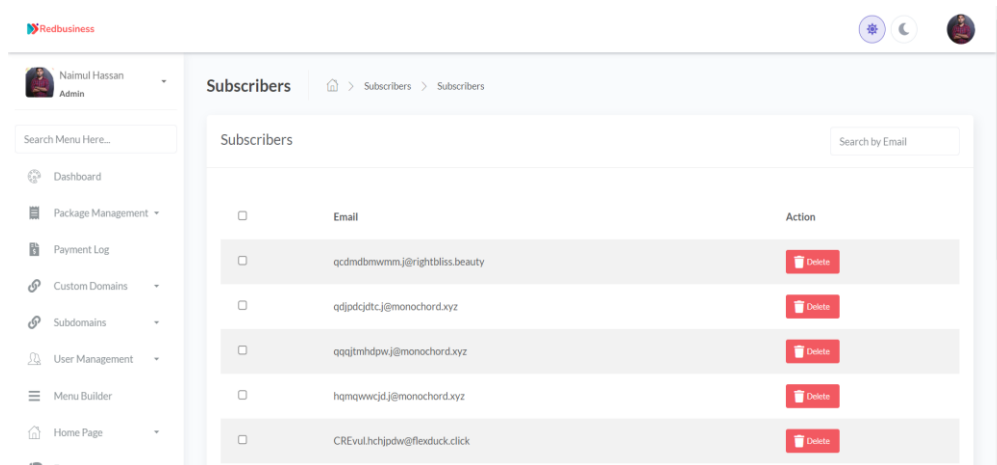
**Figure 6:** Dashboard of My Project

The name of the application is Redbusiness, the dashboard of which is shown in Figure 6. The dashboard contains the summary of the application. It includes some sections that show the number of registered users, Subscribers, packages, payment logs, Admins, and blogs, in the lower part, it shows two graphs. One is for monthly income of the current year and the other one is for premium users.

The page for registered users, represented in Figure 7, displays user data like names, email addresses, and account specifics. This page can be managed by the admin by taking necessary action.

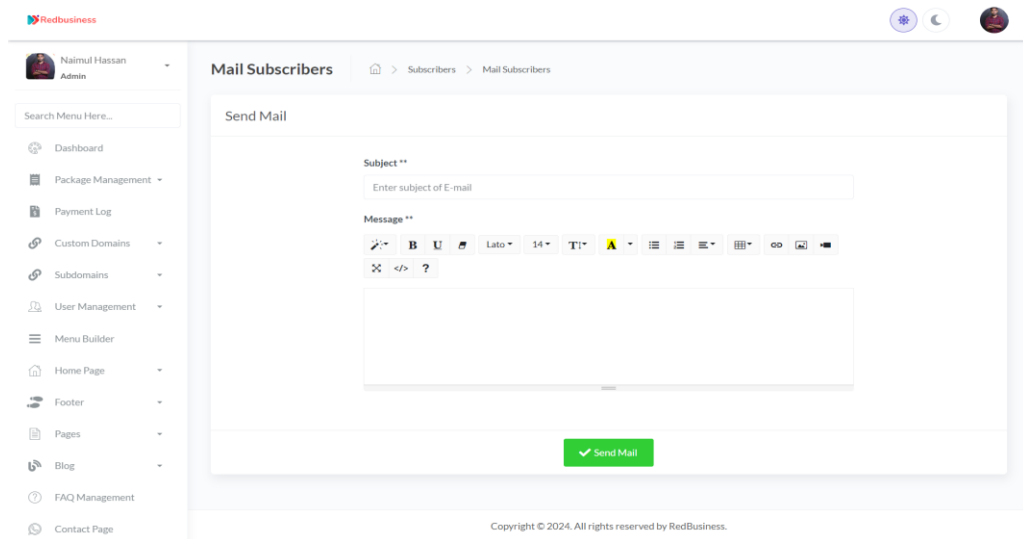


**Figure 7: Registered Users**



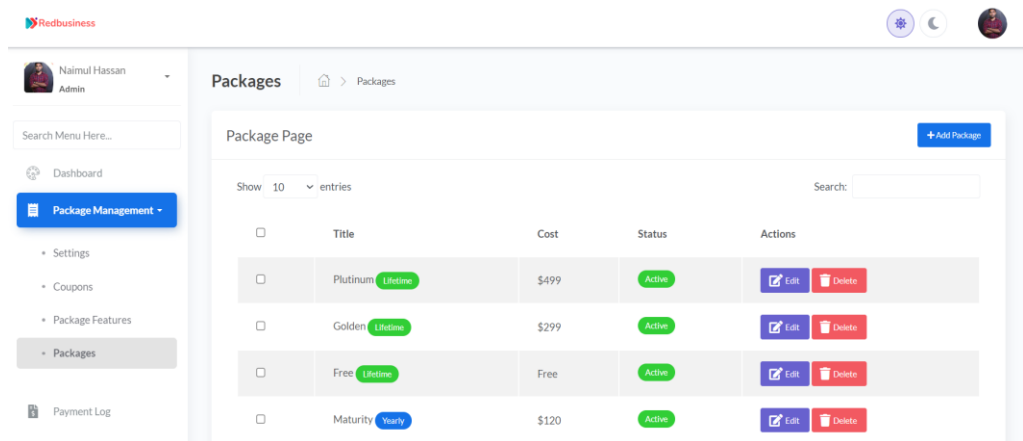
**Figure 8: Subscribers Page**

The subscriber page, shown in Figure 8, has a list of email addresses of subscribers. Individual subscribers can be managed by the admin by choosing them and doing particular actions, including changing subscription settings or deleting subscribers from the list.



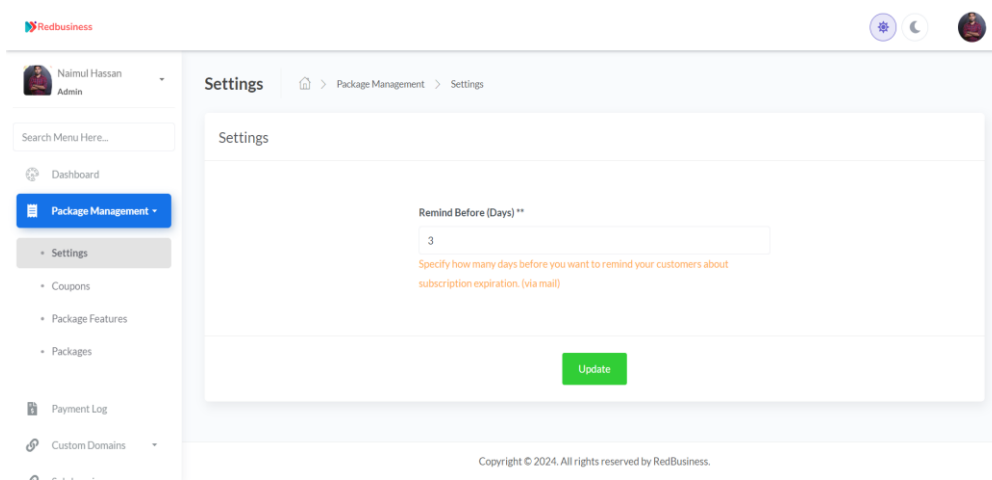
**Figure 9:** Mail Subscriber page

The mail subscribers page, shown in Figure 9, allows administrators to write and send emails to a single subscriber or to several subscribers at once. A robust dynamic text editor on the page enables users to create visually pleasing and properly formatted email content. To make the emails interesting and useful, this editor allows to alter the text, photos, and other components.



**Figure 10:** Packages Page

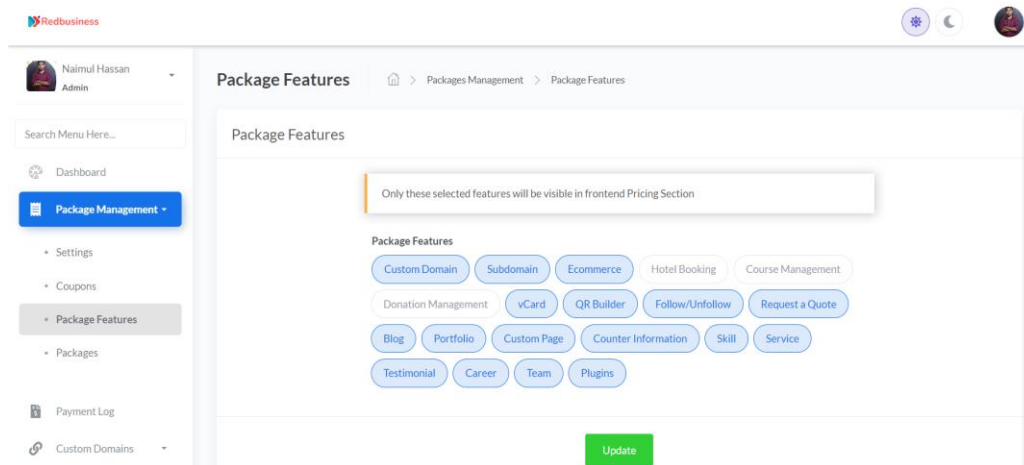
The package page, shown in Figure 10, offers an in-depth overview of all the packages that are available within the program. The admin has access to comprehensive details of each package and can modify or remove any already-existing packages as needed. Furthermore, by selecting the 'Add Package' button, which opens a form for entering package details, more packages can be generated.



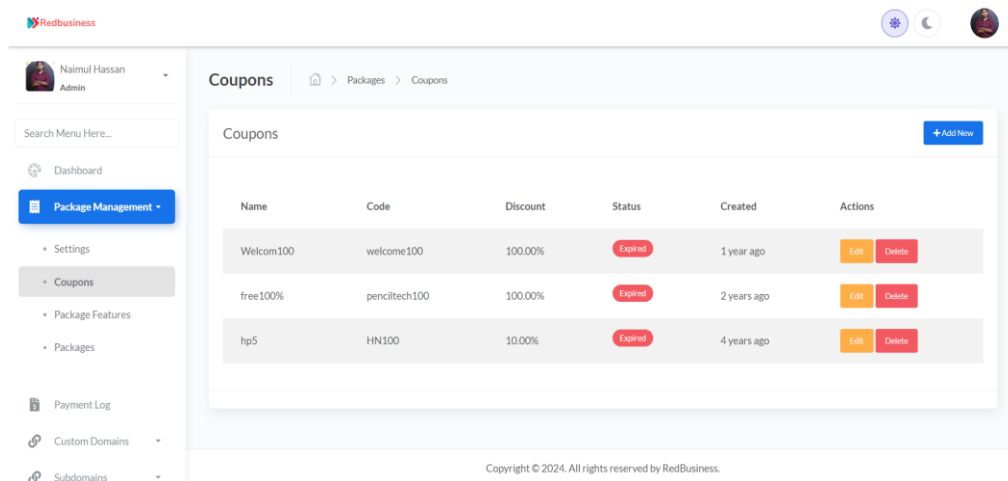
**Figure 11:** Package Settings Page

The packages settings page, shown in Figure 11, enables admins to set up subscription expiration reminders for members. With the help of the above feature, users can receive email reminders from the application automatically, notifying them when their packages expire and encouraging them to renew.

The package features page, shown in Figure 12, allows admins to control and alter the features of various packages following their requirements. This page lets one add and remove features from packages so that users of the application can have a customized and adaptable experience.



**Figure 12: Package Feature Page**



**Figure 13: Coupons Page**

The coupon assignment page, shown in Figure 13, allows admins to apply coupons to particular products to give discounts. The coupons on this page can be edited,

added to, or removed by admins, giving them broad control over promotions and discounts for different packages.

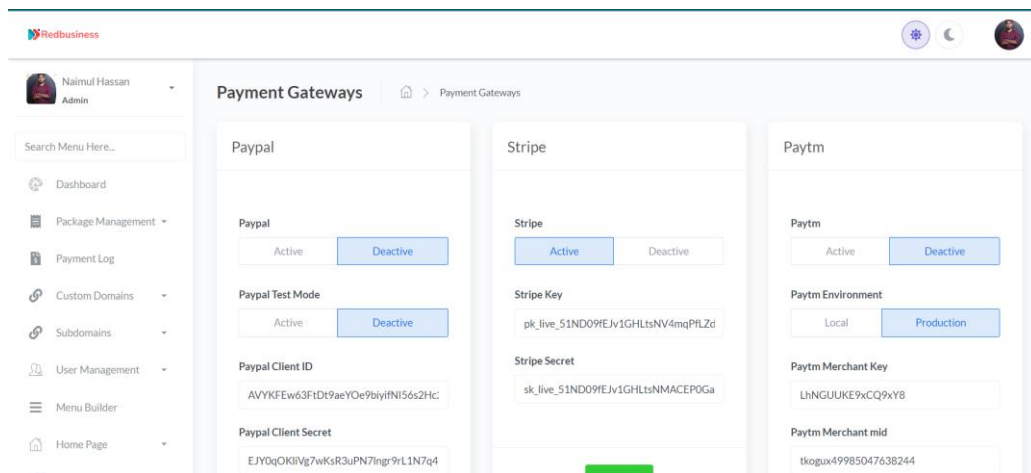
The screenshot displays the 'Payment Logs' page in an admin dashboard. The page title is 'Payment Logs' and the breadcrumb is 'Payment > Payment Log Page'. A search bar is available with the placeholder 'Search by Transaction ID'. The main content is a table with the following data:

Transaction Id	Amount	Payment Status	Payment Method	Receipt	Actions
7a3d0901	\$499	Success	Stripe	-	<a href="#">Detail</a>
fa0dda31	\$10	Success	BKASH	-	<a href="#">Detail</a>
6513f91dd14ce	\$499	Success	BKASH	-	<a href="#">Detail</a>
53e59ead	\$10	Success	BKASH	<a href="#">Show</a>	<a href="#">Detail</a>
bcbec2c3	\$999	Success	BKASH	<a href="#">Show</a>	<a href="#">Detail</a>

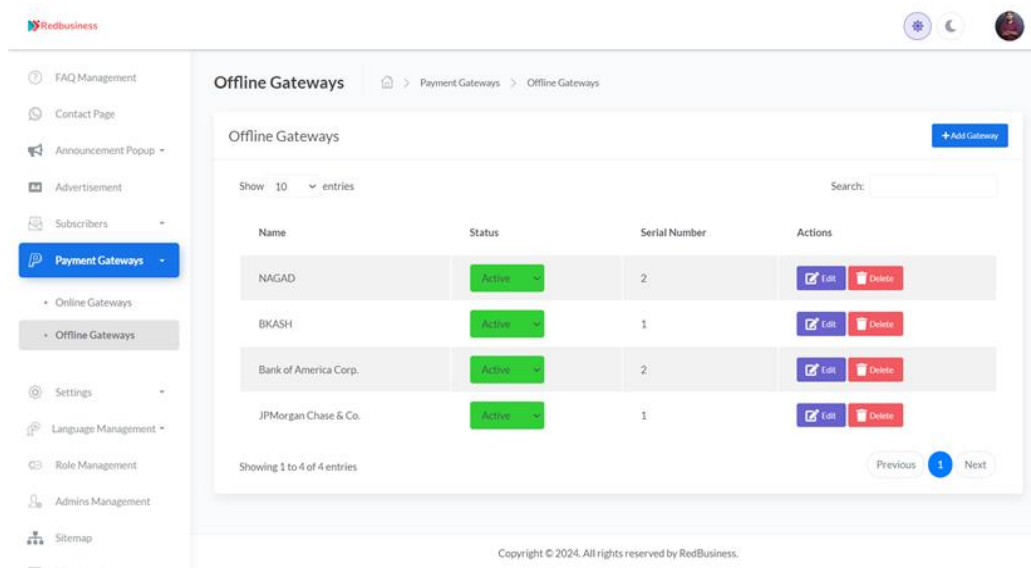
**Figure 14:** Payment Logs page

The payment details page, shown in Figure 14, allows admins to look into every transaction and payment made by users. An extensive summary of past payments, including transaction IDs, dates, amounts, and modes of payment, is given on this page. The admin may look at movements or find any disparities in the data by filtering and searching through it. The website also has tools for handling payment disputes or refunds, guaranteeing efficient money management.

The online payment options are shown in Figure 15. Along with Authorize.net and Mercadopago, the program supports several popular payment gateways, including PayPal, Stripe, Paytm, Instamojo, Paystack, Flutterwave, and Razorpay. This wide variety of payment options accommodates different regional preferences and payment methods, giving users choice and convenience. When making payments, users can choose their preferred method, which streamlines the transaction method.



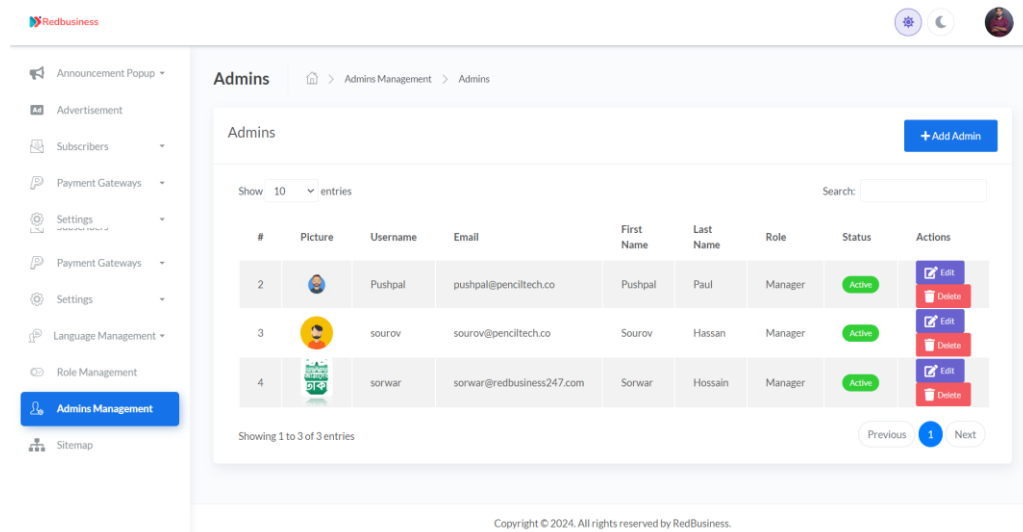
**Figure 15: Online Payment Gateways**



**Figure 16: Offline Payment Gateways**

The offline payment options offered by the project, including conventional bank transfers and other comparable techniques, are depicted in Figure 16. Customers have the option to pay using the banks of their choice, which offers a safe and

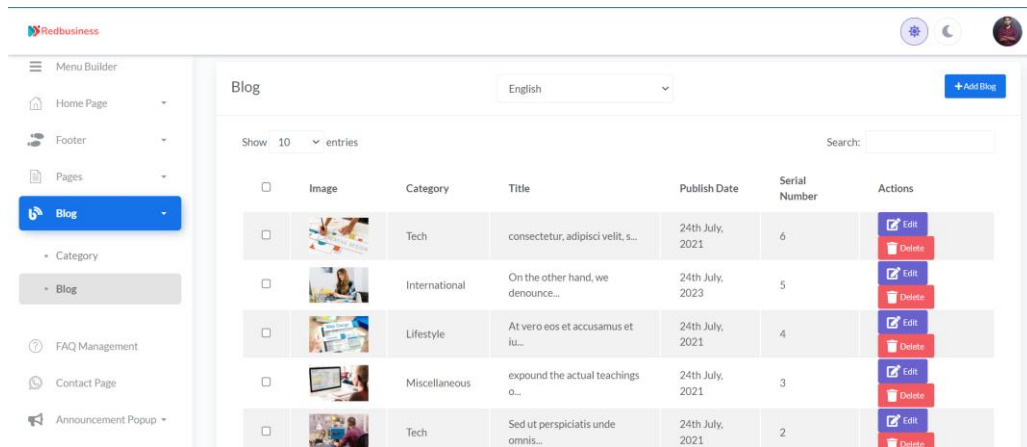
dependable offline transaction processing technique. For consumers who might choose not to use online payment systems, this option provides an alternative.



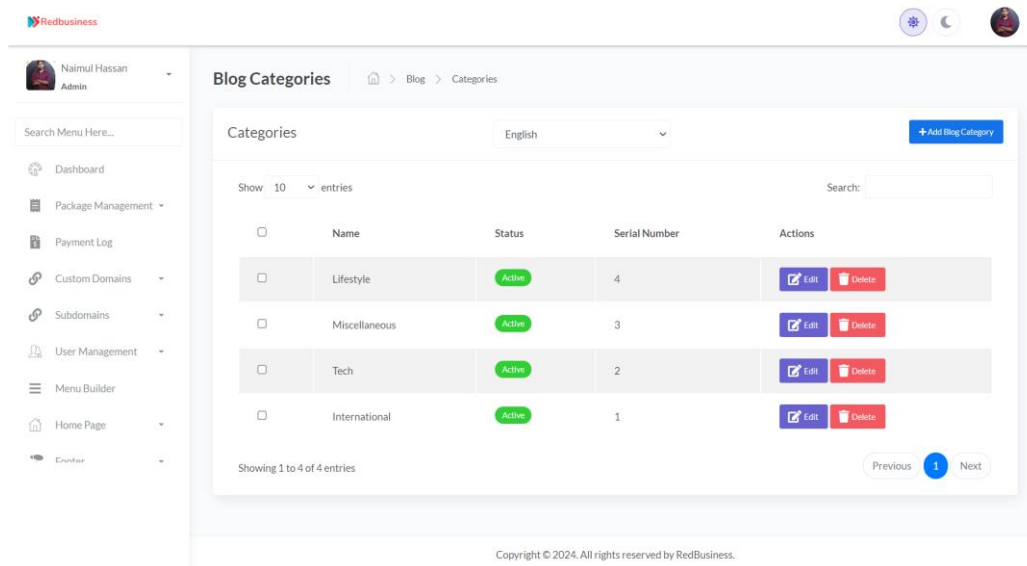
**Figure 17:** Admin Management page

The admin management page, shown in Figure 17, allows admins to provide various admin users distinct roles and rights. With the customized access management provided by this page, each admin will have the right amount of access according to their duties. The admin roles can be designed to the project requirements, improving security and simplifying management.

The blog page, shown in Figure 18, allows admins to control detailed blog material on the blog page itself create new blog postings, and manage those that already exist fall under this category. For users to find information interesting and new, the admin can write, modify, and publish blogs. The exchange of knowledge procedure with readers is made easy and organized by using this page as the primary platform for all blog-related activity.

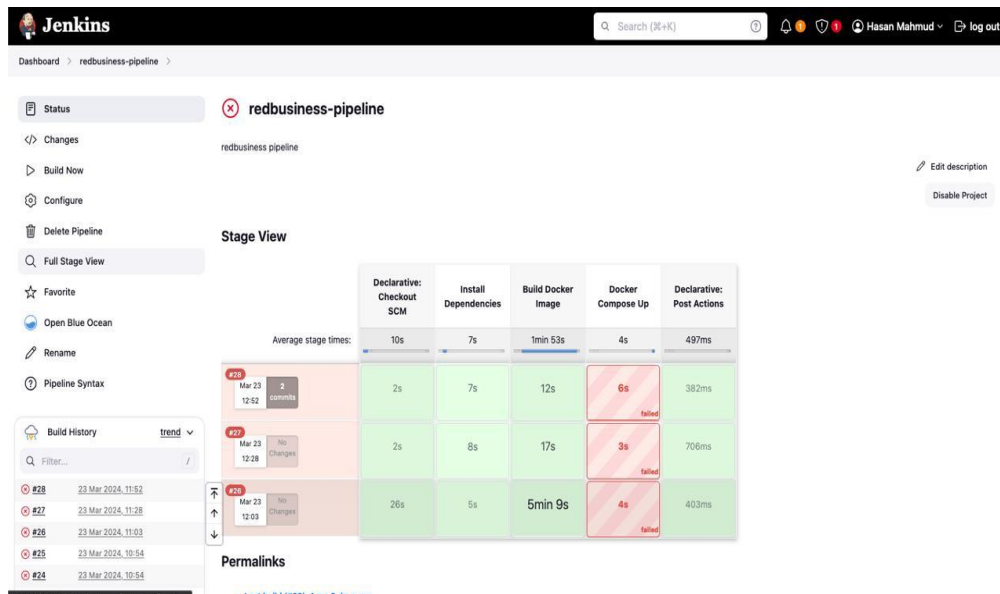


**Figure 18: Blog Page**



**Figure 19: Blog Categories Page**

Figure 19 shows the blog categories on the website. By classifying each blog post, admins can use this page to manage and categorize the content of their blogs. It is easier for users to navigate and find interesting content according to this sorting, which also helps blog themes keep a clear structure. Administrators can create, modify, and remove categories as needed to keep the blog current and relevant.



**Figure 20:** Project Pipeline

Jenkins' project workflow is shown in Figure 20. The several steps in the project's ongoing development and deployment (CI/CD) process are shown in this graphic representation. Unit testing, integration testing, packaging, deployment, and code compilation are just a few of the workflow processes that are automated by the pipeline. Every phase in the pipeline is intended to carry out particular operations and advance the project toward its ultimate state of deployment. Jenkins gives the developer real-time monitoring and feedback, enabling them to see problems early overall effectiveness and quality of the project.

The project pipeline, which outlines the steps in the continuous integration and deployment (CI/CD) process, is shown in text form in Figure 21. This written description follows through each step, which begins with obtaining the code from the repository and continues with the application development and testing. The next step in the process is to create Docker images and store them in the Nexus repository if testing is completed. The program is then deployed to different environments, including development, staging, and production, as part of the pipeline.



## 6 DESCRIPTION OF THE RESULTS OF THE DEVELOPMENT

Programmers are always looking for ways to make their work more efficient and less expensive. This is especially true for SMEs that want to use technology without costing a lot of money. This is what motivated the development process described here. The main goal was to make a cloud-based solution that was affordable, efficient, and had strong data security measures that were tailored to the limited budgets of small and medium-sized businesses.

The smart use of open-source technologies, a feature of modern software development that provides cheaper options to secure software solutions, was a key part of this project. It worked on the solution and was able to avoid the high permitting fees that come with commercial software by using open-source tools. This made the solution much cheaper overall. This choice not only fit with small businesses' budgets but also drew attention to the open-source movement's values of community-driven creation and working together.

Moreover, the concept of installing the solution on-premises developed as a practical approach to reducing expenses, which ultimately resulted in the decision to select this particular option. By utilizing the tools and assets that were already in location, such as physical servers and networking equipment, it was able to eliminate the need for costly cloud-based services. This helped to reduce the amount of money that was spent on cloud-based services. Not only did this on-premises deployment option provide a higher level of control over the configurations of the hardware and software, but it also ensured that the data was contained within the boundaries of the organization's internal network. This not only expanded the organization's efforts to meet guidelines and ensure security, but it also provided another benefit.

Furthermore, in spite of the fact that the development process was carried out with a concentration on cost, there were no compromises made with regard to the technological capabilities of the product. On the other hand, the solution made use of a collection of cloud-based tools, such as Git for version control, Nexus for artifact repository management, and Grafana for monitoring and visualization, in order to simplify the processes involved in the development process and improve the effectiveness of the operations. Even though these tools were open-source in nature, it is essential to point out that they contained powerful qualities and capabilities that were comparable to those of their private counterparts. As a result, this indicates that technological competency does not necessarily have to be sacrificed to achieve cost-effectiveness.

The findings of this study show that SMEs can achieve substantial savings in costs and efficiency gains by utilizing a range of open-source solutions, such as Jenkins, Grafana, Nexus Repo, Git, Docker, Certbot, Python, Laravel Framework, and React Framework. With more flexibility and customization available at a reduced cost, the suggested approach offers a competitive substitute for conventional cloud services. The comparison between the proposed solution and the traditional solution's costs is provided in Table 2. From Table 2, It is clear that the proposed solution indeed reduces the cost of cloud adoption. But this solution still needs more optimization and we are working on it.

It is important to note, though, that the strategy had some problems, even though it was very efficient and saved a lot of money. The most important of these was scalability, which is a problem that many on-premises operations have. Unlike cloud-based solutions, which can be scaled up or down almost constantly by adding more resources as needed, the suggested solution was limited by the hardware capacity of the infrastructure it was built on. As a result, scaling processes needed to be upgraded and changed by hand, which could cause problems during sudden increases in demand or workloads that use a lot of resources.

Despite this, the thesis was still being done to fix this problem and make the approach more scalable. The development team tried to make the process of growing operations easier by looking into ways to automate them and make the best use of resources. This way, the solution would be able to adapt to the changing needs of small businesses. Also, because open-source technologies are naturally flexible, they allow for incremental improvements and enhancements. This lets the answer change naturally over time in response to feedback and changes in the market.

In conclusion, the development process described here is a great example of how difficult it is to find the right mix between cutting costs and coming up with new technologies in software development. By using open-source technologies, on-premises deployment strategies, and cloud-based tools, the solution was able to create a platform that was cost-effective, quick, and safe, just what small businesses needed. This solution is less expensive than the existing solutions that are available in the market. It reduces costs, it optimizes resource utilization and flexibility. This solution has its limitations alongside its benefits. The main limitation of this solution is scalability. If we start with two servers, we have to go with these two servers only, it cannot quickly expend its resources if for example, there is an urgent need for computing power, storage, network capacity and such. This is the main drawback of this solution. But this solution is still in progress. This shows that we want to keep improving and changing to be the best at software creation.

## 7 CONCLUSIONS AND ASSESSMENT

This thesis shows the potential of providing a low-cost, cloud-based solution that meets the demands of small and medium enterprises. The strategic focus on open-source tools, on-premises cloud applications, and cloud-based tools such as Git, Nexus, and Grafana significantly lowers expenses for SMEs looking to capitalize on cloud benefits. The resulting system provides operational efficiency, and improved data security, all in a cost-effective framework. It is important to note the explicitly mentioned limitation about scalability. Although the current approach may not give the quick scalability that public cloud providers offer, choosing for an on-premises strategy establishes a solid foundation for addressing this issue. The potential future implementation of Kubernetes could help with docker automation, allowing the solution to efficiently allocate resources under the limitations of the on-premises architecture. This thesis proves the practicality of providing a cost-efficient, cloud-based solution specifically designed for the requirements of SMEs. The resulting solution provides efficient operations, flexibility with remote work, and improved data security, all while being cost-effective.

This thesis was able to demonstrate that offering a cost-effective, cloud-based solution designed especially for the needs of small and medium-sized businesses is both possible and useful. Because it uses open-source tools, an on-premises rollout strategy, and cloud-based technologies, the solution saves a lot of money, makes operations more efficient, and keeps data safer. Scalability is still a problem that could come up, but new features like Kubernetes automation could help fix this problem and make the answer even better. Overall, the answer that was created is a big step towards giving more small businesses access to the benefits of the cloud, which will help them compete and do well in the age of technology.

## **7.1 Reliability**

The dedication of the developed solution to the best practices and standards in the industry is a significant factor that contributes to the reliability of the solution. The solution takes advantage of an extensive ecosystem of community-centered support and continuous improvement since it makes use of open-source tools and processes that have already been identified and implemented. A further advantage of the on-premises deployment option is that it provides a higher level of control and stability over the infrastructure of the system, hence reducing the likelihood of unanticipated disruptions or downtime.

The identification of major tool types and their related business demands is imperative when discussing the actual application of open-source tools for cloud services in small and medium enterprises (SMEs). These tools facilitate vital business processes like order management and inventory tracking with inventory management tools, financial transactions with billing solutions, customer interactions and data management with customer relationship management (CRM) systems, data management, and analysis via spreadsheet software, and e-commerce operations via online store platforms. With the help of affordable open-source technologies, this thesis seeks to provide a comprehensive cloud solution that combines these essential features, improving affordability and operational effectiveness for SMEs. Nevertheless, it is of the utmost importance to recognize the potential constraints in scalability that are inherent in this technique. These restrictions could affect reliability in situations where there is a large demand.

## **7.2 Usability**

Within SMEs, this project places a primary focus on providing developers and technical personnel with a user-friendly experience. Containers like Docker and Docker Compose make it easier to deploy applications by ensuring that the

environment is maintained in the same manner throughout the development, testing, and production phases. Jenkins automates the continuous integration and continuous delivery pipeline, which increases efficiency and reduces the number of errors that are caused by human intervention throughout the process of building, testing, and deploying software. The artifact management process is simplified by Nexus, which provides dependable version control for Docker images and the dependencies that they require. Grafana provides a centralized view of the application's health, which may be utilized for troubleshooting and performance optimization purposes. It does this by visually presenting essential performance data.

When it comes to SMEs who are creating and delivering web-based applications or services that need to scale as the organization grows, this configuration is especially ideal. It is compatible with microservice architectures, which are configurations in which applications are made up of smaller services that may be deployed separately. Testing and rapid prototyping are encouraged by this configuration, which enables SMEs to rapidly develop and adapt to changes in the market. Furthermore, although it is labeled as on-premises, the technologies and procedures involved lay the path for future migration to a cloud infrastructure. This enables SMEs to begin cost-effectively and to exploit cloud scalability as their requirements gradually change. Scalable E-commerce platforms, internal communication tools that are adapted to the needs of the organization, and customer relationship management (CRM) systems that are designed to promote client engagement are some specific examples.

When it comes to the acceptance and sustainability of the generated solution across a variety of organizations and industries, the transferability of the solution is an important factor to take into consideration. Even though the particular implementation specifics could change depending on the specific requirements of each SME, the fundamental ideas and technologies are still transportable. To adapt and implement similar solutions in their unique settings, organizations can

harness this expertise by documenting the development process, best practices, and insights learned. The flexible design and the utilization of freely available technologies both allow interoperability and ease of integration with third-party systems and services, which further enhances the transferability of the system.

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## APPENDICES

### APPENDIX 1: Comparing Current Configuration with Typical Cloud Resources for Cost and Feature.

**Table 2.** Comparing Proposed Application Vs Typical Cloud Resources

Feature	Proposed Application	Typical Cloud Resources
Cost	€60 per month for the whole cloud service	A basic VPS-like instance may cost between €40 and €70 a month, but the price would increase according to usage and requirements. There could be some hidden fees too.
Scalability	Limited to physical hardware capacity. Scaling requires manual upgrades.	Highly scalable. Add/remove service on demand, often with automation features.
Remote Operation	Limited remote access capabilities.	Can be managed from anywhere
Technology	Open-source tools	The mix of open-source and proprietary offerings. The choice of open-source depends on the provider.
Control	Full control over hardware and software choices.	Lower-level control compared to on-premises but varies between IaaS, PaaS, and SaaS cloud offerings.
Maintenance Overhead	Full responsibility for hardware/software maintenance and updates.	Depends on the service model chosen.