



INFORMATION TECHNOLOGY PROGRAMME
SOFT807 Cloud Applications Development

Assessment 3

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Lecturer: Rakesh Kumar

Group Members:

Jingjing Yu (20231563)

Caique Ribeiro Silva (20241524)

Van Hong Vo (20231599)

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1. Introduction

Nowadays, in a rapidly technology-developed society, increasing numbers of companies use cloud computing to enhance scalability, flexibility, and efficiency and decrease costs. However, whether the security of cloud computing can meet the companies' requirements still needs to be considered. TechWave Solutions Ltd. is a startup IT enterprise aiming to deliver dynamic web applications and solutions using cutting-edge technologies, including HTML, JavaScript, React, and Node.js, and with plans to expand into mobile application solutions in future.

To achieve this goal, the company needs to choose one cloud application that can provide scalability and security. In this report, a shopping application will be deployed to Microsoft Azure and AWS to analyse security strategies and solutions of infrastructure as a Service (IaaS), Platform as a Service (PaaS), and Data Security best practices, with considering the features such as Antimalware protection, disk encryption, web application firewalls, and SSL/TLS encryption. Based on the comprehensive analysis, TechWave Solutions will finally determine which can better fit TechWave's requirements.

2. Understanding the Security of Azure and AWS

2.1. Best Practices for Implementing Security

2.1.1. IaaS Security

2.1.1.1. Azure

- **Best Practise 1: Antimalware Protection**

Installing anti-malware software to protect against malware is the fundamental solution for IaaS security (Al-taharwa et al., 2011). Azure Microsoft Antimalware is a free solution, and it is real-time for Azure cloud service and virtual machines, which is to identify and delete viruses, spy software and other malware. Microsoft Antimalware for Azure can adapt applications or tenant environments. When malware tries to install itself on Azure virtual machines, the antimalware can notify the developer with alerts and then take action based on configuration, such as removing or blocking the malware. (Microsoft, 2024a)

- **Best Practise 2: Manage Virtual Machine (VM) Updates**

Azure does not force the VM operating system (OS) to upgrade, but developers should manage the VM update and maintain their build on the most recent version. In this situation, the Update Management on Azure can keep the Windows or Linux system automatically updated. Azure Update Management uses Microsoft Monitoring Agent (MMA) to collect data and monitor the status of virtual servers' OS versions. Their latest OS versions include a patched and secure system, giving more opportunities to defend against malware and system vulnerabilities. (Microsoft, 2024a)

Using Azure Resource Manager template to define VMs gives developers a patched and secure VM as configured. At the same time, enabling Microsoft Defender for Cloud is a rapid way to identify and apply missing security updates. (Microsoft, 2024a)

- **Best Practise 3: Restrict direct internet connectivity**

If a VM is never exposed to the internet, it will have high security. However, most VMs need to access the internet to provide services or get configurations. Attackers constantly scan public IPs for vulnerabilities or common passwords to attack the system, threatening system security. Monitoring and restricting VM direct internet connectivity is a valuable way to protect against attacks. Use Azure RBAC to ensure that only the central networking group has permission to access network resources. In addition, restricting management ports, such as RDP and SSH, is a common way to control connectivity. (Microsoft, 2024a)

Moreover, Microsoft Defender for Cloud can identify and remediate VMs exposed to risk source addresses, advise deployers to restrict access from risk IP addresses, and allow source IP addresses that actually need to visit the resources. (Microsoft, 2024a)

2.1.1.2.AWS

- **Best Practise 1: Amazon GuardDuty**

Amazon GuardDuty, a threat detective service of AWS, can consistently monitor for malware and other unauthorised behaviours. Unlike Microsoft Antimalware for Azure, which needs to be installed and configured in each virtual machine, Amazon GuardDuty is a cloud platform service that only needs to click [Get Start] in the AWS Management Console to enable it. GuardDuty provides anomaly detection, threat identification and alerts for instances of the AWS (Routavaara, 2020). In addition, GuardDuty provides actionable advice to remediate the

detected issues, helping to protect the AWS accounts and resources. (Amazon Web Services [AWS], 2024b)

- **Best Practise 2: Amazon Detective**

Amazon Detective is an integrated security service of AWS. It automatically collects log data from Amazon Guard, AWS CloudTrail, and Amazon VPC Flow. It analyses the linked data to investigate potential security issues or suspicious activities and discover their root causes. Amazon Detective automatically consolidates and creates a unified, interactive view of your resource behaviours and the interactions between them over time.

Furthermore, Amazon Detective is easy to enable in the Detective console. Deployers can add multiple AWS accounts and review all their logs, Which offers a general view for the security team to see consolidated findings for all accounts. (Amazon Web Services [AWS], 2024a)

- **Best Practise 3: AWS Systems Manager Session Manager for Remote Access**

AWS Session Manager manages Amazon Elastic Compute Cloud (EC2) instances, edge devices, on-premises servers, and virtual machines (VMs) for secure remote access to EC2 instances without opening SSH/RDP ports to the internet. Deployers or developers can use AWS Command Line Interface (AWS CLI) or browser-based shell to deploy, update or manage the instances, reducing the attack. Additionally, all accesses based on AWS Session Manager are auditable, ensuring accesses are traceable. (Amazon Web Services [AWS], 2024d)

2.1.2. PaaS Security

As TechWave Solutions Ltd is concerned about Malware attacks we investigated security features on both Microsoft Azure and Amazon Web Service to protect its projects, customers as well as user's data.

2.1.2.1. Azure

- **Best Practise 1: to secure Paas web and mobile applications in Azure App Services**

Azure App Service is a cloud computing-based solution that allows you to build applications at scale, as well as for any platform or device and integrate with data from any location in the cloud or operating system (Microsoft, 2024b).

App Service also offers **OAuth 2.0** service for your identity provider you need for your application. **Microsoft Entra ID** utilises OAuth 2.0 to let you directly grant access to the mobile and Web applications (Microsoft, 2024b).

Azure role-based access control (RBAC) is ideal for organisations that seeks to create security policies that defines data access rights in the context of the organisations users, groups or applications (Microsoft, 2024b).

Azure Key Vault assists in the protection of cryptographic keys and secrets applied by the Cloud apps and services. Key Vault allows an easy encryption of keys and secrets (for example authentication keys, storage account keys, data encryption keys, .PFX files, and passwords) by using protected by HSMs (Microsoft, 2024b).

App Service Environments provides network integration feature in which you can block incoming source IP address by configuring network security groups. For App Service on Windows you can also block IP addresses dynamically through the web.config file (Microsoft, 2024b).

- **Best Practise 2: to secure Paas web and mobile applications in Azure Storage**

Azure Storage is comprised of storage accounts and when you create a storage account, two 512-bit storage account keys (SAKs get produced). Some of the access keys being stored include high priority secrets and should only be available to people in the storage access control. If they fall into the wrong hand then the personnel or individuals controlling storage will have the ability to change, remove or even add content within storage. For access to objects in storage shared access signature is using (Microsoft, 2024c).

Shared access signature (SAS) offers more privileges access which makes it possible to you to grant definite permissions. It enables you to be able to share the content as you wish in terms of your storage account keys (Microsoft, 2024c).

With **Azure role-based access control (RBAC)**, you focus on granting employees only the necessary level of access based on Azure need-to-know and least privilege orthodoxy. It is also good to note that when working with the Azure plate form you are able to assign privileges to users through the use of the Azure built-in roles (Microsoft, 2024c).

Client-side encryption allows to encrypt where data in transit can be programmatically encrypted before being upload to Azure Storage and programmatically decrypted when

download is done. Client-side encryption offers protection of data in communication but it also offers protection of data in storage (Microsoft, 2024c).

Enabling **Storage Service Encryption** for File storage enables AES-256 encryption on the data set by default. In encryption and decryption processes, the key management is solely in the hand of Microsoft.

- **Best Practise 3: to secure Paas web and applications in Azure SQL Database and Azure Synapse Analytics.**

SQL Authentication involves using username and password to be granted an access to other databases on servers as the owner of the credentials.

Microsoft Entra authentication uses identities from Microsoft Entra ID and is supported for managed and integrated domains. Microsoft Entra ID is now a handy login alternative to SQL Server authentication so that you will no longer see user identity spread across the database server. Microsoft Entra authorisation helps you to control simultaneously the identities of database users and other facilities, exceeding Microsoft services. Central ID management enables-single location for database and database users and easy Granting of permissions (Microsoft, 2024d).

By creating firewall rules you can **restrict access based on IP addresses**. These rules can be targeted at both as a server level and a database level (Microsoft, 2024d).

Transparent data encryption (TDE) is enabled by default to protect the structure of the SQL Server, Azure SQL Database and Azure Synapse analytics data and the logs. TDE shields against loss of direct control of the files as well as their backups. This allows you to encrypt data that are at rest, without modifying existing applications (Microsoft, 2024d).

2.1.2.2.AWS

As TechWave Solutions Ltd is concerned about Malware attacks, to protect its projects, customers as well as user data, AWS offers **AWS Identity and Access Management (IAM)**.

Best Practise 1: AWS IAM Identity Center

Human identities who use the company's products could be clients, developers, and administrators,.. should have an identity to access environments and applications. They are encouraged to utilise the federation with an identity provider to gain access to AWS with

temporary credentials. As demonstrated by Zhang et al., with AWS IAM Identity Center we can manage access to your account and permissions in that accounts.

Best Practise 2: IAM roles

It is recommended to use IAM roles for human users and workload. A workload is a set of processes accompanied by code that is deployed to provide relevant business utility more often from an application or a backend process. These identities include machines, for example, instances into Amazon environments like Amazon EC2, or AWS Lambda functions (Amazon Web Services [AWS], n.d.).

Best Practise 3: Multi-factor authentication (MFA)

Besides IAM roles, it is required to use Multi-factor authentication (MFA) in case we need an IAM and root user for an account. When using MFA, the user has a device that can produce a response to that challenge of authentication. Both, user credentials and device generated response are necessary for them to sign in successfully for a personal account (Amazon Web Services [AWS], n.d.).

If possible, it is advised to use short-term authentication credentials rather than use access key, which is long-term. There is a need to change the access keys each time an employee leaving the company. By using *IAM access last used information*, we can add as well as delete a particular access key in a very secure manner (Amazon Web Services [AWS], n.d.).

2.1.3. Data Security

Data security and integrity are crucial for platforms to care about and for their users, a way to build trust in the providers. Data is all information that the computer can read and use: pictures, words, videos, or files. Access to this data is generally made through virtual requests sent from sides A to B.

As a matter of fact, there are three states in which data can be found in a system: at rest, in transit and use. Each one of these states can have their security assured in different ways

- Data at rest

It references data when it is not actively travelling between devices or networks, nevertheless, when it is not being requested or in use (Dinic, 2022).

- Data in transit

It references data when it is travelling from one point to another. This part of the process can be especially critical, as the information is successive to be corrupted, intercepted or altered (Dinic, 2022).

- Data in use

Nonetheless, the state where data is actively being used, either for verification, retrieving or while being created. It is the most vulnerable moment, as it can be exposed to multiple threats, from malware to human interaction (Dinic, 2022).

2.1.3.1.Azure

- **Best Practise 1: Key Vault Secrets**

Microsoft offers to replace in-code secrets for centred vault storage. For best practices, utilising an encrypted vault for passkeys, passwords, and secrets is of absolute importance for the integrity of a system; as for databases and a few specific programs, storing passwords and strings in the code is necessary.

The vault works as a storage for passwords and database connection strings. For instance, this service does not offer any semantics validator, and it simply receives the data, encrypts it, stores it and returns a secret identifier. The secret length can be up to 255 characters. In addition, Azure Key Vault will encrypt 100% of the data stored using FIPS (Federal Information Processing Standard) 140-2. Boboň (2021) stated that FIPS grants security requirements that must be satisfied to products; the requirements extend to a wide range of applications and areas related to a product's implementation, security and secure design. This standardisation provides 4 levels of security, each increasing in quality compared to the previous. In Azure, the key cryptography can be done by RSA or EC cryptography. RSA offers options of 2048, 3072 or 4098 sizes an EC, P-256, 384, 521 and 256K. The size of the keys impacts their complexity in being encrypted and decrypted. In another other, larger, safer they are.

- **Best Practise 2: Disk Encryption Set**

Microsoft Azure has different types of disk encryption services. For best practice and enhancement of security level, it is recommended to encrypt the data at the rest state. For example, the data can be encrypted at the disk level using a server-side, which means that all the data at rest in the server will be encrypted. On the other hand, there is also host-side

encryption, although this can only be achieved with specific configurations provided by Microsoft Azure.

Disk Encryption types:

- Azure Disk Storage Server-Side Encryption

Provide for the operational system and data disks at the rest state of the data (Microsoft, 2024).

- Encryption at host

Encryption on the client side also encrypts temporary disks and cache disks (Microsoft, 2024).

- Azure Disk Encryption

Encryption of the data disk and virtual machines utilises the encryption structure of DM-Crypt for Linux and BitLocker for Windows (Microsoft, 2024).

- Confidential disk encryption

Encryption of data with a condition of only being accessible by a selected VM (Microsoft, 2024).

Lastly, a copy of the virtual hard disk is also available, it is called a snapshot, and it is a read-only copy, also known as a point-in-time backup.

- **Best Practise 3: Protecting data in transit**

Moving on to situations where the data must go from point A to B, protecting it during transit is essential. For this situation, the best practice and the safest and most well-known option are to utilise SSL (Secure Sockets Layers) or TLS (Transport Layer Security) protocols. Due to flaws, SSL is no longer in use. Although the industry still refers to it. In this case, TLS has come as a replacement for the former transport protocol.

Microsoft Azure allows the configuration of TLS certificates and protocols. For instance, using Azure Virtual Machines (VMs), it is possible to create Virtual Private Networks (VPN) gateways that will send encrypted data from Azure networks throughout the public internet or send information from Azure VM to another in cases where utilising Web App services it is possible to secure the DNS with TLS protocols, which can be configurated, by using HTTPS

only. However, it is necessary to have a scale-up that matches the correct pricing tier for this service.

2.1.3.2.AWS

- **Best Practise 1: AWS Key Management Service (KMS)**

AWS offers a service that allows the user to send and encrypt data. The same works the opposite way, requiring data decryption through KMS. This tool can store and encrypt data using FIPS 140-2. Amazon uses the structure of its service to build confidence towards the durability and physical security of the keys and, on top of that, the availability of storing secrets.

AWS KMS offer symmetric and asymmetric keys; the former is in the format of one key, which is used for both encrypting and decrypting. As for the asymmetric key, one is created for encrypting and the other for decrypting (Poggi, 2021). The service also includes options to allow managing who will be the user with access to the key(s). Therefore, the previous information is considered good practice for centring and encrypting small and large amounts of data. Customer Master Keys (CMKs) permit the storage of up to 4KB in data. Any size larger than that should use Data Encryption Keys (DEK) (Amazon Web Services, 2024).

For instance, as the name suggests, KMS works with the keys' encryption. When encrypting data, a data key will be created and then encrypted by a master key. So, in this way, the data key will be stored with the encrypted data. For decryption, the master key has to decrypt the data key and then decrypt the encrypted data.

- **Best Practise 2: Amazon EBS Encryption**

Amazon Elastic Block Store is a block storage. This tool allows users to create highly scalable volumes and availability, as well as, most importantly, encryption and backup of in-time data. More specifically, EBS service can be coupled with EC2. In that manner, it allows instances to use encryption when the data is at rest and in transit states. Equally important are snapshots, which are point-in-time copies of the current data that are independent of the original volume (Amazon Web Services, 2024).

Best practices for users: Creating a KMS is crucial, as it can directly interfere with the performance of EBS. On top of that, Amazon permits default encryption as well as the encryption of snapshots. This process is mainly focused on data at the rest condition. The volumes are encrypted with AES-256. The Advanced Encryption Standard (AES) is a

technology to protect confidential information utilising 256-bit length symmetric key (Indrayani & Suartana, 2019 cited by Nirwan, Hamidin, Azzalea, 2024). Rijndael first introduced this advanced encryption system from the US National Institute, and it quickly became an industry pattern of quality.

- **Best Practise 3: Manage SSL / TSL**

For in-transit data, good practice is resumed for TSL certificates; Amazon has two services to manage: AWS Certification Manager and AWS Private Certification Authority. The former helps handle TSL certificates and keys, which will protect multiple domains and unlimited subdomains, and the latter supports the creation of private certification authorities that can use keys RSA 2048 and 4096 and ECC 384. However, for a deeper understanding, let us consider the installation of a Certification Manager, which will validate the user domain automatically, saving time and resources. Private certification authorities allow the exporting or creation of certifications that are responsible for distributing those same certificates through HTTPS; in other words, only browsers with the correct certificate can access the content.

All the information above is valid to remind people not to use deprecated versions of SSL (v3.0) and to avoid using TSL 1.0 (most recent version 1.2). Databases can also have their connection encrypted with TSL. Those certificates are dependable on regions. Amazon provides a list of supported regions and certificates.

2.1.3.3.Data Security Best Practices Platform Overview

Overall, Microsoft Azure and Amazon Web Services are seriously focused on providing customers with numerous encryption options in different data stages. Best practices for both platforms have similar characteristics, whether creating a vault to store secrets and strings or, on the other side, using key management services for encryption. Either Azure or AWS gives the option of choosing the key's size, from 2048, 3072, or 4096, although the larger the size, the more computational processing is necessary. It is important to understand that an exclusion or loss of the identifier for Microsoft Azure or the data key for AWS will cause the loss of data. Additionally, both platforms charge for the rotation of the keys \$1 USD per renewal and \$0,03 USD per secret transaction for Azure (Microsoft Azure, 2024e) and \$1 USD monthly cost for 1 KMS in AWS (Amazon Web Services [AWS], 2024e).

Regarding disk encryption, both providers offer the service. However, they differ in functionality, as Azure has different types of disk encryption with straightforward solutions for

server-side, client-side and exclusive virtual machine access. AWS compacts its use to block storage; a plus for this technology is the quick access to horizontal scalability and snapshots (backups). EBS works by encrypting the block and creating a safe environment for the instances added to it. Price wisely: Azure does not charge for the encryption service, although having a Key Vault is charged, and it is highly recommended to have one, as cited by Microsoft Learn (2024). Turning to EBS, a breakdown of the pricing is necessary: Volumes - the volume storage in the EBS is charged by the amount of GB. Snapshots are charged by the amount of data being consumed in the instance. As important, the selected region may vary in value (AWS, 2024).

Lastly, both companies provide best practice FAQs and Forums for setting up SSL/TLS configuration for data encryption in transit. However, Amazon Web Services further facilitates the understanding of adding certificates to TLS and creating private certificates using RSA 2048/4096. In contrast, Microsoft Azure provides concrete information about security protocols with less room for understanding what mechanisms are being used. Both companies offer a free inclusion of certificates that are widely used by browsers.

2.2. IaaS, PaaS and Data/Application Security for TechWave Solutions Ltd On Azure

2.2.1. IaaS Security

TechWave Solutions Ltd need to implement antimalware protection across all virtual machines used on Azure. This configuration protects VMs against malware, spyware, and other malicious software. To reduce the application's network loading during the weekend, the full disk antimalware scan will be performed on Saturday night to avoid affecting client usage. Moreover, restriction of inbound access will reduce the risk of attack for the database server.

Step 1: Choose a VM in "VV_group" which needs the antimalware software.

VV_group - Microsoft Azure

Microsoft Azure

Home > VV_group > BackEndApp

Overview

Resources Recommendations

Filter for any field... Type equals all Location equals all Add filter

Showing 1 to 6 of 6 records. Show hidden types

Name	Type	Location	...
BackEndApp	Virtual machine	Australia East	...
BackEndApp-ip	Public IP address	Australia East	...
BackEndApp-nsg	Network security group	Australia East	...
BackEndApp-vnet	Virtual network	Australia East	...
backendapp861_z1	Network Interface	Australia East	...
BackEndApp_OsDisk_1	Disk	Australia East	...

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Give feedback

Figure 1: Choose a VM in VV_group

Step 2: In Settings – Extension + applications, add an extension.

BackEndApp - Microsoft Azure

Microsoft Azure

Home > VV_group > BackEndApp

BackEndApp | Extensions + applications

Extensions VM Applications

Add Refresh Update Enable automatic upgrade Disable automatic upgrade Feedback

Search to filter items...

Showing all 0 items

Name	Type	Version	Latest Version	Status	Automatic upgrad
No resource extensions found.					

Figure 2: Add an extension to this VM

Step 3: Search Microsoft Antimalware and click Next.

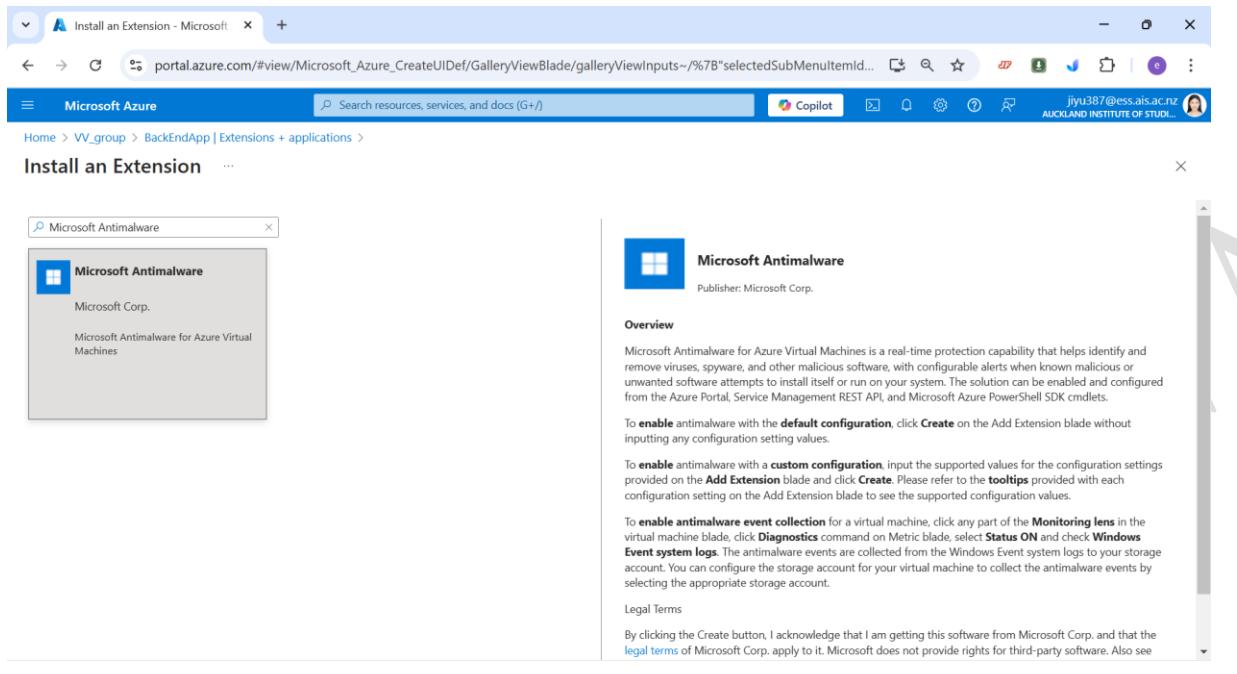


Figure 3: Install Microsoft Antimalware to this VM

Step 3: Configure the extension on Azure. Configure the Microsoft Antimalware extension with the following settings:

- Exclude file and locations: choose C:\Temp, for example
- Exclude file extensions: None
- Exclude processes: None
- Real-time protection: Choose Enable to protect the server
- Run a scheduled scan: Enable a scheduled scan every Saturday at 2:00 AM to scan the full disk.

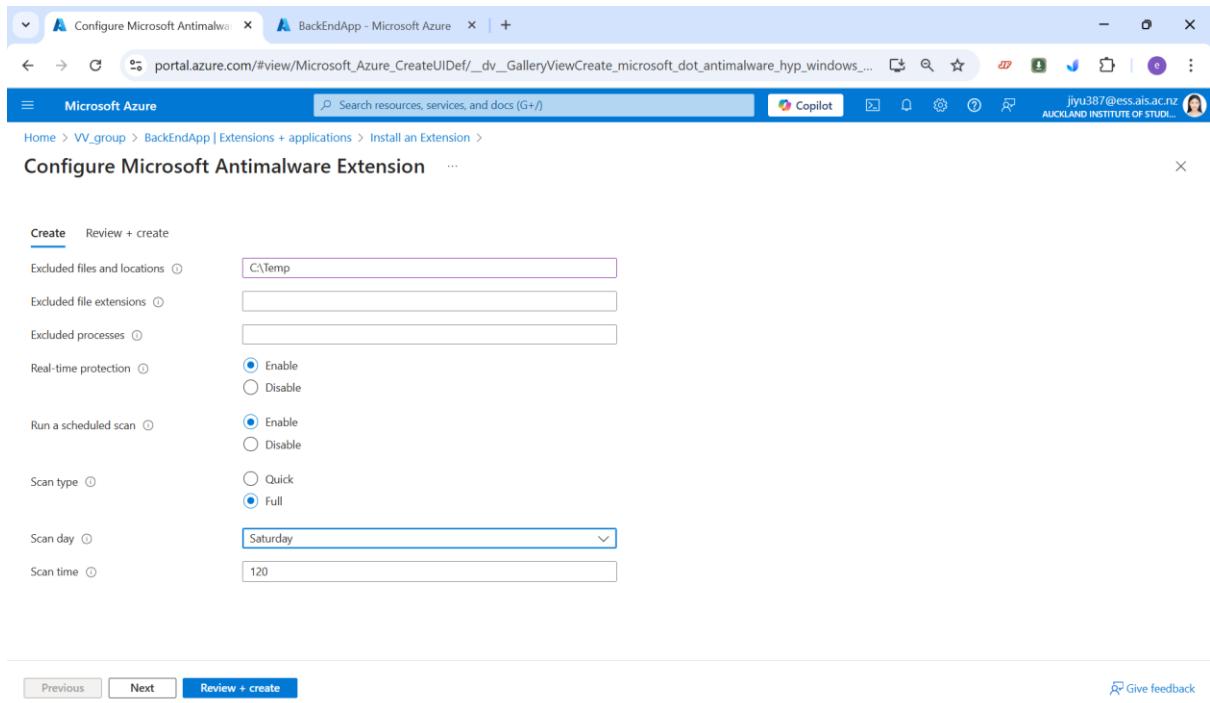
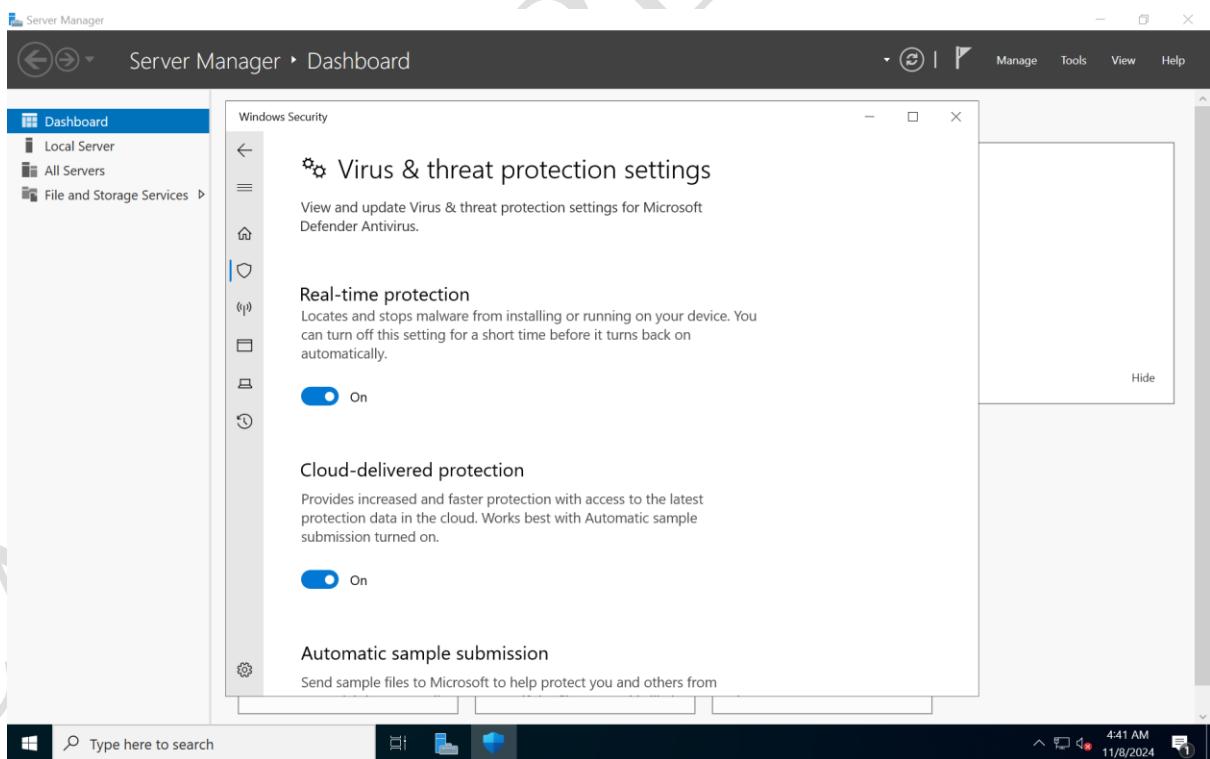


Figure 4: Configure the extension

Step 4: Check the setting and running statue on the server.



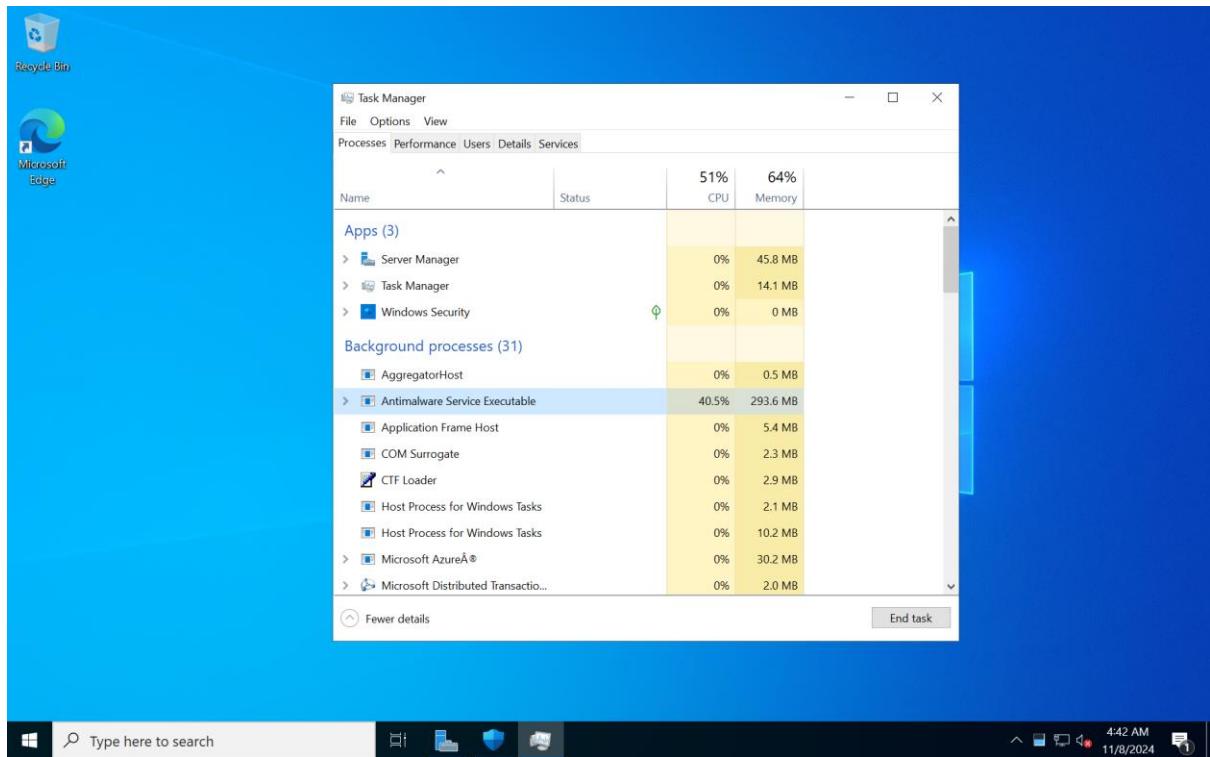


Figure 5: The Antimalware Service is configured and running

In addition, when creating the backend and database server, set restrictions on public inbound ports to ensure that the application does not have many attack interfaces.

Microsoft Azure Search resources, services, and docs (G+) Copilot ... jlyu387@essais.auckland.ac.nz AUCKLAND INSTITUTE OF STUD...

Home > Virtual machines > Create a virtual machine ...

Validation passed

Help me create a low cost VM | Help me create a VM optimized for high availability | Help me choose the right VM size for my workload

Basics Disks Networking Management Monitoring Advanced Tags Review + create

Price
1 X Standard DS1 v2 by Microsoft Subscription credits apply ⓘ **0.1400 USD/hr** [Pricing for other VM sizes](#)

TERMS
By clicking "Create", I (a) agree to the legal terms and privacy statement(s) associated with the Marketplace offering(s) listed above; (b) authorize Microsoft to bill my current payment method for the fees associated with the offering(s), with the same billing frequency as my Azure subscription; and (c) agree that Microsoft may share my contact, usage and transactional information with the provider(s) of the offering(s) for support, billing and other transactional activities. Microsoft does not provide rights for third-party offerings. See the [Azure Marketplace Terms](#) for additional details.

⚠ You have set RDP, SSH port(s) open to the internet. This is only recommended for testing. If you want to change this setting, go back to Basics tab.

Basics

Subscription	Azure for Students
Resource group	(new) VV_group
Virtual machine name	BackEndApp
Region	Australia East
Availability options	Availability zone
Zone options	Self-selected zone
Availability zone	1
Security type	Trusted launch virtual machines
Enable secure boot	Yes
Enable vTPM	Yes
Integrity monitoring	No
Image	Windows Server 2022 Datacenter: Azure Edition - Gen2
VM architecture	x64
Size	Standard DS1 v2 (1 vcpu, 3.5 GiB memory)
Enable Hibernation	No
Username	ellyji
Public inbound ports	RDP, SSH
Already have a Windows license?	No
Azure Spot	No

Disks

OS disk size	Image default
OS disk type	Premium SSD LRS
Use managed disks	Yes
Delete OS disk with VM	Enabled
Ephemeral OS disk	No

Networking

Virtual network	(new) BackEndApp-vnet
Subnet	(new) default (10.0.0.0/24)
Public IP	(new) BackEndApp-ip
Accelerated networking	On
Place this virtual machine behind an existing load balancing solution?	No
Delete public IP and NIC when VM is deleted	Enabled

Management

Microsoft Defender for Cloud	None
System assigned managed identity	Off
Login with Microsoft Entra ID	Off
Auto-shutdown	Off
Enable hotpatch	Off
Patch orchestration options	OS-orchestrated patching: patches will be installed by OS

Monitoring

Alerts	Off
Boot diagnostics	On
Enable OS guest diagnostics	Off
Enable application health monitoring	Off

Advanced

Extensions	None
VM applications	None
Cloud init	No
User data	No
Disk controller type	SCSI
Proximity placement group	None
Capacity reservation group	None

< Previous Next > **Create** Download a template for automation ⚙ Give feedback

Figure 6: Control connectivity

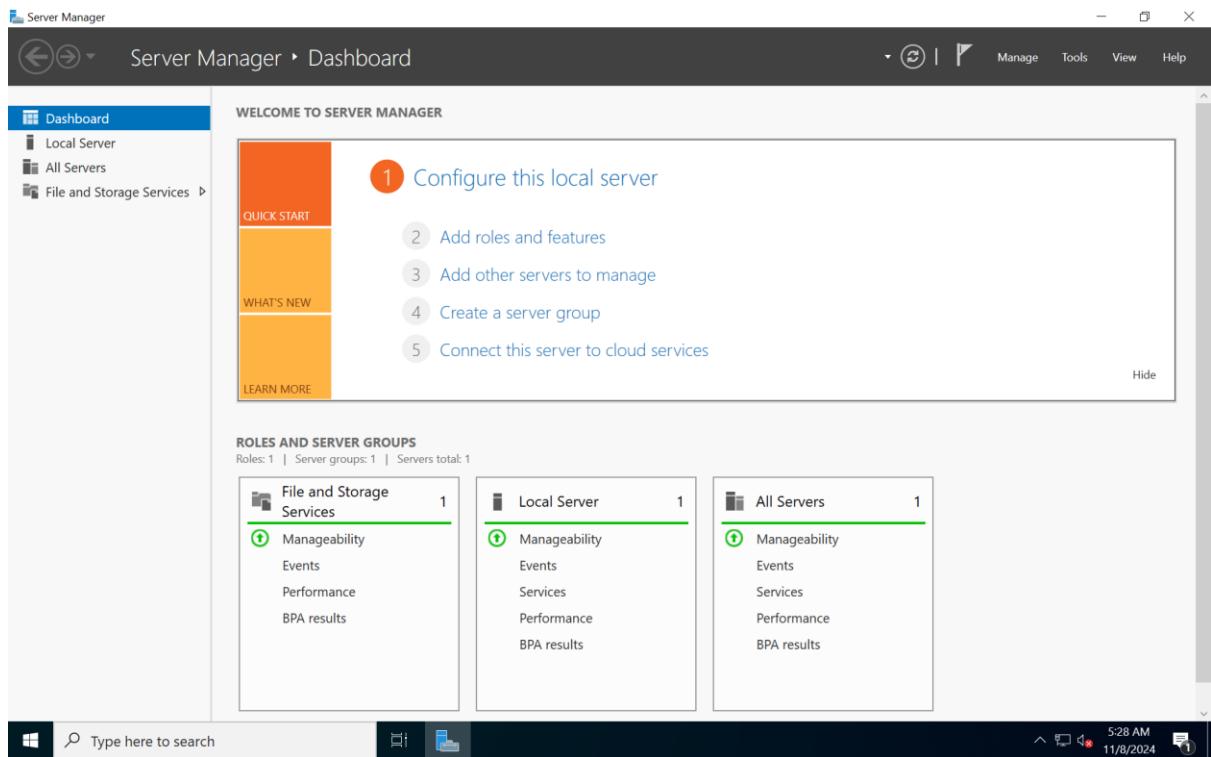


Figure 7: Connect the server with RDP (port 3389)

2.2.2. PaaS Security

Azure role-based access control (Azure RBAC) is the tool you use to grant control access to Azure resources. To grant access, develop role assignments at a specific scope that may include users, groups or service principals, and managed identities. This article also shows how to assign roles through the Azure portal.

Below is the implementation for creating a new user role assigned to a user to access and read a resource group.

Step 1: Specify a scope where your resources is access to.

Sign in to the Azure portal and search for scope. For example, I select a resource group, namely "VV_Group"

The screenshot shows the Microsoft Azure Resource Groups Overview page for a resource group named "VV_Group". The left sidebar lists various options like Create, Group by none, Activity log, Access control (IAM), Tags, Resource visualizer, Events, Settings, Cost Management, Monitoring, Insights (preview), Alerts, Metrics, Diagnostic settings, Logs, Advisor recommendations, Workbooks, Automation, and Help. The main area is titled "Overview" and displays the following details:

- Subscription (move):** Azure for Students
- Subscription ID:** 2e7e4fab-dad9-42fe-88f7-8c4894cf43b7
- Tags:** Tags (edit) Add tags
- Deployments:** No deployments
- Location:** Australia East

Below this, there's a search bar and a table with columns for Name, Type, and Location, showing 0 results. A message at the bottom states "No resources match your filters".

Figure 8: Open the resource group "VV_group"

Step 2: Click on Access control (IAM)

The screenshot shows the Microsoft Azure Access control (IAM) page for the "VV_Group" resource group. The left sidebar has "Access control (IAM)" selected. The main area is titled "VV_Group | Access control (IAM)" and contains the following sections:

- Check access:** Role assignments, Roles, Deny assignments, Classic administrators.
- My access:** View my current and eligible access to this resource. Includes a "View my access" button.
- Check access:** Review the level of access a user, group, service principal, or managed identity has to this resource. Includes a "Check access" button.
- Grant access to this resource:** Grant access to resources by assigning a role. Includes a "Add role assignment" button.
- View access to this resource:** View the role assignments that grant access to this and other resources. Includes a "View" button.
- View deny assignments:** View the role assignments that have been denied access to specific actions at this scope. Includes a "View" button.
- Create a custom role:** Create a custom role for Azure resources with your own set of permissions to meet the
- New! Permissions Management:** Discover, monitor and remediate unused permissions in your Azure environment with

Figure 9: Click on Access control (IAM)

Step 3: Click the **Role assignments** tab to show the current role assignments at this level of scope.

Microsoft Azure

Home > Resource groups > VV_Group

VV_Group | Access control (IAM)

Search resources, services, and docs (G+)

Copilot

vavo001@ess.ais.ac.nz AUCKLAND INSTITUTE OF STUD...

Overview Activity log Access control (IAM) Tags Resource visualizer Events Settings Cost Management Monitoring Insights (preview) Alerts Metrics Diagnostic settings Logs Advisor recommendations Workbooks Automation Help

Add Add role assignments Download role assignments Edit columns Refresh Delete Feedback

Check access Role assignments Roles Deny assignments Classic administrators

Number of role assignments for this subscription: 1 to 4000

Privileged: 2

View assignments

Search by name or email Type: All Role: All Scope: All scopes State: All End time: All Group by: Role

All (2) Job function roles (0) Privileged administrator roles (2)

Name	Type	Role	Scope	State	Condition
20231599 vavo001@ess.ais.ac.nz	User	Owner	Subscription (Inherited)	Loading...	None
Gopi Krishna gopik@ais.ac.nz	User	User Access Administrator	Root (Inherited)	Loading...	None

Showing 1 - 2 of 2 results.

Figure 10: Open Role assignments tab.

Step 4: Click **Add > Add role assignment**. The Add role assignment page opens.

On the **Role** tab, select a role that you want to use. Here, I select Reader.

Microsoft Azure

Home > Resource groups > VV_Group | Access control (IAM) >

Add role assignment

Search resources, services, and docs (G+)

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Role Members Conditions Assignment type (Preview) Review + assign

A role definition is a collection of permissions. You can use the built-in roles or you can create your own custom roles. [Learn more](#)

Job function roles Privileged administrator roles

Grant access to Azure resources based on job function, such as the ability to create virtual machines.

Name	Description	Type	Category	Details
Reader	View all resources, but does not allow you to make any changes.	BuiltinRole	General	View
AcrlDelete	acr delete	BuiltinRole	Containers	View
AcrlImageSigner	acr image signer	BuiltinRole	Containers	View
AcrlPull	acr pull	BuiltinRole	Containers	View
AcrlPush	acr push	BuiltinRole	Containers	View
AcrQuarantineReader	acr quarantine data reader	BuiltinRole	Containers	View
AcrQuarantineWriter	acr quarantine data writer	BuiltinRole	Containers	View
Advisor Recommendations Contributor	View assessment recommendations, accepted review recommendations, and manage the recommendations lifecycle (m...)	BuiltinRole	None	View
Advisor Reviews Contributor	View reviews for a workload and triage recommendations linked to them.	BuiltinRole	None	View
Advisor Reviews Reader	View reviews for a workload and recommendations linked to them.	BuiltinRole	None	View

Review + assign Previous Next Feedback

Figure 11: Add role assignment.

Step 5: On the **Members** tab, select **User, group, or service principal** to assign the selected role to one.

Click **Select members**. Input and select user/ group. Click **Select**.

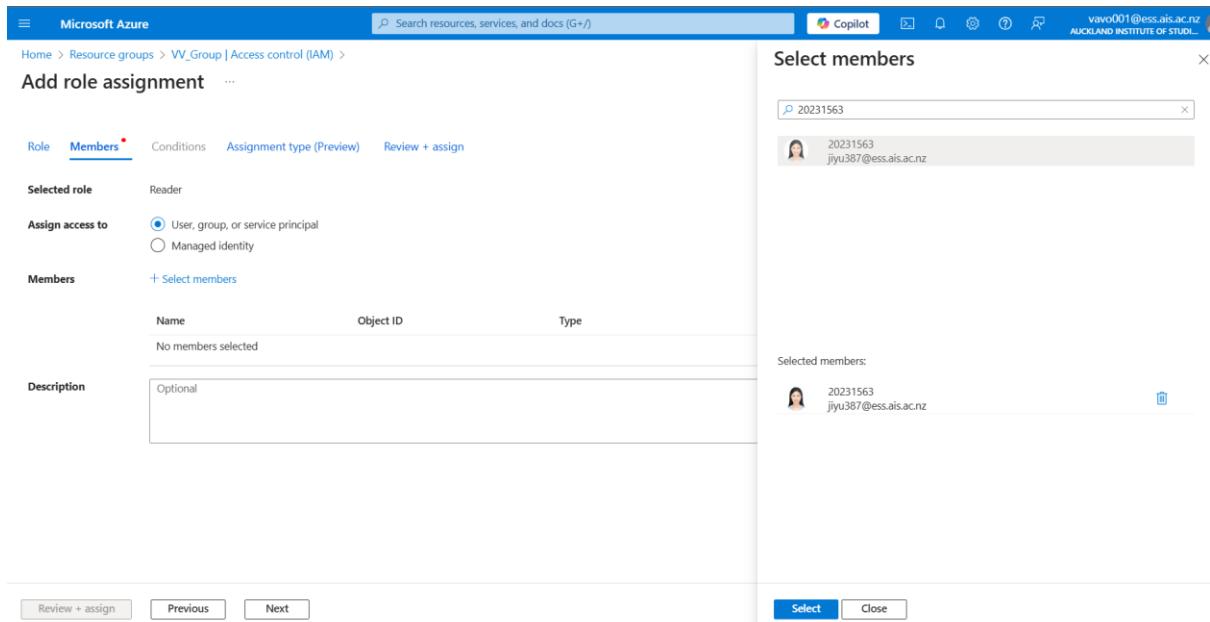


Figure 12: Select members.

Step 6: On the **Assignment type** tab, select the **Assignment type**.

For **Assignment duration**, select **Permanent** or **Time bound**.

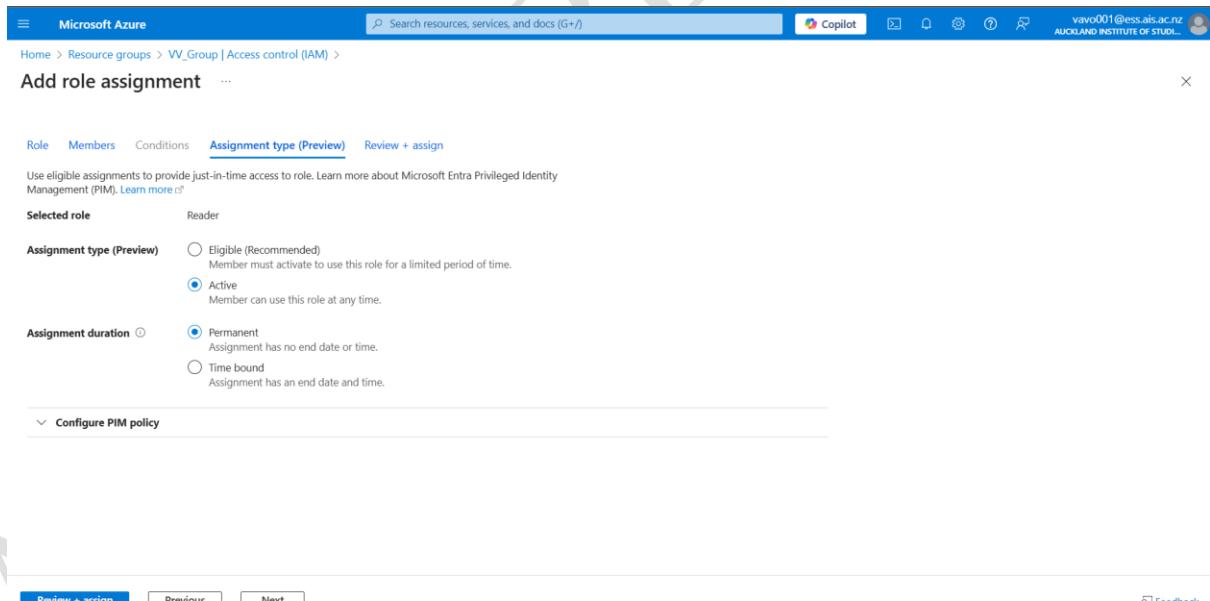


Figure 13: Select assignment type and duration.

Step 7: On the **Review + assign** tab, review the role assignment settings.

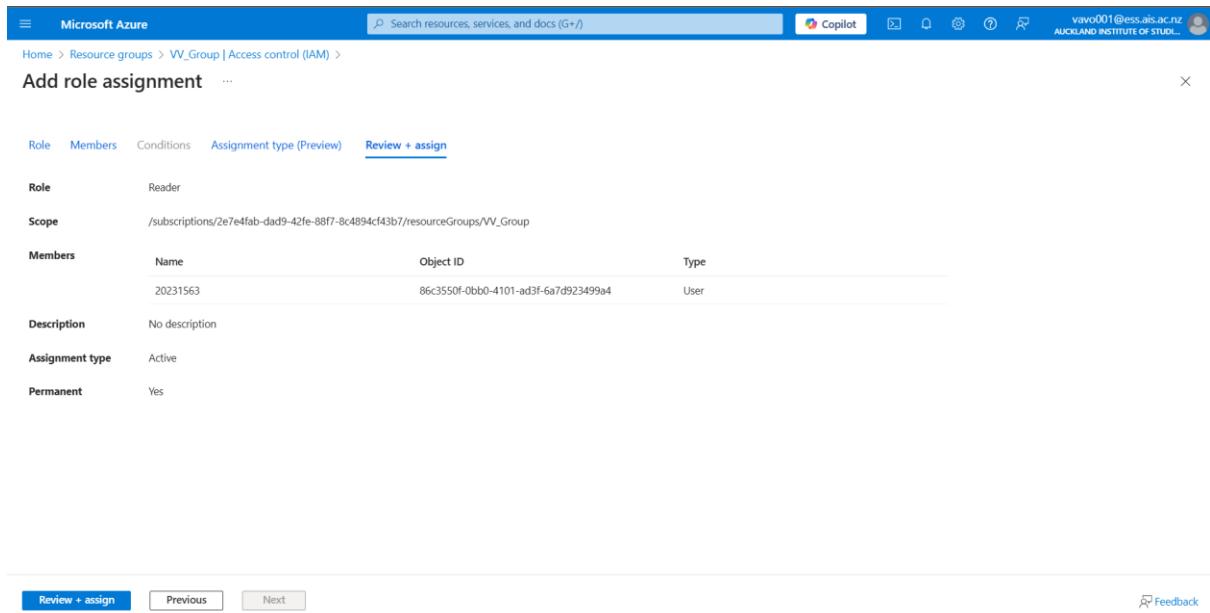


Figure 14: Review the role assignment settings.

Step 8: Click **Review + assign** to assign the role.

The new user role is created.

Microsoft Azure

Search resources, services, and docs (G+)

Copilot

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Home > Resource groups > VV_Group

VV_Group | Access control (IAM) ☆ ...

Overview Activity log Access control (IAM) Tags Resource visualizer Events Settings Cost Management Monitoring Insights (preview) Alerts Metrics Diagnostic settings Logs Advisor recommendations Workbooks Automation Help

Add Activate role Download role assignments Edit columns Refresh Delete Feedback

Check access Role assignments Roles Deny assignments Classic administrators

Number of role assignments for this subscription 2

Privileged 2

View assignments

All (3) Job function roles (1) Privileged administrator roles (2)

Name	Type	Role	Scope	State	Condition
20231563	User	Owner	Subscription (Inherited)	Active permanent	None
20231563	User	Reader	This resource	Active permanent	None
Gopi Krishna	User	User Access Administrator	Root (Inherited)	Active permanent	None

Showing 1 - 3 of 3 results.

Figure 15: The new user role is created.

2.2.3. Data Security

For the ensuing pages, the implementation of data security concepts to ensure Tech Wave Solution's reliability to their client and, on top of that, guarantee the company's data infrastructure. A Virtual Machine will be created in Microsoft Azure for the following example.

Type in the search bar for Virtual Machine and click on the first option shown. On the Basics page, fill in the required fields: Choose the Subscription, Resource Group, Virtual Machine Name, Region, Availability Options, Security Type, OS Image, VM Architecture, and Size. To secure the VM, choose a strong password.

Moving to the Disk section, it is possible to apply a security concept in this section: include a key management to the virtual machine. However, there are a few prerequisites for enabling and selecting a managed key, such as creating a disk encryption set and the key secret storage in the key vault.

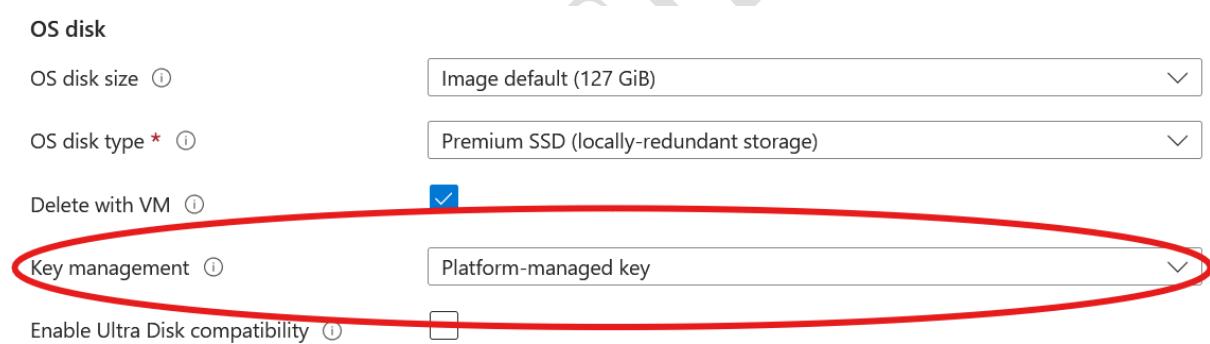


Figure 16: Include a customised key to the virtual machine

Click now on Networking to this page permits the configuration of a network interface, where it is possible to define an IP range of computer that can access your virtual machine. In that case, Tech Wave Solution might use a VM as a Web Server host and would like to restrict the computer's access to this machine.

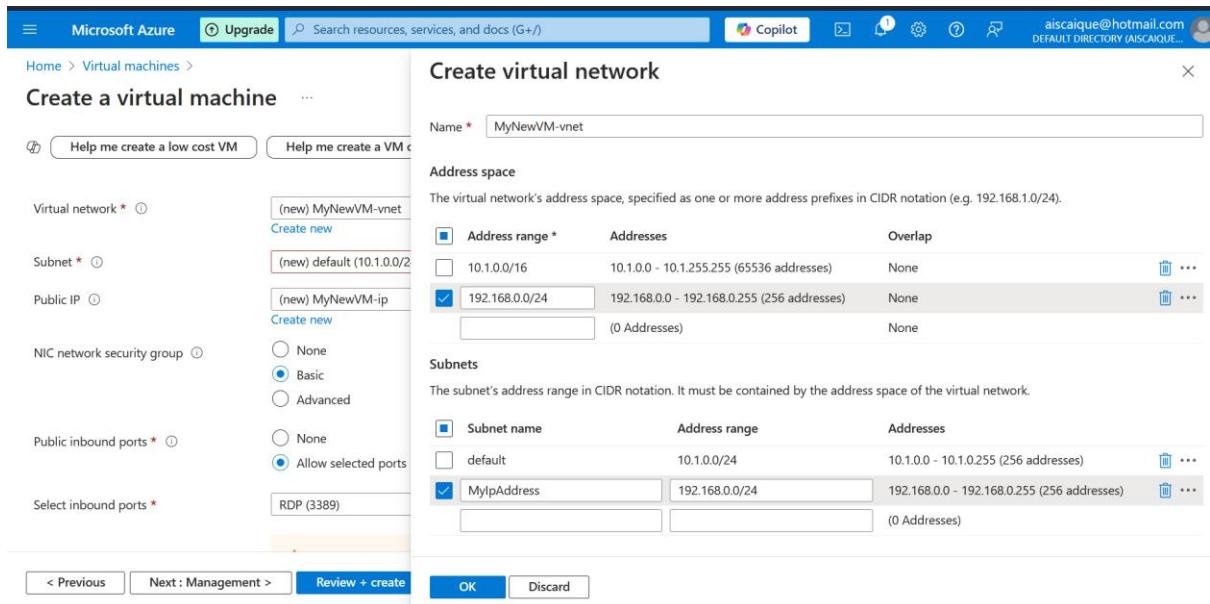


Figure 17: Creating an IP address range and a subnet address for the VM

For this virtual machine, the IP range created user is 192.168.0.0/24, which returns the range of available IPs subnet (256 addresses in the subnet). Setting a range of IPs is important for data security because it restricts the number of computers allowed to connect to a server or virtual machine.

Lastly, for a complete assurance of data safety, click on the advanced tab and include an Antimalware Extension in the virtual machine.

Microsoft Azure Virtual Machine complete overview tab

Basics	
Subscription	Azure subscription 1
Resource group	(new) VMCloud_group
Virtual machine name	VMCloud
Region	Australia Southeast
Availability options	No infrastructure redundancy required
Zone options	Self-selected zone
Security type	Trusted launch virtual machines
Enable secure boot	Yes
Enable vTPM	Yes
Integrity monitoring	No
Image	Windows Server 2022 Datacenter: Azure Edition Hotpatch - Gen2
VM architecture	x64
Size	Standard B1s (1 vcpu, 1 GiB memory)
Enable Hibernation	No
Username	cario002
Public inbound ports	RDP
Already have a Windows license?	No
Azure Spot	No

Disks

OS disk size	Image default
OS disk type	Premium SSD LRS
Use managed disks	Yes
Delete OS disk with VM	Enabled
Ephemeral OS disk	No

Networking

Virtual network	(new) MyNewVM-vnet
Subnet	(new) default (10.1.0.0/24)
Public IP	(new) VMCloud-ip
Accelerated networking	Off
Place this virtual machine behind an existing load balancing solution?	No
Delete public IP and NIC when VM is deleted	Disabled

Management

Microsoft Defender for Cloud	Basic (free)
System assigned managed identity	Off
Login with Microsoft Entra ID	Off
Auto-shutdown	Off
Backup	Disabled
Enable hotpatch	On
Patch orchestration options	Azure-orchestrated patching (preview): patches will be installed by Azure
Reboot setting	Reboot if required

Monitoring

Alerts	Off
Boot diagnostics	On
Enable OS guest diagnostics	Off
Enable application health monitoring	Off

Advanced

Extensions	Microsoft Antimalware
VM applications	None
Cloud init	No
User data	No
Disk controller type	SCSI
Proximity placement group	None
Capacity reservation group	None

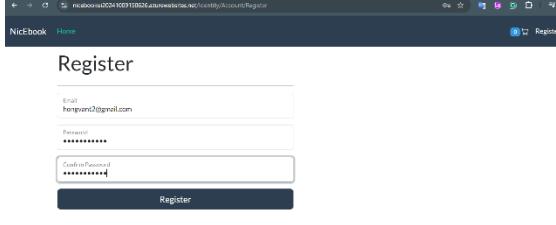
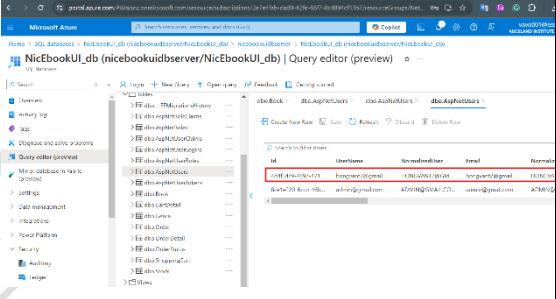
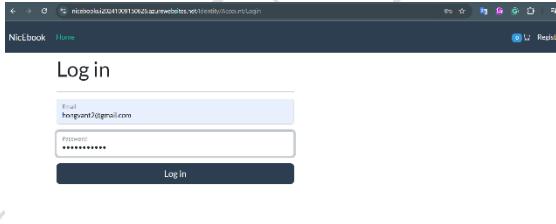
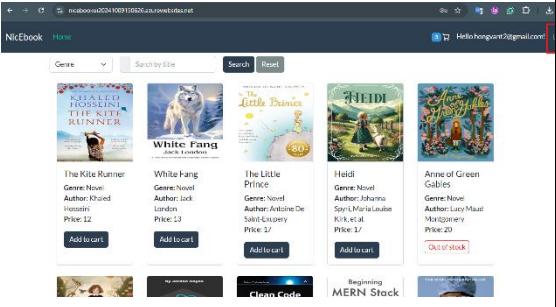
Figure 18: Virtual Machine creation page

3. Design, Develop, Deploy, and Evaluate Secure and Scalable Applications on Azure and AWS

3.1. Application Scalability

3.1.1. Application deployment on MS Azure

Interface for customer

Customers can Register an account.	The user account is saved to the cloud database.
	
Customers can Log in with the account registered.	Customers can Logout.
	
Customers can Add a book to the cart.	The book added into cart and visible in database.

NicEbook Home

Genre: Search by title | Search | Reset

White Fang
Author: Jack London
Price: 13
Add to cart

The Little Prince
Author: Antoine de Saint-Exupéry
Price: 17
Add to cart

Heidi
Author: Johanna Spyri, Maria Louise Kirk, et al.
Price: 17
Add to cart

Anne of Green Gables
Author: Lucy Maud Montgomery
Price: 20
Add to cart

nicbooku20241018t05005.azurewebsites.net/Home/Index

Hello hongyan2@gmail.com!

nicbooku20241018t05005.azurewebsites.net/Home/IndexCartCount

NicEbook Home

Genre | Search by title | Search | Reset

White Fang
Author: Jack London
Price: 13
Add to cart

The Little Prince
Author: Antoine De Saint-Exupéry
Price: 17
Add to cart

Heidi
Author: Johanna Spyri, Maria Louise Kirk, et al.
Price: 17
Add to cart

Anne of Green Gables
Author: Lucy Maud Montgomery
Price: 20
Add to cart

nicbooku20241018t05005.azurewebsites.net/Home/IndexCartCount

Hello hongyan2@gmail.com!

Customers can View the cart.

NicEbook Home

My Cart

Book	Image	Genre	Unit Price(INR)	Total Price	Action
White Fang		Novel	13 X 1	13	[+][+]
The Little Prince		Novel	17 X 1	17	[+][+]
Heidi		Novel	17 X 1	17	[+][+]

Total(INR): 47

nicbooku20241018t05005.azurewebsites.net/GetUserCart

Hello hongyan2@gmail.com!

Items in the user's cart from database.

Microsoft Azure

NicEbookUI_db (nicbookuidbserver/NicEbookUI_db) | Query editor (preview)

nicbooku20241018t05005.azurewebsites.net/GetUserCart

Hello hongyan2@gmail.com!

nicbooku20241018t05005.azurewebsites.net/Home/IndexCartCount

NicEbook Home

Genre | Search by title | Search | Reset

White Fang
Author: Jack London
Price: 13
Add to cart

The Little Prince
Author: Antoine De Saint-Exupéry
Price: 17
Add to cart

Heidi
Author: Johanna Spyri, Maria Louise Kirk, et al.
Price: 17
Add to cart

Anne of Green Gables
Author: Lucy Maud Montgomery
Price: 20
Add to cart

nicbooku20241018t05005.azurewebsites.net/Home/IndexCartCount

Hello hongyan2@gmail.com!

Customers can Update the items in the cart.

NicEbook Home

My Cart

Book	Image	Genre	Unit Price(INR)	Total Price	Action
White Fang		Novel	13 X 2	26	[+][+]
The Little Prince		Novel	17 X 4	68	[+][+]

Total(INR): 94

nicbooku20241018t05005.azurewebsites.net/GetUserCart

Hello hongyan2@gmail.com!

The cart is updated in databases.

Microsoft Azure

NicEbookUI_db (nicbookuidbserver/NicEbookUI_db) | Query editor (preview)

nicbooku20241018t05005.azurewebsites.net/GetUserCart

Hello hongyan2@gmail.com!

nicbooku20241018t05005.azurewebsites.net/Home/IndexCartCount

NicEbook Home

Genre | Search by title | Search | Reset

White Fang
Author: Jack London
Price: 13
Add to cart

The Little Prince
Author: Antoine De Saint-Exupéry
Price: 17
Add to cart

Heidi
Author: Johanna Spyri, Maria Louise Kirk, et al.
Price: 17
Add to cart

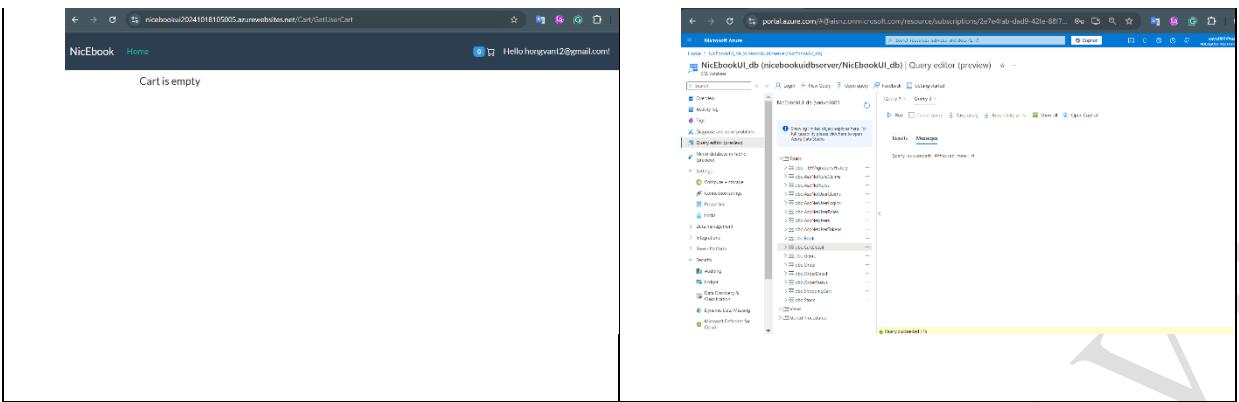
Anne of Green Gables
Author: Lucy Maud Montgomery
Price: 20
Add to cart

nicbooku20241018t05005.azurewebsites.net/Home/IndexCartCount

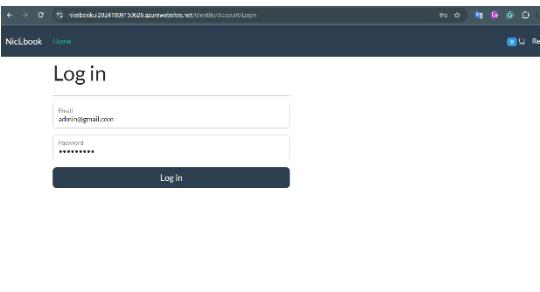
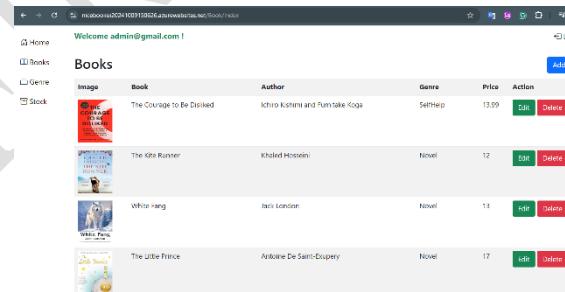
Hello hongyan2@gmail.com!

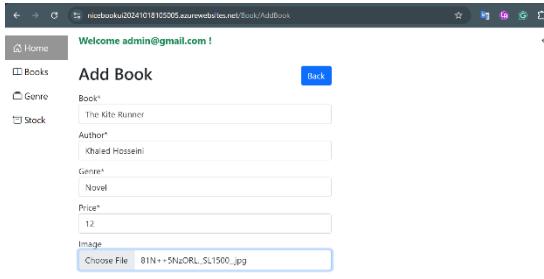
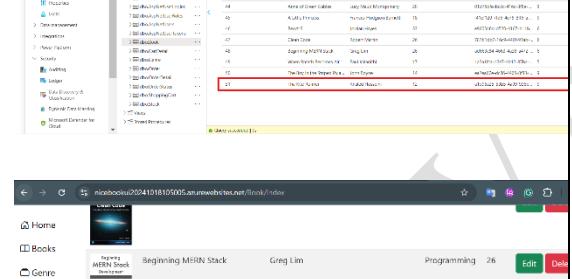
Customers can Delete all the books from the cart.

The books are deleted in databases.



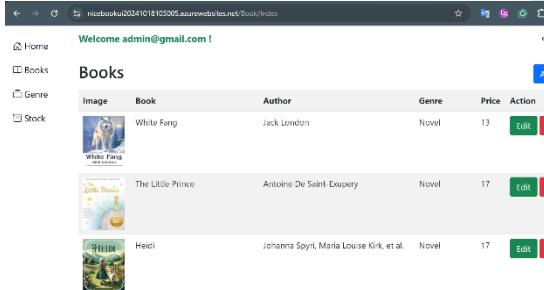
Dashboard for admin to manage system

<p>Admin can log in to the website with admin account stored in the cloud database.</p> 	<p>Admin login successfully. User can logout using the Logout button on the top-right corner.</p> 
<p>Admin can Add a new book.</p>	<p>After adding, the book is visible on the website and database.</p>

 <p>Welcome admin@gmail.com !</p> <p>Add Book</p> <p>Book* <input type="text" value="The Kite Runner"/></p> <p>Author* <input type="text" value="Khaled Hosseini"/></p> <p>Genre* <input type="text" value="Novel"/></p> <p>Price* <input type="text" value="12"/></p> <p>Image <input type="file" value="Choose File 81N++5NzORL_S1500.jpg"/></p> <p>Add</p>	 <p>NicBookUI_db [nicbookuidbserver/NicBookUI_db] Query editor (preview)</p> <p>Results Messages</p> <table border="1"> <thead> <tr> <th>ID</th> <th>BookName</th> <th>AuthorName</th> <th>Price</th> <th>Image</th> <th>Genre</th> </tr> </thead> <tbody> <tr> <td>1</td> <td>White Fang</td> <td>Jack London</td> <td>13</td> <td></td> <td>Novel</td> </tr> <tr> <td>2</td> <td>The Little Prince</td> <td>Antoine De Saint-Exupery</td> <td>17</td> <td></td> <td>Novel</td> </tr> <tr> <td>3</td> <td>Heidi</td> <td>Johanna Spyri, Maria Louise Kirk, et al.</td> <td>17</td> <td></td> <td>Novel</td> </tr> <tr> <td>4</td> <td>Anne of Green Gables</td> <td>Lucy Maud Montgomery</td> <td>20</td> <td></td> <td>Novel</td> </tr> <tr> <td>5</td> <td>War and Peace</td> <td>Leo Tolstoy</td> <td>25</td> <td></td> <td>Novel</td> </tr> <tr> <td>6</td> <td>Crime and Punishment</td> <td>Fyodor Dostoevsky</td> <td>25</td> <td></td> <td>Novel</td> </tr> <tr> <td>7</td> <td>The Brothers Karamazov</td> <td>Fyodor Dostoevsky</td> <td>25</td> <td></td> <td>Novel</td> </tr> <tr> <td>8</td> <td>The Idiot</td> <td>Fyodor Dostoevsky</td> <td>25</td> <td></td> <td>Novel</td> </tr> <tr> <td>9</td> <td>The Master and Margarita</td> <td>Fyodor Dostoevsky</td> <td>25</td> <td></td> <td>Novel</td> </tr> <tr> <td>10</td> <td>The House on the Rock</td> <td>John C. Maxwell</td> <td>15</td> <td></td> <td>SelfHelp</td> </tr> <tr> <td>11</td> <td>The Seven Habits of Highly Effective People</td> <td>Raymond James</td> <td>15</td> <td></td> <td>SelfHelp</td> </tr> <tr> <td>12</td> <td>The 48 Laws of Power</td> <td>Robert Greene</td> <td>20</td> <td></td> <td>SelfHelp</td> </tr> <tr> <td>13</td> <td>The Art of War</td> <td>Sun Tzu</td> <td>15</td> <td></td> <td>Strategy</td> </tr> <tr> <td>14</td> <td>The 7 Habits of Highly Effective Families</td> <td>Raymond James</td> <td>15</td> <td></td> <td>SelfHelp</td> </tr> <tr> <td>15</td> <td>The 7 Habits of Highly Effective Teenagers</td> <td>Raymond James</td> <td>15</td> <td></td> <td>SelfHelp</td> </tr> <tr> <td>16</td> <td>The 7 Habits of Highly Effective Teachers</td> <td>Raymond James</td> <td>15</td> <td></td> <td>SelfHelp</td> </tr> <tr> <td>17</td> <td>The 7 Habits of Highly Effective Families</td> <td>Raymond James</td> <td>15</td> <td></td> <td>SelfHelp</td> </tr> <tr> <td>18</td> <td>The 7 Habits 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All the books from database.

 <p>Welcome admin@gmail.com !</p> <p>Books</p> <table border="1"> <thead> <tr> <th>Image</th> <th>Book</th> <th>Author</th> <th>Genre</th> <th>Price</th> <th>Action</th> </tr> </thead> <tbody> <tr> <td></td> <td>White Fang</td> <td>Jack London</td> <td>Novel</td> <td>13</td> <td>Edit Delete</td> </tr> <tr> <td></td> <td>The Little Prince</td> <td>Antoine De Saint-Exupery</td> <td>Novel</td> <td>17</td> <td>Edit Delete</td> </tr> <tr> <td></td> <td>Heidi</td> <td>Johanna Spyri, Maria Louise Kirk, et al.</td> <td>Novel</td> <td>17</td> <td>Edit Delete</td> </tr> <tr> <td></td> <td>Anne of Green Gables</td> <td>Lucy Maud Montgomery</td> <td>Novel</td> <td>20</td> <td>Edit Delete</td> </tr> </tbody> </table>	Image	Book	Author	Genre	Price	Action		White Fang	Jack London	Novel	13	Edit Delete		The Little Prince	Antoine De Saint-Exupery	Novel	17	Edit Delete		Heidi	Johanna Spyri, Maria Louise Kirk, et al.	Novel	17	Edit Delete		Anne of Green Gables	Lucy Maud Montgomery	Novel	20	Edit Delete
Image	Book	Author	Genre	Price	Action																									
	White Fang	Jack London	Novel	13	Edit Delete																									
	The Little Prince	Antoine De Saint-Exupery	Novel	17	Edit Delete																									
	Heidi	Johanna Spyri, Maria Louise Kirk, et al.	Novel	17	Edit Delete																									
	Anne of Green Gables	Lucy Maud Montgomery	Novel	20	Edit Delete																									

The book is updated successfully on UI and database.

The screenshot shows the 'Update Book' form. The book 'White Fang - edited' is selected. The author is Jack London, genre is Novel, and price is 10. The image is a placeholder for 'White Fang'. The 'Edit' button is highlighted.

Image	Book	Author	Genre	Price	Action
	White Fang - edited	Jack London	Novel	10	Edit
	The Little Prince	Antoine De Saint-Exupery	Novel	17	Edit
	Heidi	Johanna Spyri, Maria Louise Kirk, et al.	Novel	17	Edit
	Anne of Green Gables	Lucy Maud Montgomery	Novel	20	Edit

The screenshot shows the Microsoft Azure portal's Query editor. The 'Books' table is displayed with the following data:

ID	Title	Author	Genre	Price
1	White Fang	Jack London	Novel	10
2	The Little Prince	Antoine De Saint-Exupery	Novel	17
3	Heidi	Johanna Spyri, Maria Louise Kirk, et al.	Novel	17
4	Anne of Green Gables	Lucy Maud Montgomery	Novel	20

Admin can Delete a book.

The book is deleted successfully on UI and database.

The screenshot shows the 'Books' list page. The book 'White Fang - edited' is no longer present in the list, indicating it has been deleted.

Image	Book	Author	Genre	Price	Action
	The Little Prince	Antoine De Saint-Exupery	Novel	17	Edit
	Heidi	Johanna Spyri, Maria Louise Kirk, et al.	Novel	17	Edit
	Anne of Green Gables	Lucy Maud Montgomery	Novel	20	Edit
	A Little Princess	Frances Hodgson Burnett	Novel	18	Edit

The screenshot shows the Microsoft Azure portal's Query editor. The 'Books' table is displayed with the following data:

ID	Title	Author	Genre	Price
1	White Fang	Jack London	Novel	10
2	The Little Prince	Antoine De Saint-Exupery	Novel	17
3	Heidi	Johanna Spyri, Maria Louise Kirk, et al.	Novel	17
4	Anne of Green Gables	Lucy Maud Montgomery	Novel	20
5	A Little Princess	Frances Hodgson Burnett	Novel	18

Application scalability

- Vertical scale

Scale up/down to upgrade or downgrade CPU, memory, diskspace and many more in windows Azure as per our requirements. The prices will also have to be adjusted to suit these new levels of cost.

Step 1: Open the Application deployed on App Service. On the left bar, select Scale up.

SKU	ACU	CPU	RAM	Storage	Price
Premium v3 P0V3	195*	1	4	250	0.164 USD
Premium v3 P1V3	195	2	8	250	0.328 USD
Premium v3 P1mv3	195*	2	16	250	0.362 USD
Premium v3 P2V3	195	4	16	250	0.656 USD
Premium v3 P3V3	195	8	32	250	1.312 USD
Premium v3 P2mv3	195*	4	32	250	0.723 USD
Premium v3 P3mv3	195*	8	64	250	1.446 USD
Premium v3 P4mv3	195*	16	128	250	2.893 USD
Premium v3 P5mv3	195*	32	256	250	5.786 USD

Figure 19: MS Azure vertical scale step 1

Step 2: Select a plan, then click Select button. Then select Upgrade button to confirm.

SKU	ACU	CPU	RAM	Storage	Price
Premium v3 P1V3	195	2	8	250	0.328 USD
Premium v3 P1mv3	195*	2	16	250	0.362 USD
Premium v3 P2V3	195	4	16	250	0.656 USD
Premium v3 P3V3	195	8	32	250	1.312 USD
Premium v3 P2mv3	195*	4	32	250	0.723 USD
Premium v3 P3mv3	195*	8	64	250	1.446 USD
Premium v3 P4mv3	195*	16	128	250	2.893 USD
Premium v3 P5mv3	195*	32	256	250	5.786 USD

Figure 20: MS Azure vertical scale step 2

Step 3: App service plan is updated successfully.

SKU	ACU	CPU	Memory	Storage	Bandwidth	Price	Price
Premium v3 P0V3	195*	1	4	250	0.164 USD	119.72 USD	
Premium v3 P1V3	195	2	8	250	0.328 USD	239.44 USD	
Premium v3 P1mv3	195*	2	16	250	0.362 USD	263.968 USD	
Premium v3 P2V3	195	4	16	250	0.656 USD	478.88 USD	
Premium v3 P3V3	195	8	32	250	1.312 USD	957.76 USD	
Premium v3 P2mv3	195*	4	32	250	0.723 USD	527.936 USD	
Premium v3 P3mv3	195*	8	64	250	1.446 USD	1055.872 USD	
Premium v3 P4mv3	195*	16	128	250	2.893 USD	2111.744 USD	
Premium v3 P5mv3	195*	32	256	250	5.786 USD	4223.488 USD	

Figure 21: MS Azure vertical scale step 3

➤ Horizontal scale

Scale in/ out (increase or decrease the number of instance count)

Step 1: Open App Service plan, then select Scale out (App Service plan).

Scaling

App service provides multiple features that help applications perform their best when scaling demand changes. You can choose to scale your resource manually to a specific instance count, or via a custom Autoscale rule based policy that scales based on metric(s) thresholds, or schedule instance count which scales during designated time windows. You can also use Automatic Scaling features which enables platform managed scale in and scale out for your apps based on incoming HTTP traffic. [Learn more about Azure Autoscale, Automatic Scaling or view the how-to video.](#)

Scaling method:

- Manual: Maintain a constant instance count for your application
- Automatic: Platform managed scale out and in based on traffic
- Rules Based: User defined rules to scale on a schedule or based on any app metric

Instance count:

Save Discard

Figure 22: MS Azure horizontal scale step 1

Step 2: Select scaling method, increasing/ decreasing instance count, then select Save.

The screenshot shows the Microsoft Azure portal interface. The top navigation bar includes the URL portal.azure.com/#@aisnz.onmicrosoft.com/resource/subscriptions/2e7e4fab-dad9-42fe-88f7-8c4894cf43b7/resourceGroups/Net..., the Microsoft Azure logo, a search bar with placeholder text 'Search resources, services, and docs (G+)', and various account and settings icons.

The main content area displays the title 'NicEbookUI20241009150626 | Scale out (App Service plan)'. Below the title, there's a 'Web App' icon and the status 'Scale out'. A green checkmark icon indicates the 'Scale out' operation has been submitted. To the right, a message states: 'The scale out operation for the plan 'NicEbookUI20241009150626Plan' has been submitted.'

The left sidebar contains a navigation menu with the following items:

- Custom domains
- Certificates
- Networking
- Scale up (App Service plan)
- Scale out (App Service plan)** (selected)
- WebJobs
- MySQL In App
- Service Connector
- Properties
- Locks

The 'Scale out (App Service plan)' section is expanded, showing the 'Scaling' sub-section. It describes how App service provides multiple features for scaling demand changes, including manual scaling (selected), automatic scaling based on traffic, and rules-based scaling. It also links to 'Azure Autoscale', 'Automatic Scaling', and a 'how-to video'.

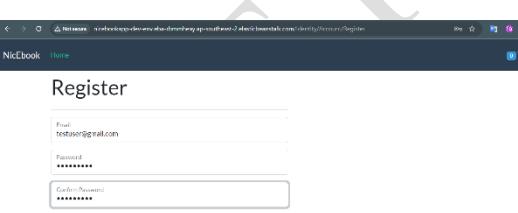
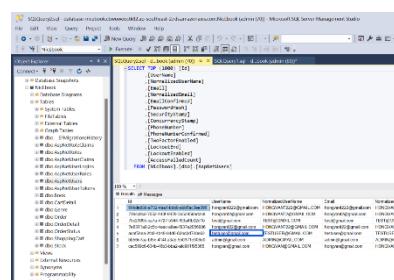
The 'Scale out method' section shows three options: 'Manual' (selected), 'Automatic', and 'Rules Based'. The 'Instance count' section includes a slider set to 4 and a text input field showing the value 4.

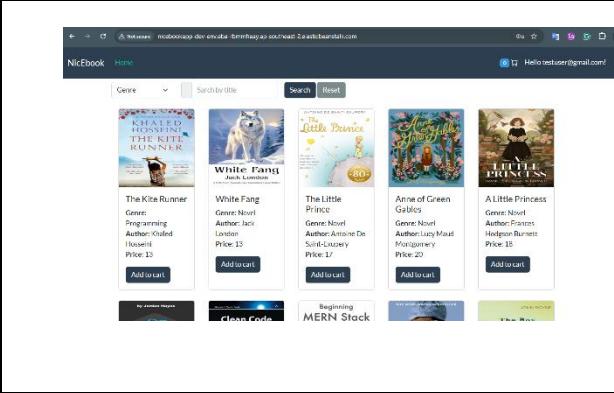
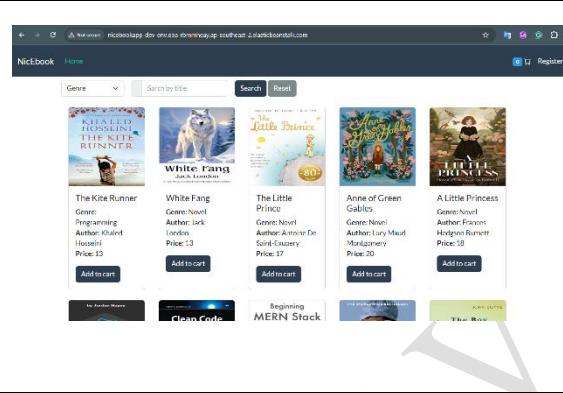
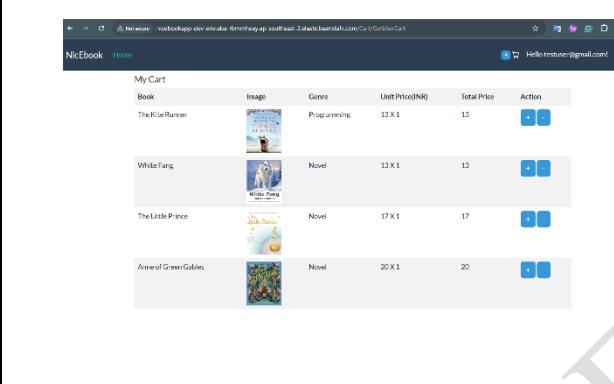
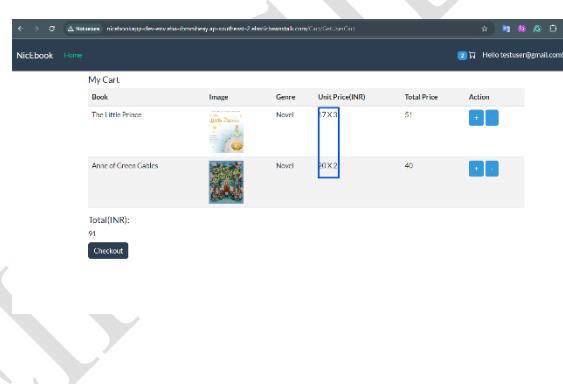
At the bottom, there are 'Save' and 'Discard' buttons.

Figure 23: MS Azure horizontal scale step 2

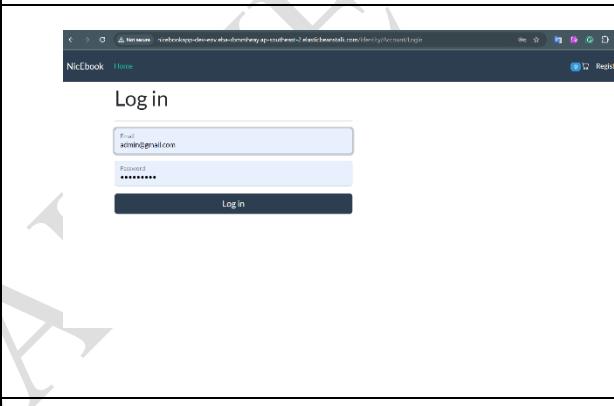
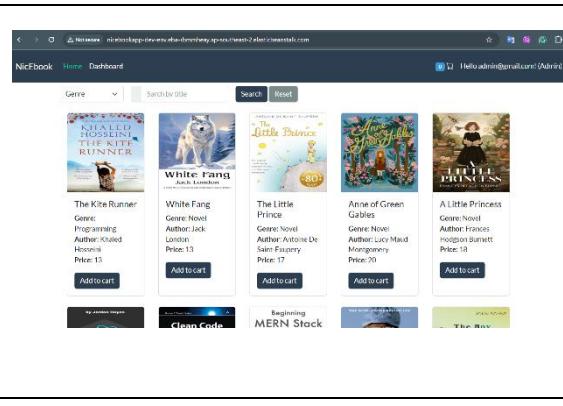
3.1.2. Application deployment on Amazon Web Services

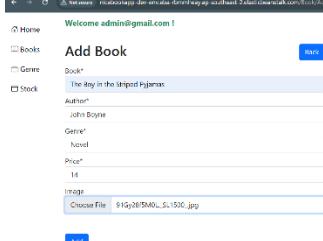
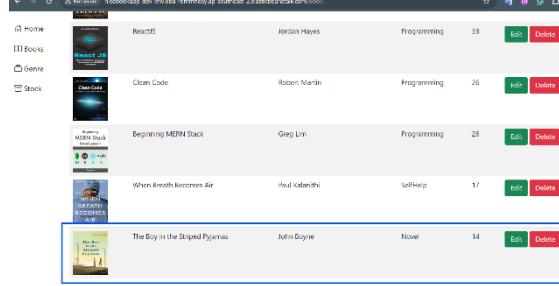
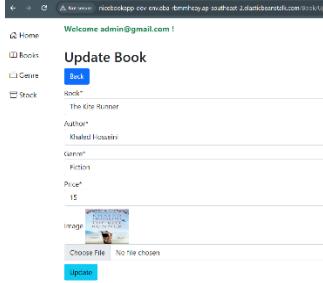
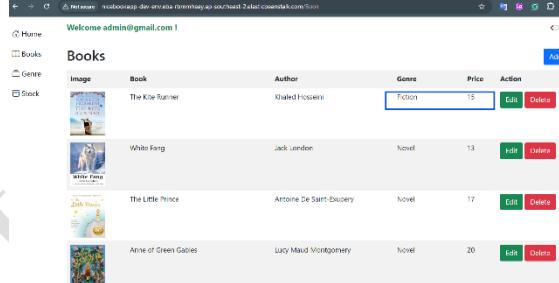
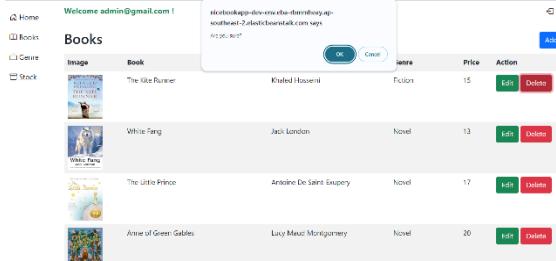
Interface for customer

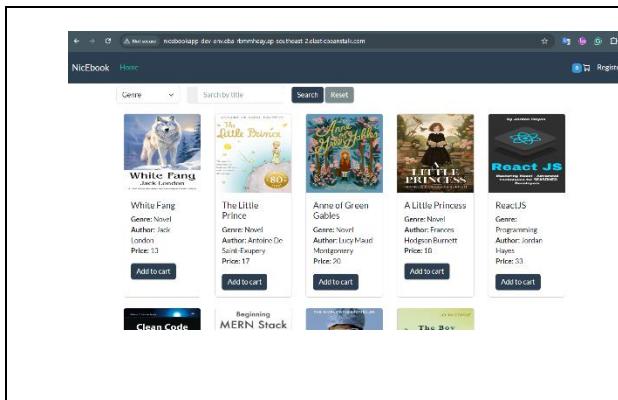
<p>Customers can Register an account.</p>	<p>The user account is saved to the cloud database.</p>
	
<p>Customers can Log in with the account registered.</p>	<p>Customers can Logout.</p>

	
<p>Customers can View the items in the cart.</p>	<p>Customers can Edit the items in the cart.</p>
	

Dashboard for admin to manage system

<p>Admin can log in to the website with admin account stored in the cloud database.</p>	<p>Admin login successfully.</p>
	
<p>Admin can Add new book.</p>	<p>After adding, the book is visible on the website.</p>

	
<p>Admin can Edit.</p>	<p>After adding, the book is updated on the website.</p>
	
<p>Admin can Delete a book.</p>	<p>The book is deleted successfully.</p>
	
<p>Admin can logout.</p>	



Application scalability

- Vertical scale

Scale up/down to upgrade or downgrade CPU, memory, diskspace and many more in windows Azure as per our requirements. The prices will also have to be adjusted to suit these new levels of cost.

Step 1: Open Elastic Beanstalk and navigate to configuration.

Scroll down to Instance traffic and scaling, and select Edit.

The screenshot shows the AWS Elastic Beanstalk configuration interface. On the left, there's a sidebar with 'Elastic Beanstalk' selected. Under 'Configuration', 'Events', 'Health', 'Logs', 'Monitoring', 'Alarms', 'Managed updates', and 'Tags' are listed. Under 'Recent environments', 'Nicelbookapp-dev-env', 'Nicelbookapp-dev-env', 'Nicelbook-3rd-dev-env', 'Nicelbook4-dev-env', and 'Nicelbook-2nd-dev-env' are listed. The main panel shows a success message about environment updates. Below it, under 'Configuration', there are sections for 'Service access', 'Networking and database', 'Network', and 'Instance traffic and scaling'. The 'Instance traffic and scaling' section is highlighted with a blue box. It contains a note about customizing capacity and scaling for instances, selecting security groups, and configuring software. Buttons for 'Edit', 'Cancel', 'Review changes', and 'Apply changes' are at the bottom right.

Figure 24: AWS vertical scale step 1

Step 2: On the Configure instance traffic and scaling screen, select Root volume type.

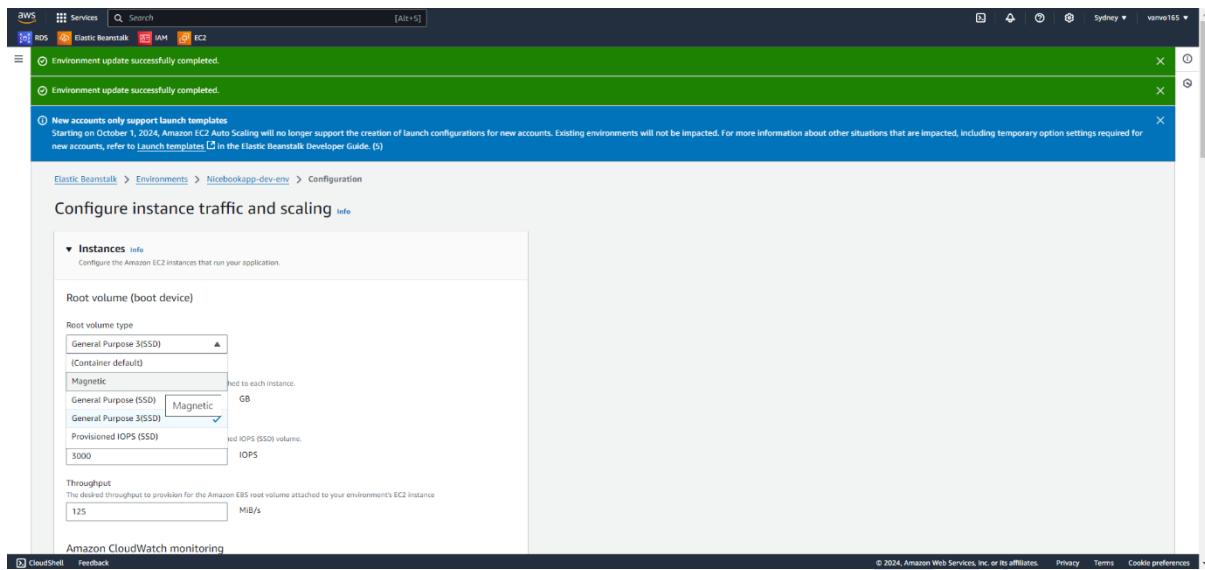


Figure 25: AWS vertical scale step 2

Step 3: Modify the Size of the instance.

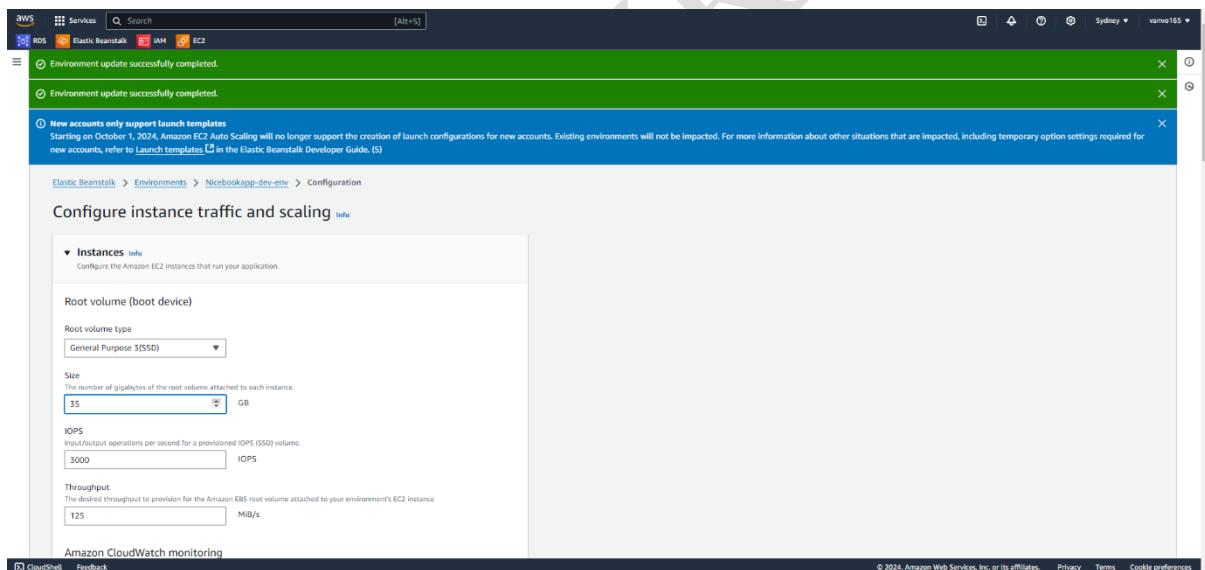


Figure 26: AWS vertical scale step 3

Step 4: Select Instance type.

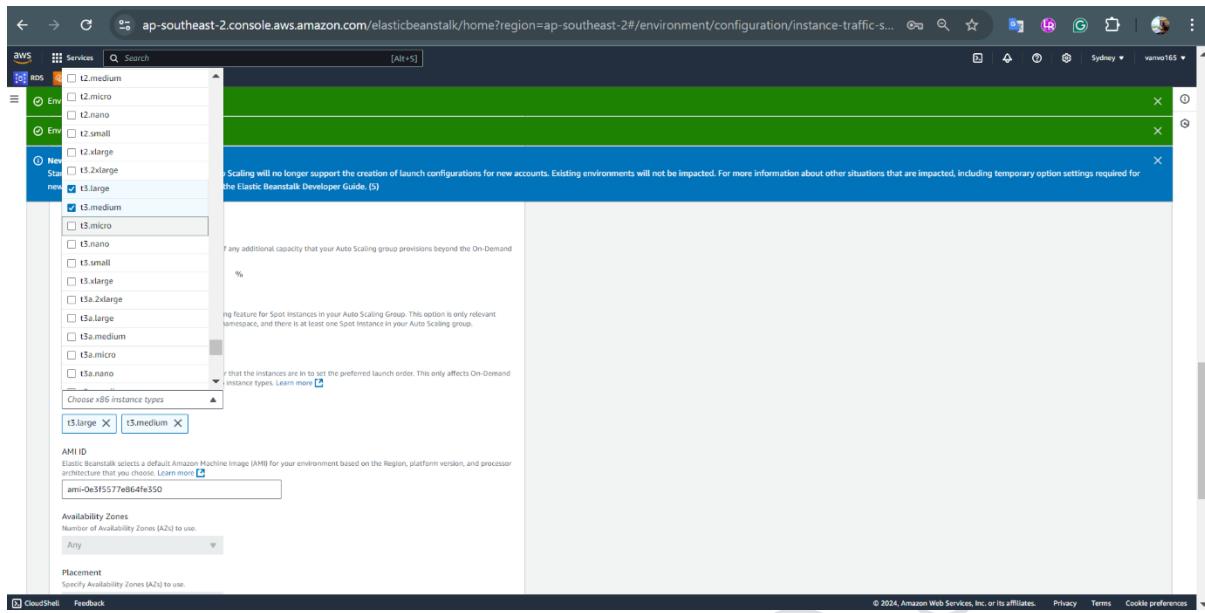


Figure 27: AWS vertical scale step 4

➤ Horizontal scale

Scale in/ out (increase or decrease the number of instance count)

Step 1: Scroll down to Capacity section, change number of instances.

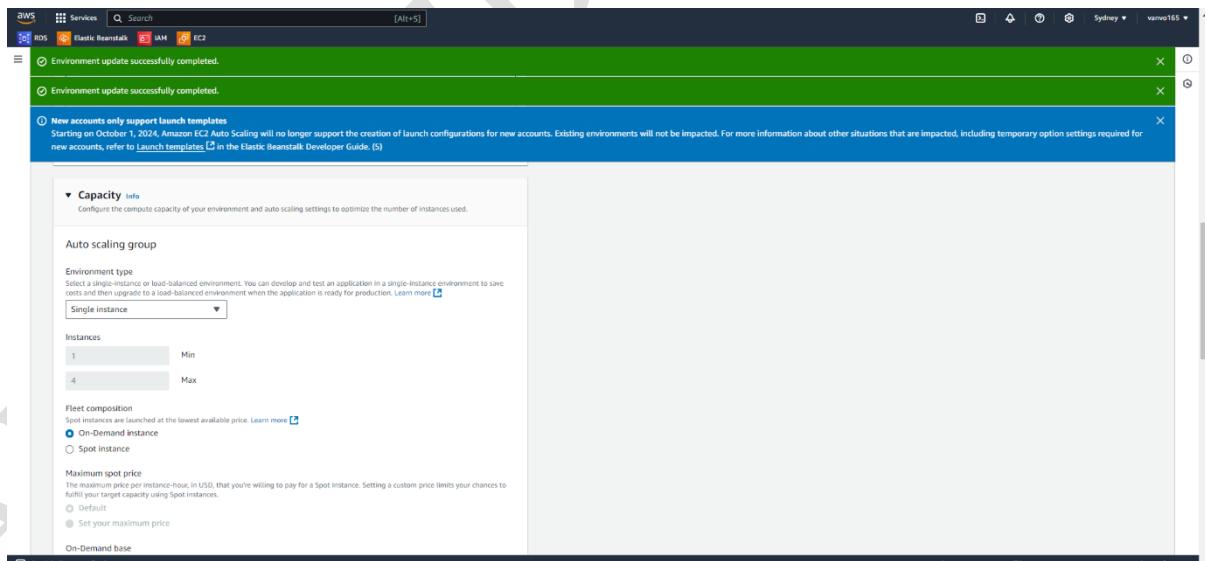


Figure 28: AWS horizontal scale step 1

Step 2: Click Apply to apply changes.

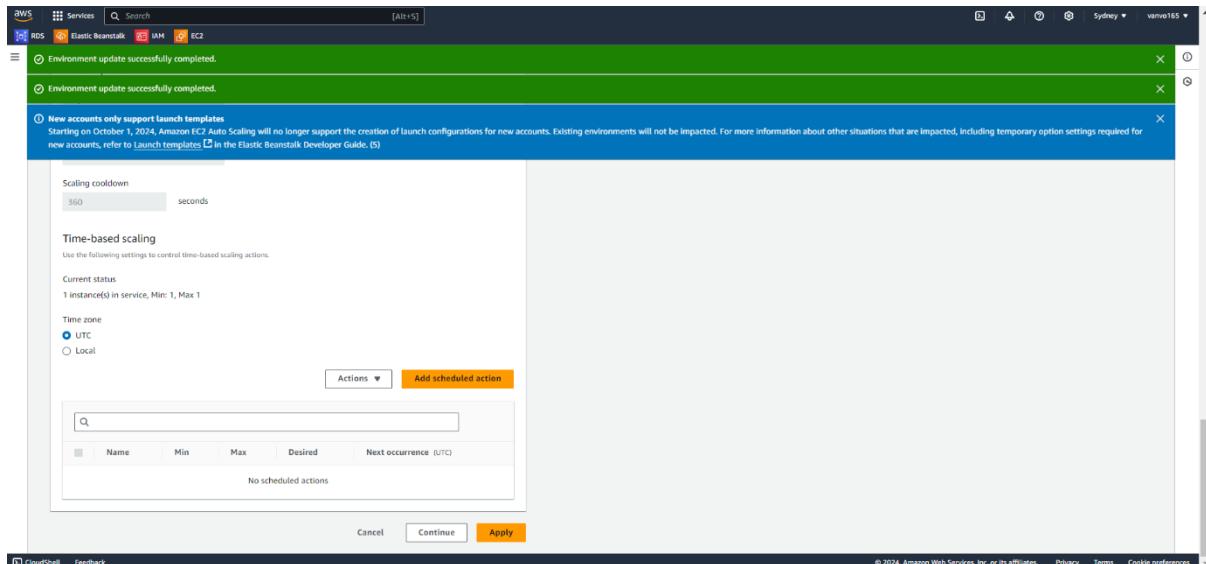


Figure 29: AWS horizontal scale step 2

3.2. Infrastructure Security

3.2.1. Antimalware Configuration for Azure

Step 1: Create a VM for configuration.

Microsoft Azure Search resources, services, and docs (G+) Copilot AUSTRALIA INSTITUTE OF STUD... jiyu387@essais.ac.cn

Home > Virtual machines > Create a virtual machine

Validation passed

Help me create a low cost VM | Help me create a VM optimized for high availability | Help me choose the right VM size for my workload

Basics Disks Networking Management Monitoring Advanced Tags **Review + create**

Price

1 X Standard DS1 v2 by Microsoft Subscription credits apply ⓘ **0.1400 USD/hr** [Pricing for other VM sizes](#)

TERMS

By clicking "Create", I (a) agree to the legal terms and privacy statement(s) associated with the Marketplace offering(s) listed above; (b) authorize Microsoft to bill my current payment method for the fees associated with the offering(s), with the same billing frequency as my Azure subscription; and (c) agree that Microsoft may share my contact, usage and transactional information with the provider(s) of the offering(s) for support, billing and other transactional activities. Microsoft does not provide rights for third-party offerings. See the [Azure Marketplace Terms](#) for additional details.

⚠️ You have set RDP, SSH port(s) open to the internet. This is only recommended for testing. If you want to change this setting, go back to Basics tab.

Basics

Subscription	Azure for Students
Resource group	(new) VV_group
Virtual machine name	BackEndApp
Region	Australia East
Availability options	Availability zone
Zone options	Self-selected zone
Availability zone	1
Security type	Trusted launch virtual machines
Enable secure boot	Yes
Enable TPM	Yes
Integrity monitoring	No
Image	Windows Server 2022 Datacenter: Azure Edition - Gen2
VM architecture	x64
Size	Standard DS1 v2 (1 vcpu, 3.5 GiB memory)
Enable Hibernation	No
Username	ellyjj
Public inbound ports	RDP, SSH
Already have a Windows license?	No
Azure Spot	No

Disks

OS disk size	Image default
OS disk type	Premium SSD LRS
Use managed disks	Yes
Delete OS disk with VM	Enabled
Ephemeral OS disk	No

Networking

Virtual network	(new) BackEndApp-vnet
Subnet	(new) default (10.0.0.0/24)
Public IP	(new) BackEndApp-ip
Accelerated networking	On
Place this virtual machine behind an existing load balancing solution?	No
Delete public IP and NIC when VM is deleted	Enabled

Management

Microsoft Defender for Cloud	None
System assigned managed identity	Off
Login with Microsoft Entra ID	Off
Auto-shutdown	Off
Enable hotpatch	Off
Patch orchestration options	OS-orchestrated patching: patches will be installed by OS

Monitoring

Alerts	Off
Boot diagnostics	On
Enable OS guest diagnostics	Off
Enable application health monitoring	Off

Advanced

Extensions	None
VM applications	None
Cloud init	No
User data	No
Disk controller type	SCSI
Proximity placement group	None
Capacity reservation group	None

< Previous Next > **Create** Download a template for automation ⚙ Give feedback

Figure 30: Create a virtual machine

Or choose a VM which exists and needs the antimalware software.

The screenshot shows the Microsoft Azure portal interface. The top navigation bar includes the Azure logo, a search bar, and user information. Below the header, the 'VV_group' resource group is selected. The left sidebar has a tree view with 'Overview' selected. The main content area shows a table of resources under the 'Resources' tab. The table includes columns for Name, Type, Location, and three-dot more options. The resources listed are:

Name	Type	Location	More Options
BackEndApp	Virtual machine	Australia East	...
BackEndApp-ip	Public IP address	Australia East	...
BackEndApp-nsg	Network security group	Australia East	...
BackEndApp-vnet	Virtual network	Australia East	...
backendapp861_z1	Network Interface	Australia East	...
BackEndApp_OsDisk_1_52a3d03b40f14fd430e7b21c903f8a3	Disk	Australia East	...

At the bottom, there are navigation links for < Previous, Page 1 of 1, and Next >, along with a 'Give feedback' link.

Figure 31: Choose a VM

Step 2: In the VM's Settings, choose [Extension + applications], then click [Add] to add an extension.

The screenshot shows the Microsoft Azure portal interface, specifically the settings for the 'BackEndApp' virtual machine. The top navigation bar and sidebar are similar to the previous screenshot. The left sidebar has a tree view with 'Extensions + applications' selected. The main content area shows the 'Extensions' blade. At the top, there are three informational cards: 'What extensions can help me keep my virtual machine secure?', 'What is the difference between VM applications and extensions?', and 'What are the types of VM extensions available?'. Below these is a search bar and a table header for extensions. The table has columns for Name, Type, Version, Latest Version, Status, and Automatic upgrad. The message 'Showing all 0 items' is displayed, indicating no extensions have been added yet.

Figure 32: Add an extension to this VM

Step 3: Search Microsoft Antimalware and click Next.

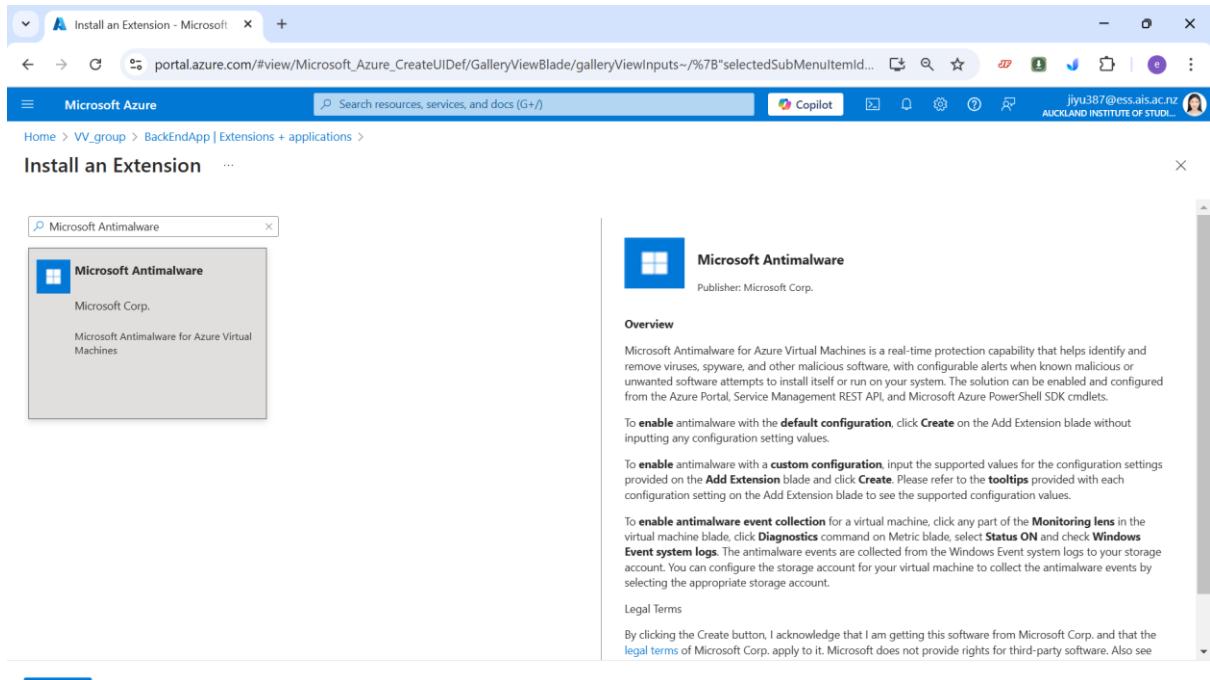


Figure 33: Install Microsoft Antimalware to this VM

Step 3: Configure the extension on Azure. Configure the Microsoft Antimalware extension with the following settings:

- Exclude file and locations: choose C:\Temp, for example
- Exclude file extensions: None
- Exclude processes: None
- Real-time protection: Choose Enable to protect the server
- Run a scheduled scan: Enable a scheduled scan every Saturday at 2:00 AM to scan the full disk.

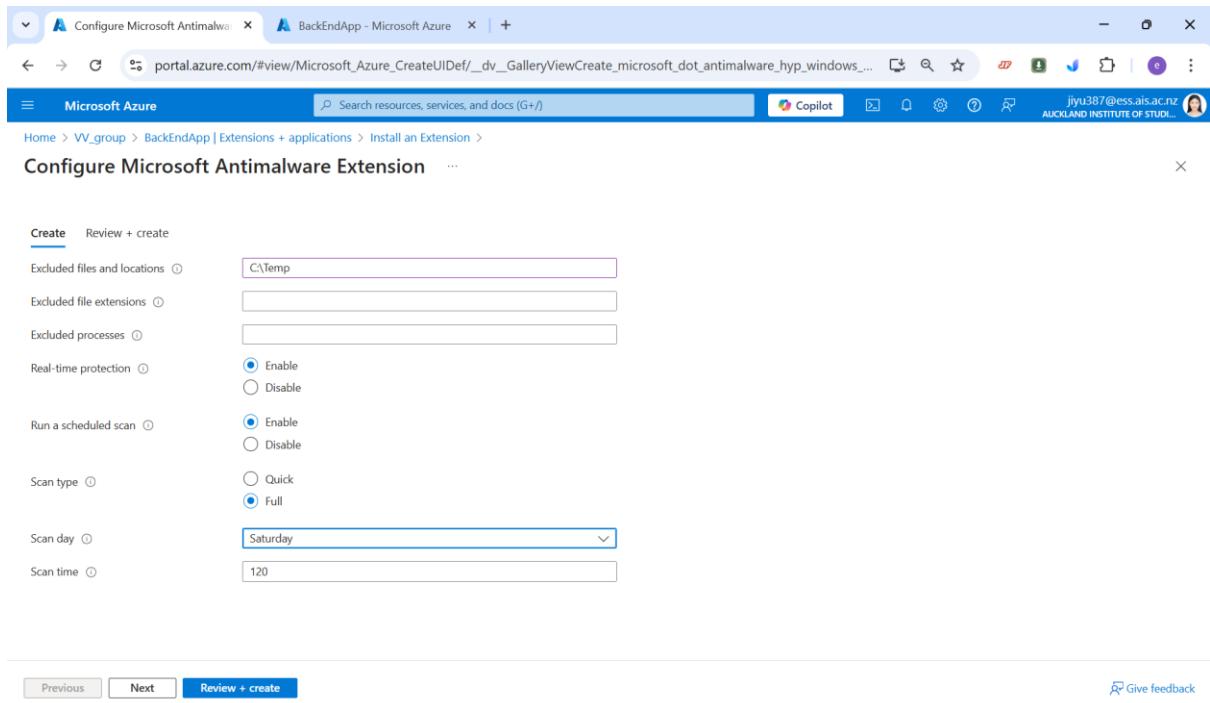
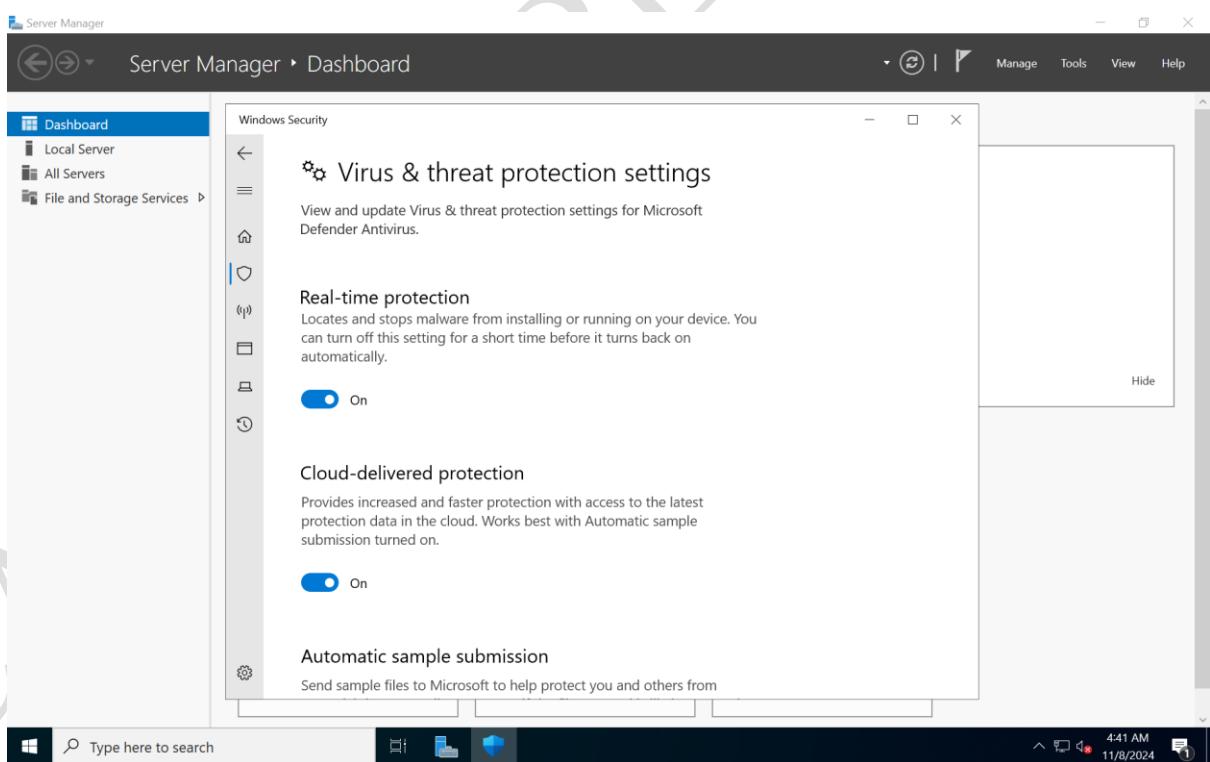


Figure 34: Configure the extension

Step 4: Check the settings and running status on the server.



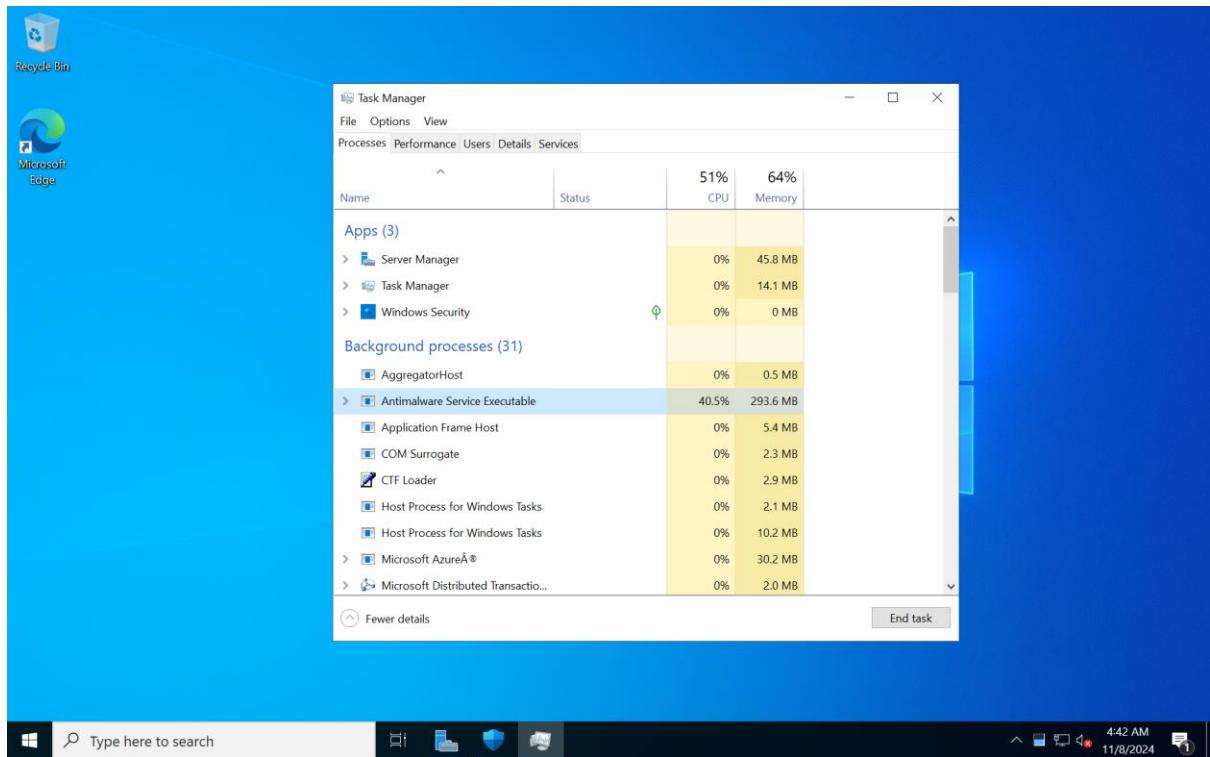


Figure 35: The Antimalware Service is configured and running

3.2.2. Antimalware Configuration for AWS

Step 1: Search GuardDuty in AWS services, try threat detection with Amazon GuardDuty - all features.

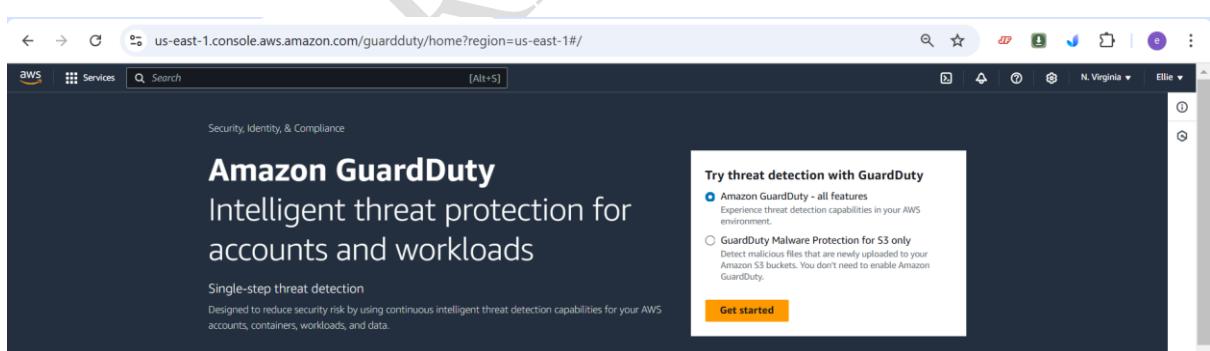


Figure 36: Choose the start the GuardDuty

Step 2: Read the protection plans and enable GuardDuty.

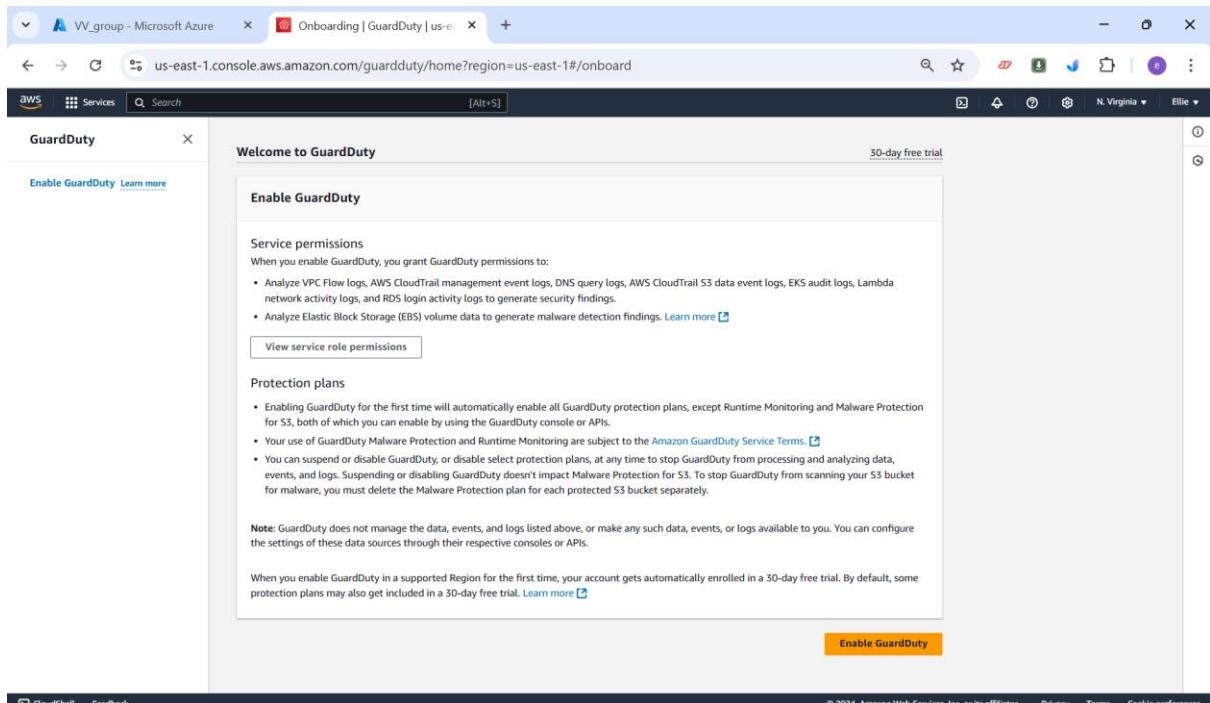


Figure 37: Enable GuardDuty

Step 2: After successfully enabled GuardDuty, the summary page shows the main information about the service. The resource of the account is under protection of antimalware.

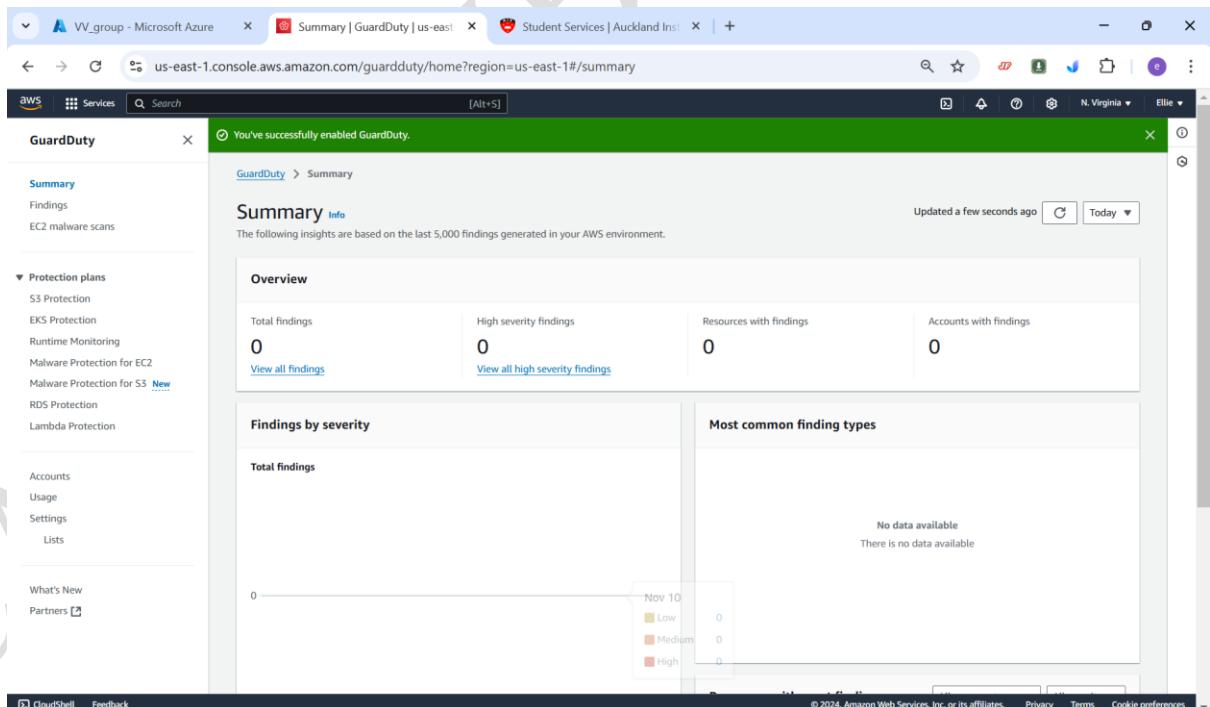


Figure 38: Summary page of GuardDuty

Step 3: The GuardDuty scan the AWS environment, and try to find security vulnerabilities.

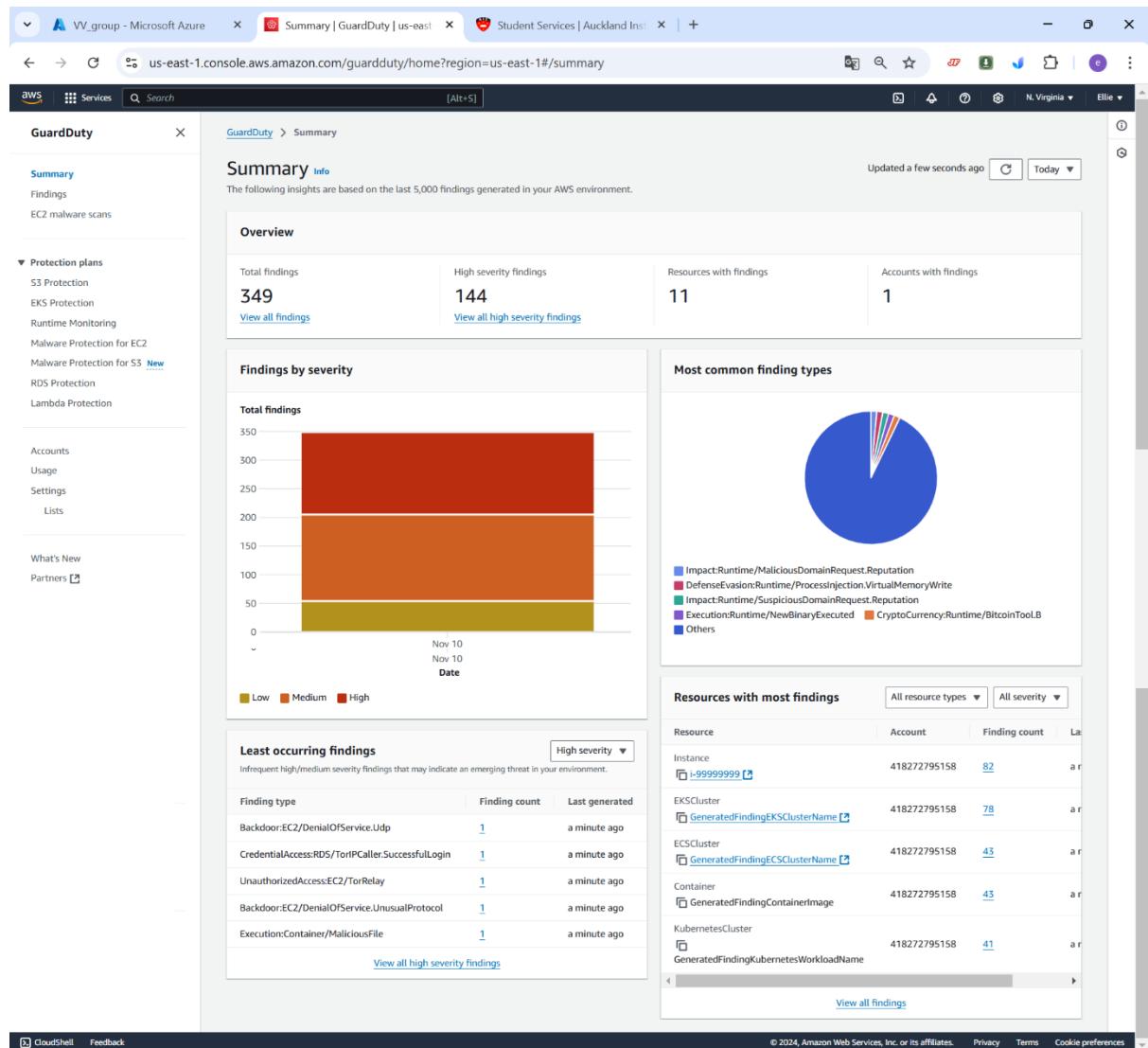


Figure 39: Summary of GuardDuty service with sample data

Step 4: Users can check the details of findings

The screenshot shows the AWS GuardDuty Findings page. The left sidebar includes sections for Summary, Findings (selected), EC2 malware scans, Protection plans (SS Protection, EKS Protection, Runtime Monitoring, Malware Protection for EC2, Malware Protection for S3, RDS Protection, Lambda Protection), Accounts, Usage, Settings, Lists, What's New, and Partners. The main content area displays a table of findings. A specific finding is highlighted: "Execution:Runtime/SuspiciousCommand" (Funding ID: 0073853f72f44f2980aaace63f79f516). The finding details show it was generated by a process named "FindingProcessName" in an instance, with the command "GeneratedCommandLineExample". The finding is categorized as Low severity. The right panel provides an overview of the finding, including its ID, creation and update times, account ID, resource ID, and instance details.

Severity	Finding type
Low	[SAMPLE] Execution:Runtime/SuspiciousCommand
Medium	[SAMPLE] Behavior:EC2/NetworkPortUnusual
Medium	[SAMPLE] DefenseEvasion:EC2/UnusualDoHActivity
High	[SAMPLE] Backdoor:EC2/DenialOfService.Udp
Medium	[SAMPLE] UnauthorizedAccess:Runtime/TorRelay
High	[SAMPLE] Trojan:Runtime/DriveBySourceTrafficIDNS
Medium	[SAMPLE] PrivilegeEscalation:Runtime/ContainerMountsHostDirectory
High	[SAMPLE] CredentialAccess:RDS/TorIPCaller.SuccessfulLogin
Low	[SAMPLE] Execution:Runtime/SuspiciousShellCreated
Medium	[SAMPLE] Impact:EC2/AbusedDomainRequest.Reputation
Low	[SAMPLE] Discovery:Runtime/SuspiciousCommand
High	[SAMPLE] UnauthorizedAccess:EC2/TorRelay
High	[SAMPLE] Backdoor:EC2/DenialOfService.UnusualProtocol

Figure 40: Detail of a finding

3.3. Application Security

3.3.1. Encryption/decryption Implementation at the coding level

- Encryption is using in Register function

ASP.NET Core Identity is an API that used to handle the UI login options. It manages user and password, profile information, roles and identities, tokens, email confirmation etc. By using OAuth users can log in to the account created with the help of Identity, or they can use a third party login. External login providers which are supported were the Facebook, Google, Microsoft Account, and Twitter (Rick-Anderson, 2023).

When a user clicks the **Register** button on the Register page, the RegisterModel.OnPostAsync action is invoked. The user is created in the backing store with given password by CreateAsync(TUser) on the _userManager object.

```

109     // References | 0 changes | 0 authors, 0 changes
110     public async Task<IActionResult> OnPostAsync(string returnUrl = null)
111     {
112         returnUrl ??= Url.Content("~/");
113         ExternalLogins = (await _signInManager.GetExternalAuthenticationSchemesAsync()).ToList();
114         if (ModelState.IsValid)
115         {
116             var user = CreateUser();
117
118             await _userStore.SetUserNameAsync(user, Input.Email, CancellationToken.None);
119             await _emailConfirmationTokenAsync(user, Input.Email, CancellationToken.None);
120             var result = await userManager.CreateAsync(user, Input.Password);
121
122             if (result.Succeeded)
123             {
124                 // Assigning role to user
125                 await _userManager.AddToRoleAsync(user, Roles.User.ToString());
126                 _logger.LogInformation("User created a new account with password.");
127
128                 var userId = await _userManager.GetUserIdAsync(user);
129                 var code = await _userManager.GenerateEmailConfirmationTokenAsync(user);
130                 code = WebEncoders.Base64UrlEncode(Encoding.UTF8.GetBytes(code));
131                 var callbackUrl = Url.Page(
132                     "/Account/ConfirmEmail",
133                     pageHandler: null,
134                     values: new { area = "Identity", userId = userId, code = code, returnUrl = returnUrl },
135                     protocol: Request.Scheme);
136             }
137         }
138     }

```

Figure 41: Create an user in store.

The password is hashed and stored inside function *UpdatePasswordHash*

```

563     /// as an asynchronous operation.
564     /// </summary>
565     /// <param name="user">The user to create.</param>
566     /// <param name="password">The password for the user to hash and store.</param>
567     /// <returns>
568     /// The <see cref="Task"/> that represents the asynchronous operation, containing the <see cref="IdentityResult"/> of the operation.
569     /// </returns>
570     public virtual async Task<IdentityResult> CreateAsync(TUser user, string password)
571     {
572         ThrowIfDisposed();
573         var passwordStore = GetPasswordStore();
574         ArgumentNull.ThrowHelper.ThrowIfNull(user);
575         ArgumentNull.ThrowHelper.ThrowIfNull(password);
576
577         var result = await UpdatePasswordHash(passwordStore, user, password).ConfigureAwait(false);
578         if (!result.Succeeded)
579         {
580             return result;
581         }
582         return await CreateAsync(user).ConfigureAwait(false);
583     }
584
585     /// <summary>
586     /// Normalize user or role name for consistent comparisons.
587     /// </summary>
588     /// <param name="name">The name to normalize.</param>
589     /// <returns>A normalized value representing the specified <paramref name="name"/>.</returns>
590     [return: NotNullIfNotNull("name")]
591     public virtual string? NormalizeName(string? name)
592     {
593         return string.IsNullOrEmpty(name) ? null : name;
594     }

```

Figure 42: The password is hashed and stored inside *UpdatePasswordHash()*

```

2209     /// </summary>
2210     /// <param name="user">The user.</param>
2211     /// <param name="newPassword">The new password.</param>
2212     /// <param name="validatePassword">Whether to validate the password.</param>
2213     /// <returns>Whether the password has been successfully updated.</returns>
2214     protected virtual Task<IdentityResult> UpdatePasswordHash(IUserPasswordStore<TUser> passwordStore,
2215         TUser user, string newPassword, bool validatePassword)
2216         => UpdatePasswordHash(GetPasswordStore(), user, newPassword, validatePassword);
2217
2218     private async Task<IdentityResult> UpdatePasswordHash(IUserPasswordStore<TUser> passwordStore,
2219         TUser user, string newPassword, bool validatePassword = true)
2220     {
2221         if (validatePassword)
2222         {
2223             var validate = await ValidatePasswordAsync(user, newPassword).ConfigureAwait(false);
2224             if (validate.Succeeded)
2225             {
2226                 return validate;
2227             }
2228         }
2229         var hash = newPassword != null ? PasswordHasher.HashPassword(user, newPassword) : null;
2230         await passwordStore.SetPasswordHashAsync(user, hash, CancellationToken).ConfigureAwait(false);
2231         return IdentityResult.Success;
2232     }
2233
2234     private I UserRoleStore<TUser> GetUserRoleStore()
2235     {
2236         var cast = Store as I UserRoleStore<TUser>;
2237         if (cast == null)
2238             throw new InvalidOperationException("User role store must be implemented");
2239     }

```

Figure 43: The password is hashed.

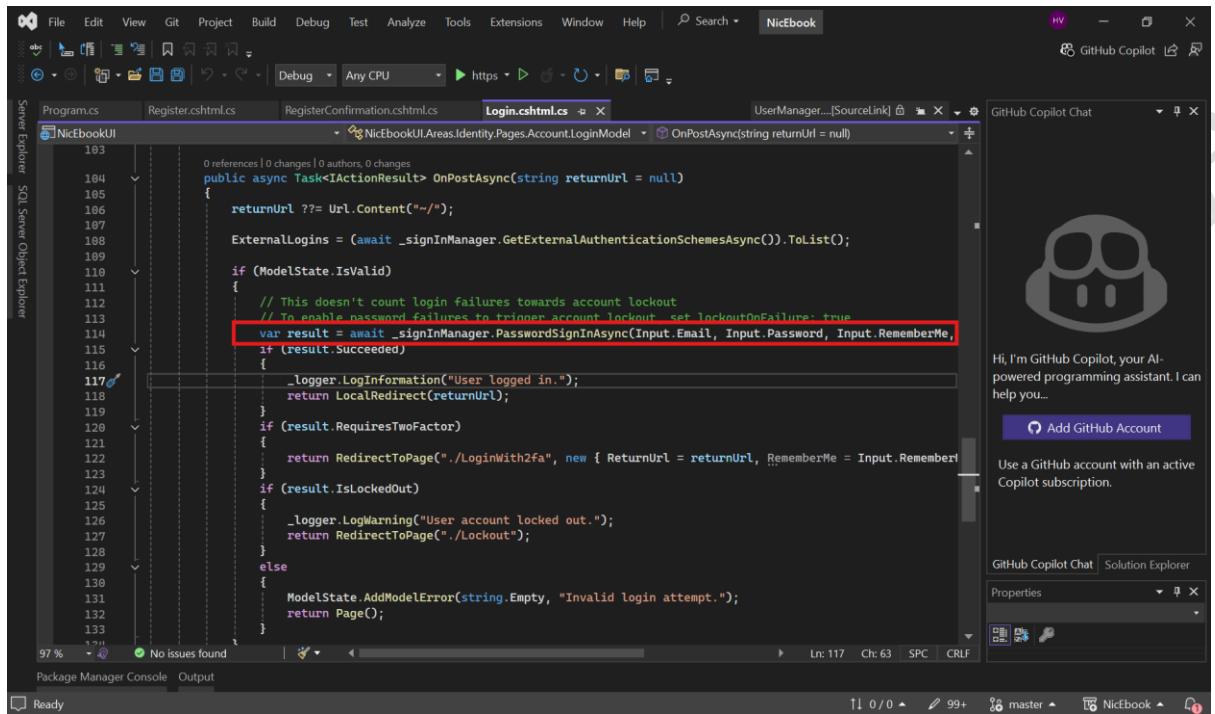
	Id	UserName	NormalizedUserName	Email	NormalizedEmail	EmailConfirmed	PasswordHash
1	030e369f-5c8d-41af-87cc-2305ad9eda01	admin@gmail.com	ADMIN@GMAIL.COM	admin@gmail.com	ADMIN@GMAIL.COM	1	AQAAAAIAAYagAAAAEoEHqGnnIm8PgdkKj
2	2bd3ffef-3a04-4c07-9e4a-2fc98a65ab06	test2@gmail.com	TEST2@GMAIL.COM	test2@gmail.com	TEST2@GMAIL.COM	0	AQAAAAIAAYagAAAEBXMsHs82N8Dy0Zp
3	a0ec3603-b0d1-453d-9321-fc5961c12087	test6@gmail.com	TEST6@GMAIL.COM	test6@gmail.com	TEST6@GMAIL.COM	0	AQAAAAIAAYagAAAEC09AUxS15Ma3d39ac
4	ed62192a-93ec-463c-a860-88ae0b9a27b3	test4@gmail.com	TEST4@GMAIL.COM	test4@gmail.com	TEST4@GMAIL.COM	1	AQAAAAIAAYagAAAECFyLppBqBEFYo+9C

Figure 44: The password is stored in database.

- Decryption is done in the Login function

This method `SignInManager.PasswordSignInAsync` hashes the provided password and compares it against the existing password hash (stored in the database). To verify

that sign in is allowed. For instance, if the status of the user should confirm the email before the sign in then the method has *SignInResult.Failed* (Microsoft, n.d).



```

103     0 references | 0 authors, 0 changes
104     public async Task<IActionResult> OnPostAsync(string returnUrl = null)
105     {
106         returnUrl ??= Url.Content("~/");
107
108         ExternalLogins = (await _signInManager.GetExternalAuthenticationSchemesAsync()).ToList();
109
110         if (ModelState.IsValid)
111         {
112             // This doesn't count login failures towards account lockout
113             // To enable password failures to trigger account lockout, set lockoutOnFailure: true
114             var result = await _signInManager.PasswordSignInAsync(Input.Email, Input.Password, Input.RememberMe,
115             result.Succeeded);
116
117             if (result.Succeeded)
118             {
119                 _logger.LogInformation("User logged in.");
120                 return LocalRedirect(returnUrl);
121             }
122             if (result.RequiresTwoFactor)
123             {
124                 return RedirectToPage("./LoginWith2fa", new { ReturnUrl = returnUrl, RememberMe = Input.RememberMe });
125             }
126             if (result.IsLockedOut)
127             {
128                 _logger.LogWarning("User account locked out.");
129                 return RedirectToPage("./Lockout");
130             }
131             else
132             {
133                 ModelState.AddModelError(string.Empty, "Invalid login attempt.");
134             }
135         }
136     }

```

Figure 45: The password is hashed to compare with existing hashed password.

Checks with the *UserManager.CheckPasswordAsync* that the password is correct (as described above).

If the password is not correct and lockout is supported the method tracks the failed sign in attempt. If the number of sign-in attempts configured is exceeded, the method lock the user, as stated above (Microsoft, n.d).

```
319     /// Only validate the security stamp if the store supports it.
320     /// Attempts to sign in the specified <paramref name="user"/> and <paramref name="password"/> combination
321     /// as an asynchronous operation.
322     /// <summary>
323     /// <param name="user">The user to sign in.</param>
324     /// <param name="password">The password to attempt to sign in with.</param>
325     /// <param name="isPersistent">Flag indicating whether the sign-in cookie should persist after the browser is closed.</param>
326     /// <param name="lockoutOnFailure">Flag indicating if the user account should be locked if the sign in fails.</param>
327     /// <returns>The task object representing the asynchronous operation containing the <see name="SignInResult"/> for the sign-in attempt.</returns>
328     public virtual async Task<SignInResult> PasswordSignInAsync(TUser user, string password,
329         bool isPersistent, bool lockoutOnFailure)
330     {
331         ArgumentNullException.ThrowIfNull(user);
332
333         var attempt = await CheckPasswordSignInAsync(user, password, lockoutOnFailure);
334         return attempt.Succeeded
335             ? await SignInOrTwoFactorAsync(user, isPersistent)
336             : attempt;
337     }
338
339     /// <summary>
340     /// Attempts to sign in the specified <paramref name="userName"/> and <paramref name="password"/> combination
341     /// as an asynchronous operation.
342     /// <param name="userName">The user name to sign in.</param>
343     /// <param name="password">The password to attempt to sign in with.</param>
344     /// <param name="isPersistent">Flag indicating whether the sign-in cookie should persist after the browser is closed.</param>
345     /// <param name="lockoutOnFailure">Flag indicating if the user account should be locked if the sign in fails.</param>
346     /// <returns>The task object representing the asynchronous operation containing the <see name="SignInResult"/> for the sign-in attempt.</returns>
347     public virtual async Task<SignInResult> SignInAsync(string userName, string password,
348         bool isPersistent, bool lockoutOnFailure)
349     {
350         // ...
351     }

```

Figure 46: Comparing the password with passwords stored in database.

3.3.2. Application Security Using Cloud Tools

Implementation of data security in Microsoft Azure

Creating a virtual machine with disk encryption using a key vault. For this process, it is necessary to develop a customer Key Vault, Azure Virtual Machines and Disk Encryption.

Key Vault creation

Type in the search bar at the top of Key Vault, select the first option and click Create.

Basics	
Subscription:	Select the currently active subscription.
Resource Group:	A collection of configurations. Include the resources you would like to be in the same group.
Instance Details	
Key Name Vault:	Choose a name for the Key Vault.
Region:	Select the closest region to your area.
Pricing Tier:	Standard
Recovery Options	
Soft delete:	Enabled. This option will keep the file retention for a period. (Soft delete is by default enabled by Microsoft)
Days to retain deleted vaults:	Choose between 7 to 90 days.
Purge Protection:	If enabled, enforce a mandatory retention period. Disabled allows the purging of objects during the retention period. In this case, select enabled
Access Configuration	

Permission Model:	Azure Role-Based Access Point is the recommended option. It uses the base model of creating a user in Azure and distributes access throughout users registered.
Resource Access	<ul style="list-style-type: none"> Virtual Machines for deployment Resource Manager for template deployment Disk Encryption for volume encryption Choose none, one or all three options. These options ensure that virtual machines, resource managers and disk encryption can retrieve certifications or secrets from the key vault. Select Disk Encryption for volume encryption.
Networking	
Enable Public Access:	If selected, choose if All Networks will have access or only the selected one.
Allow Access from:	Select this option to create a private point. It is actually necessary to have at least one resource already active. In case an Endpoint has already been created, It is recommended to use a private connection for private applications.
Virtual Networks:	Create a new Virtual Network to connect to the resource
Exception:	Create an exception for Microsoft Services to go through the firewall
Private Endpoint:	Creation of private endpoints for accessing the key vault

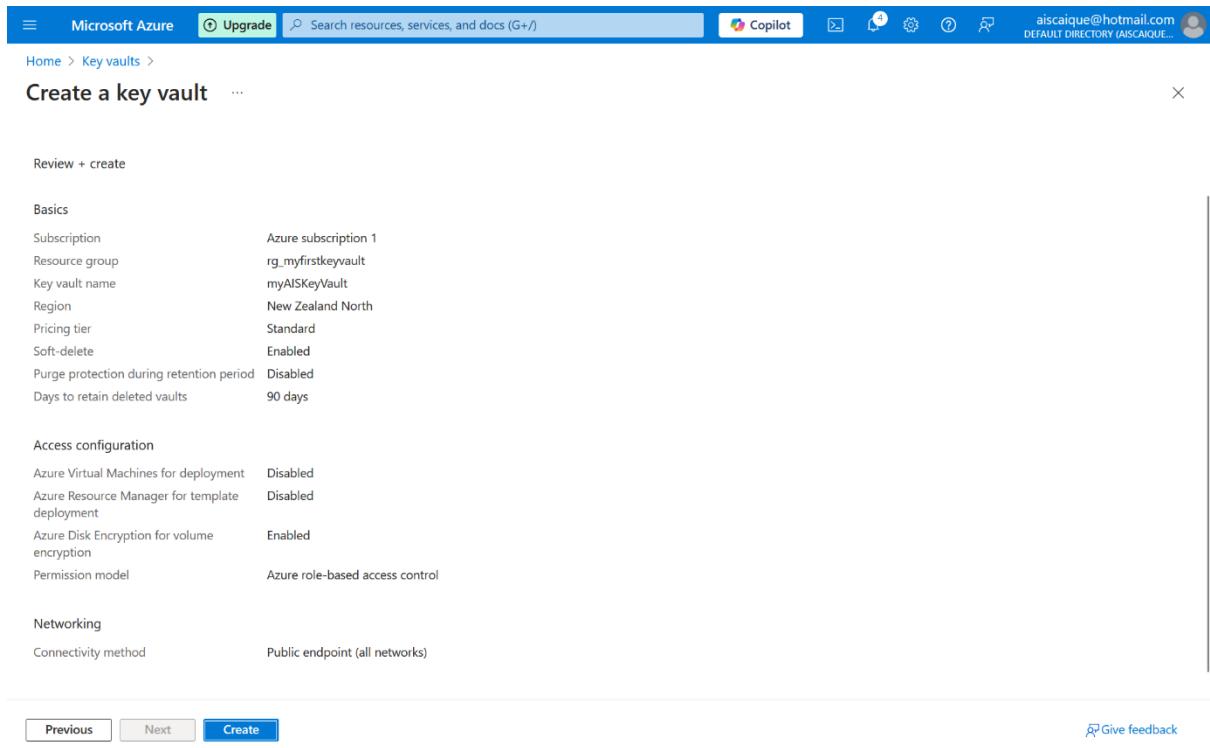


Figure 47: Review + Create a page for the setup of a key vault

Now that the key vault has been created, it is necessary to define a key administrator. Go to Resources, select the key that needs permission granted, click on Access Control (IAM), and Add Role Assignment. On this newly loaded page, assign a Key Vault Administrator (for this example, the Key Vault Admin is necessary as we operate the vault. Although, for companies, it is possible to assign users that manage certificates, keys or AI)

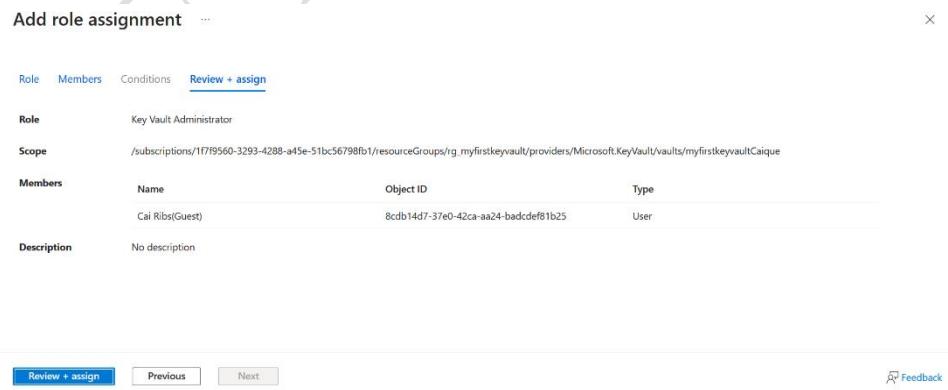


Figure 48: Overview of assignment of a user to a role.

Create a key

Options: Generate

Name:

Key type: RSA

RSA key size: 2048

Figure 49: Create a key page.

Select the type (RSA or EC) and the key size.

Generate/Import Refresh Restore Backup Manage deleted keys

The key 'myVMEncryptionKey' has been successfully created.

Name	Status	Expiration date
myVMEncryptionKey	✓ Enabled	
myKeyVault	✓ Enabled	

Figure 50: Key Vault storage main page.

Create a Microsoft Azure Virtual Machine

Go to the search bar and type Virtual Machine. Select the first option.

Click on Create and choose the Azure Virtual Machine.

Disks

- OS disk size: Image default
- OS disk type: Premium SSD LRS
- Use managed disks: Yes
- Delete OS disk with VM: Enabled
- Ephemeral OS disk: No

Networking

- Virtual network: (new) MyNewEncryptVM-vnet
- Subnet: (new) default (10.0.0.0/24)
- Public IP: (new) MyNewEncryptVM-ip
- Accelerated networking: On
- Place this virtual machine behind an existing load balancing solution?: No
- Delete public IP and NIC when VM is deleted: Disabled

Management

Microsoft Defender for Cloud	None
System assigned managed identity	Off
Login with Microsoft Entra ID	Off
Auto-shutdown	Off
Enable hotpatch	On
Patch orchestration options	Azure-orchestrated patching (preview): patches will be installed by Azure
Reboot setting	Reboot if required

Monitoring

Alerts	Off
Boot diagnostics	On
Enable OS guest diagnostics	Off
Enable application health monitoring	Off

Advanced

Extensions	None
VM applications	None
Cloud init	No
User data	No
Disk controller type	SCSI
Proximity placement group	None
Capacity reservation group	None

< Previous Next > **Create** Download a template for automation Give feedback

Figure 51: Review + Create page for setup of a key vault.

Wait for the deployment of the virtual machine

Create a Disk Encryption Set

Type in the search bar Disk Encryption Set and select the first option

Basics	
Subscription:	Select the currently active subscription.
Resource Group:	A collection of configurations. Include the resources you would like to be in the same group.
Instance Details	
Disk encryption name:	Choose a name for the disk encryption set.
Region:	Select the closest region to your area.

Encryption type:	Encryption at rest with a customer-managed key
Key vault:	Select the key vault group created previously, if not done. Create a new key
Key:	Select the key from the Key Vault group
Version	The version of the key
User-assigned identity:	No Marks
Multi-tenant application:	No Marks
Auto-key rotation:	No Marks

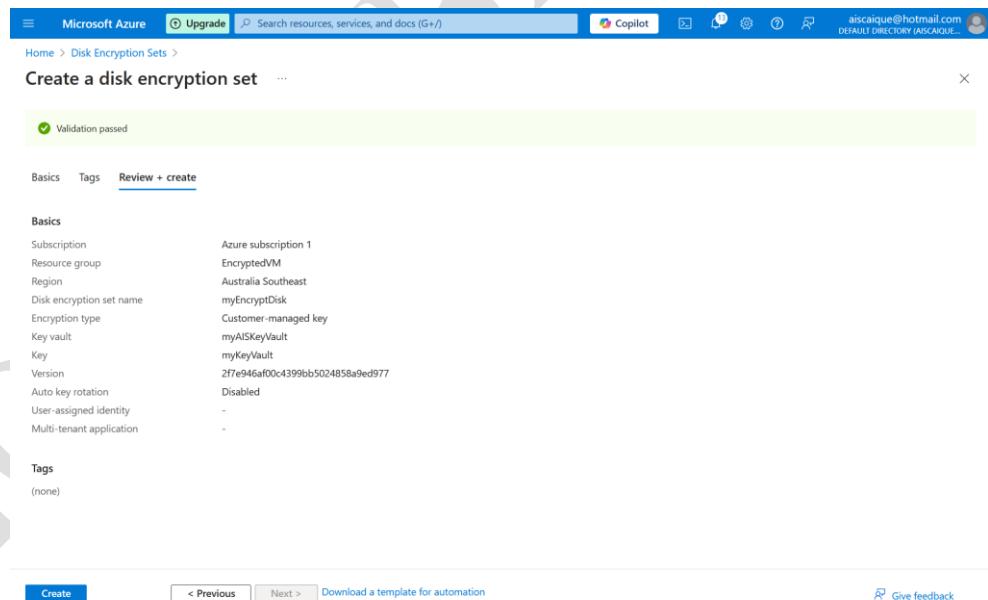


Figure 52: Overview disk encryption.

Click on Create to finish the disk encryption creation and once deployed, click on Go to Resources. On the top of the overview, allow permission for the disk encryption to connect with the key vault. Simply click on the link shown.

Lastly, it is time to configure the newly created key vault into the virtual machine operational system image.

Go to the virtual machine, which should be encrypted. Following up on the example provided above, navigate to MyNewEncryptVM (it is very important to PAUSE the virtual machine), click on Settings, Disks, on the section OS Disk, click on MyNewEncryptVM_OsDisk, go to encryption. The Key Management now should be enabled.

The screenshot shows the Microsoft Azure portal interface. The top navigation bar includes 'Microsoft Azure', 'Upgrade', 'Search resources, services, and docs (G+)', 'Copilot', and user information 'aiscaique@hotmail.com'. Below the navigation bar, the URL path is 'Home > Virtual machines > MyNewEncryptVM | Disks > MyNewEncryptVM_OsDisk_1_93fa9275e1dd481b92ebf346a5aae2d2'. The main content area displays the 'MyNewEncryptVM_OsDisk_1_93fa9275e1dd481b92ebf346a5aae2d2' disk details. The left sidebar shows navigation links like Overview, Activity log, Access control (IAM), Tags, Diagnose and solve problems, Settings (selected), Configuration, Size + performance, Encryption (selected), Networking, Disk Export, Properties, Locks, Monitoring, and Automation. The right pane shows the 'Encryption' settings for the disk, specifically the 'Key management' dropdown set to 'Platform-managed key'. A note states: 'Azure offers server-side encryption with platform-managed keys by default for managed disks. You may optionally choose to use a customer-managed key.' Below this, there are sections for 'Platform-managed key', 'Customer-managed key', 'myEncryptDisk', and 'MyEncryptedVM'. At the bottom, it says 'No available disk encryption sets with platform and customer managed keys.' To the right of the disk details, a 'Notifications' sidebar lists recent events: 'Successfully stopped virtual machine' (5 minutes ago), 'Moving resources complete' (10 minutes ago), 'Successfully assigned role' (an hour ago), and 'Deployment succeeded' (Deployment).

Figure 53: Virtual Machine disk encryption.

Select the desired key and click on save to encrypt the virtual machine disk fully.

Implementation of data security in Amazon Web Services

Create an AWS Key volume to encrypt data at rest and in transit for instances

Go to the search bar and type KMS. Open the first option and select Configure Key

Step 1	
Key type:	Symmetric
Key usage:	Encrypt and decrypt
Advanced options:	KMS Origin – This option is used when AWS creates the key and also manages it; other options are for importing keys or using an external key store
Regionality	Single-Region key, select this option to make the use of the key more strict
Step 2	
Alias	Create a name for the key
Step 3	
Define key administrative permissions Key user: Key deletion:	Select an IAM user to administrate and use the key Authorise the administrator to delete a key
Step 4	
Define key usage permission:	Select the permission of the key towards AWS services

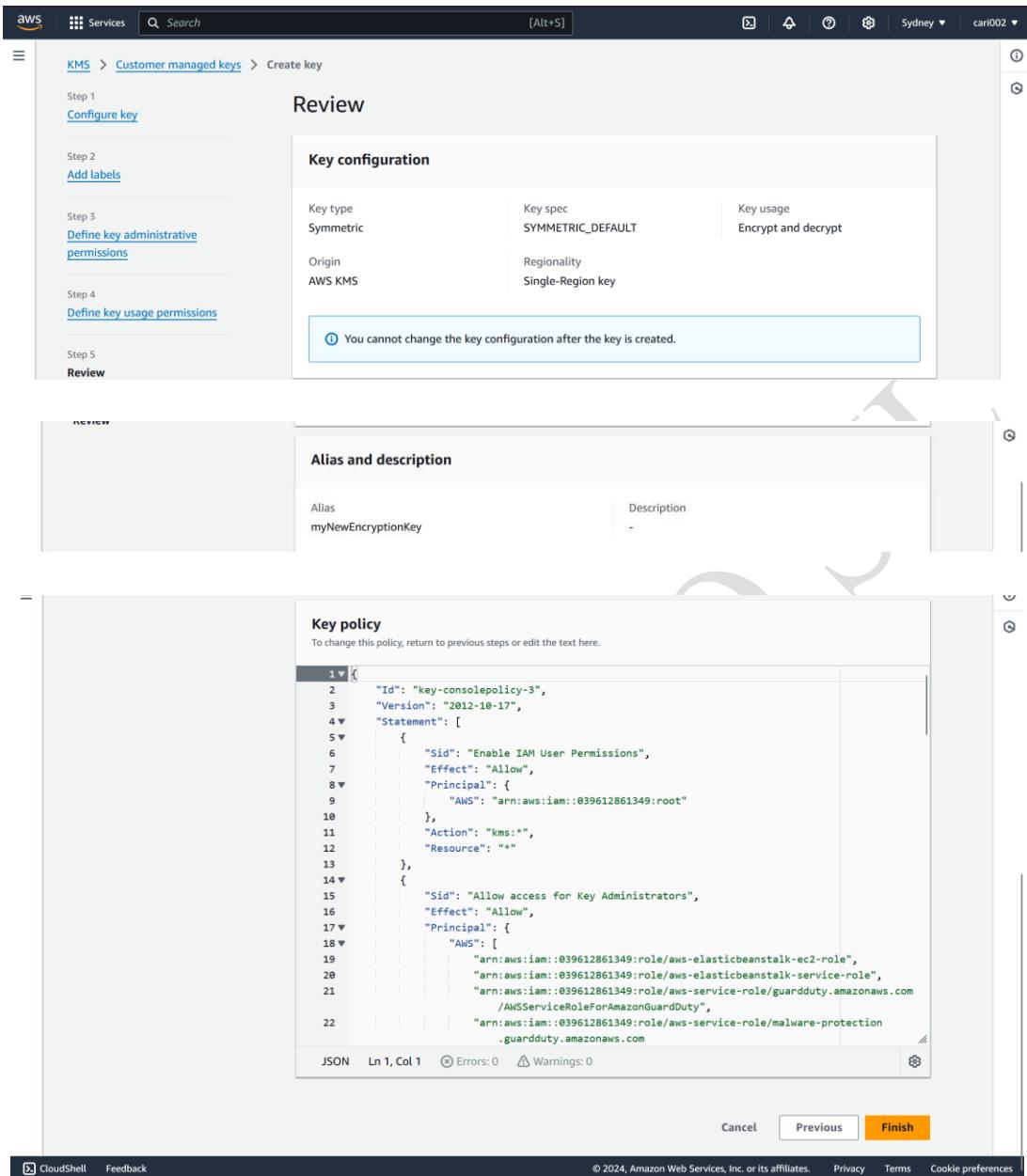


Figure 54: Review page create a KMS.

The key has been created. To apply the encrypted key to the Amazon service, type the search bar S3. A new bucket (container) will be made for the ensuing process. The intention is to use the newly created symmetric key to encrypt the bucket content from the server side.

Click on Create a Bucket, and in the default encryption, select the option AWS KMS Keys

Default encryption [Info](#)
Server-side encryption is automatically applied to new objects stored in this bucket.

Encryption type [Info](#)

- Server-side encryption with Amazon S3 managed keys (SSE-S3)
- Server-side encryption with AWS Key Management Service keys (SSE-KMS)
- Dual-layer server-side encryption with AWS Key Management Service keys (DSSE-KMS)
Secure your objects with two separate layers of encryption. For details on pricing, see [DSSE-KMS pricing](#) on the Storage tab of the [Amazon S3 pricing page](#).

AWS KMS key [Info](#)

- Choose from your AWS KMS keys
- Enter AWS KMS key ARN

Available AWS KMS keys

Choose AWS KMS key

C

[Create a KMS key](#)

Bucket Key
Using an S3 Bucket Key for SSE-KMS reduces encryption costs by lowering calls to AWS KMS. S3 Bucket Keys aren't supported for DSSE-KMS. [Learn more](#)

- Disable
- Enable

Figure 55: S3 default encryption.

```
arn:aws:kms:ap-
southeast-2:039612861349:key/7402e797-60a8-420e-9ccd-408daeb
33323
FirstKey

arn:aws:kms:ap-
southeast-2:039612861349:key/899d49c4-1552-4058-bcb9-
d5580fbaddee
myEncryptionKey

arn:aws:kms:ap-southeast-2:039612861349:alias/aws/s3
aws/s3
```

Figure 56: Available keys.

The newly created key is called myEncryptionKey. Please select it and proceed with the default configuration of the S3 Bucket.

Encrypting the AWS Virtual Server

Type on the search bar for EC2, scroll down to Elastic Block Storage and locate for volume; in Amazon, to encrypt a volume, it is first necessary to create a snapshot out of an unencrypted volume. Click on Create volume, select the volume size, and then proceed to Create. Back to the EBS volume page, select the volume, go to Actions and Create a snapshot. Once deployed, roll down to EBS > Snapshots, select the desired snapshot, go to Actions and copy the snapshot

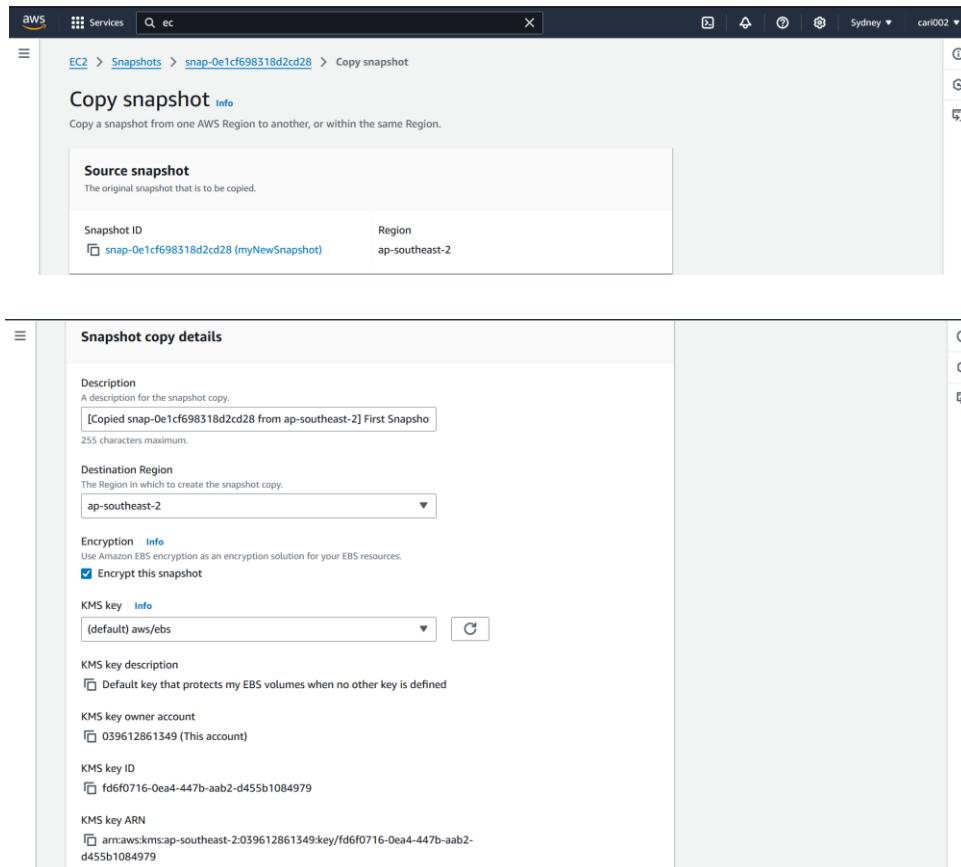


Figure 57: Main page of copying a snapshot.

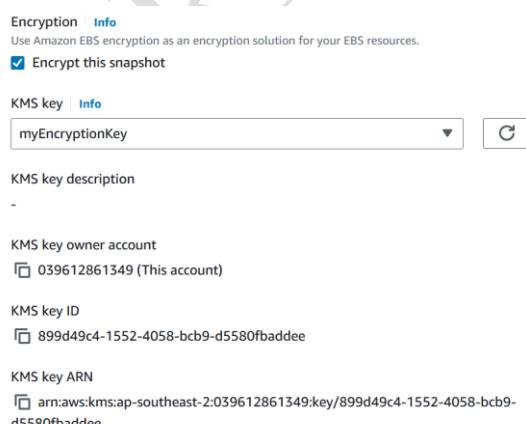


Figure 58: Encryption custom keys created previously.

To conclude, select the KMS key to be used, click on Copy Snapshot, wait for the deployment, and then move back to the EBS volume and locate the newly created encrypted volume.

3.4. Application Evaluation

3.4.1. Scalability

Microsoft Azure and Amazon Web Services (AWS) offer complex tools that allow a high level of customisation towards the processing power of virtual machines, databases, applications, and storage. As a matter of fact, both platforms have an exam to validate the use of their services, which includes scalability and security.

Regarding the scalability scenario, Azure has a more flexible interface where users can create a service you go. In case the user is creating a virtual machine and does not have a resource group, it can be quickly configurated with a few clicks by selecting Create new and named. The same applies to other options, such as creating virtual private networks. However, the reason why this is pivotal for the flow of usability and scalability is because it is not necessary to go back and forth to create pendency.

Turning to Amazon Web Services to create an Auto Scale Group is richer in details and options at the page's root. For instance, as you are making a new Scale Group, the second step already allows the customisation of the vCPU and memory GiB, whereas, for Azure, this level of customisation is achieved only by going through the initial Scale Set configuration, therefore navigating to settings and then creating an inbound or outbound rule.

3.4.2. Security

Security is a pivotal topic for cloud platforms as the infrastructure emulates complex physical networks, physical servers and physical machines. Either platform has an initial security level nominated by the user of the IAM (Identity and Access Management) (Microsoft, 2024). This access management is important because it allows the administrator of the root account to delegate access to other users based on their roles or their need for access.

Aside from that, Azure has a unique feature called Microsoft Entra ID, a resource that can be used to access Microsoft's external features beyond cloud-services products. This is an important security feature because it can mix the security parameters of Microsoft Entra ID and apply that to IAM accounts. Moreover, a system administrator will have fewer worries about a user accessing resources of the cloud platform from anywhere the person is, as Microsoft Entra has its methods of identifying user fraud. On the other hand, it is a service with

a monthly cost for their clients. As an alternative, the main administrator can create a Microsoft User and assign roles and services to a group or specific user

As for AWS, a unique feature offered is the Security Lake, a tool that can store data on users and services and later be used for analysis. It is a security feature that is quite complex and costly for the user. For user management, IAM on AWS is the alternative for deploying task and services management.

GuardDuty in AWS and Microsoft Defender in Azure are highly configurable for service health. However, both will require an upgrade in the signature and will cost. The secret vault is made available for both platforms to secure passwords and strings.

3.4.3. Pricing

The pricing model of Azure and AWS is straightforward, pay-as-you-go being the most popular. It works simply: pay for what you are using. This report shall not include whether the prices of the services are reasonable, as the selected services are charged mainly by minutes and hours, which directly impact the final bill. What is being considered is the platform's charging method and the tools to inform its users. Microsoft Azure has a dedicated page for Cost Management + Billing. On this page, it is possible to customise cost alerts, check how much a specific account costs the company and administrator, check the total amount spent, and foresee future charges. It is a dynamic panel that permits the saving of current numbers in the format of reports. Aside from that, Azure will always pop up a tab with the current cost for every first time you access the account after logging out. It is a very useful reminder. Turning to the bill's current state, let us say that a new Virtual Machine is on its way to be deployed. On the last page (Review + Create), the total cost per hour of the service will be displayed in U.S. dollars. The same goes for every paid service. Any additional cost (software license, elasticity) will be displayed straightforwardly in the option. For example, creating a new SQL database will show the cost summary on the second page. That is because it includes different types of licenses and different vCPUs.

Regarding AWS, Billing and Cost Management will summarise all the costs associated with the account. A budget status and cost anomalies checker is available to foresee future costs, a cost breakdown and a chart that will discriminate all the costs. The pricing for services is much more direct than Azure; for instance, creating a virtual machine in AWS brings the cost of the entire operational system and its costs per hour. This avoids navigating back to

previous pages if you disagree with what is being charged. An interesting feature AWS offers is the free tier of 750h for the first year. Unlike most more popular cloud platforms, Amazon has been innovative towards its free-tier services, which go beyond a month. In addition, the service provider also sends an email every time a free tier service comes to its maximum usage, in that way, preventing the switch from a free account to a pay-as-you-go.

3.4.4. Summary

Moreover, in my experience with Azure and AWS, the platforms demonstrate a cutting-edge technology infrastructure. They offer flexibility and scalability that could only be achievable by physical installation. Regarding Scalability, AWS has a more straightforward interface for creating a scale set; the process is more concise and clearer when applied under services such as Beanstalk, instances, and RDS.

Turning to security, Microsoft Azure seems to be much more efficient and user-friendly, tutorials on their FAQs are much more precise and the usability and flexibility to create groups while configuring another service has been developed amazingly well.

Hence, pricing-wise, the platform has a similar way of charging. However, AWS seems to be trying to gain more territory with its free tier plans, which gives the impression that it is longer and more effective than the Microsoft Azure trial period.

In conclusion, cloud service has evolved over the years and is more than a trend. It is what technology will be based on in the future; new platforms will have to dedicate their time to developing tools to outperform existing ones, as they are solid and flexible.

4. Conclusion

Based on the compareson and evaluation of Microsoft Azure and Amazon Web Services (AWS) in security, scalability, integration and price, Microsoft Azure with is robust infrastructure, user-friendly interface and comprehensive cloud and security solutions become the first choice of the TechWave Solutions Ltd. Microsoft Azure provides modern development tools, the RBAC based on roles and responsibilities and the advanced security features such as Microsoft Defender, Key Vault, network security management. In addition, Azure supports horizontal and vertical scaling on requirements, offers straightforward cost management page, ensured the transparency and predictability in budgeting, which are essential for a company like TechWave Solutions. In conclusion, the TechWave Solutions will benefit from the secure ,

scalable and cost-effective of Microsoft Azure. And it also can support the development and innovation of the TechWave Solutions in the future.

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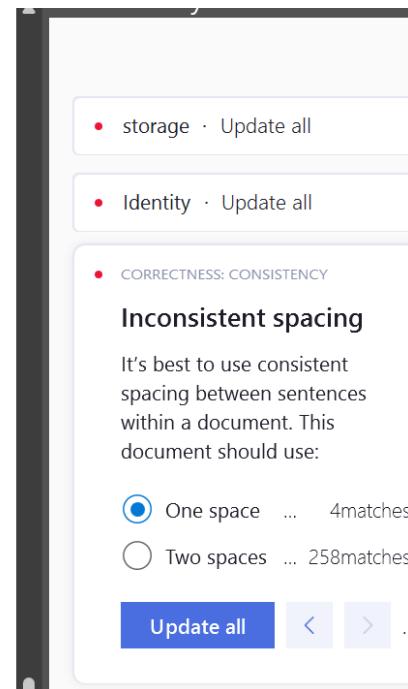


Figure 59: Demonstration of using Grammarly

We would like to acknowledge the assistance of ChatGPT, a large language model developed by OpenAI, for providing conceptual explanations, language refinement, and citation formatting checks while preparing this essay.

how can i check the Antimalware on remote desktop connection

To check if Microsoft Antimalware is running on an Azure Virtual Machine (VM) through a **Remote Desktop Connection (RDC)**, follow these steps:

Step-by-Step Guide:

1. Connect to the VM via Remote Desktop:
 - Open the **Remote Desktop Connection** application on your local machine.
 - Enter the public IP or DNS name of your Azure VM and click **Connect**.
 - Log in with your VM's credentials (username and password).
2. Check Antimalware Status:
 - Once connected, go to the **Start menu** in the VM.

Figure 60: Demonstration of using ChatGPT 1

https://aws.amazon.com/architecture/security-identity-compliance/?cards-all.sort-by=item.additionalFields.sortDate&cards-all.sort-order=desc&awsf.content-type=*all&awsf.methodology=*all



Here is the citation for the AWS page on security, identity, and compliance architecture with today's date:

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Figure 61: Demonstration of using ChatGPT 2