Provisioning for Azure   
Cost Optimization & Monitoring Project  
 Project Starter Template



STEP 0: Problem Background

Company “X” is an engineering company that has offices in both the US East & West Coast. They currently host all their data and applications in a single East coast data center and are constantly worried about both cost and resiliency. Below is how their current servers are configured.

| Server(s): | **Purpose:** Windows/Linux Server  **Environment:** Physical Servers  **Operating System:** Windows  **Operating System License:** DataCenter  **Servers:** 10  **Procs per server:** 2  **Core(s) per proc:** 8 Cores  **RAM:** 256 GB  **Optimize By:** CPU  **GPU:** None  **Usage:** These are the servers where all your engineering workloads happen. Currently they all are being leveraged at regular capacity. |
| --- | --- |
| Server(s): | **Purpose:** Web App  **Environment:** Physical Servers  **Operating System:** Windows  **Operating System License:** DataCenter  **Servers:** 3  **Procs per server:** 1  **Core(s) per proc:** 8 Cores  **RAM:** 64 GB  **Optimize By:** CPU  **GPU:** None  **Usage:** These are the web app servers for your company. Currently they all are being leveraged at regular capacity. |
| Server(s): | **Source:** Database Server  **Database:** Microsoft SQL Server  **License:** Enterprise  **Environment:** Physical Servers  **Operating System:** Windows  **Operating System License:** Datacenter  **Servers:** 3  **Procs per server:** 1  **Cores per proc:** 16 Cores  **RAM:** 64 GB  **Optimize By:** CPU  **Usage:** These three servers are running Microsoft SQL Server and provide the database for your engineering company. It is critical that they are always running.  **Destination**  Service: SQL Database  Purchase Model: vCore  Service Tier: Business Critical  Instance Cores: 2  SQL Server Storage: 5  SQL Server backup: 0 |
| Storage | **Purpose:** Storage  **Type:** Local Disk / SAN  **Disk Type:** HDD  **Capacity:** 1 TB  **Back-Up:** None currently  **Archive:** None |
| Networking | Amount of network bandwidth you currently consume in your on-premises environment: 1 GB |

# **STEP 1: Assessing the On-Premises Environment & Generating Total Cost of Ownership (TCO) Report**

Purpose: To identify the Azure services needed to ensure Company “X”’s business continuity in the cloud.

| **Current Environment/** **Background**  Make a list of all current on-premises servers and services. | There are 10 Windows VM’s which are used for engineering purposes.  There are 3 web apps servers which host the front end of the company.  There are 3 database servers.  There is a storage which is also used to store data. |
| --- | --- |
| **Matching Azure Services**  Match the list of on-premises servers and services to the corresponding Azure ones. | Make a list of all servers and services you would create on Azure and explain why you chose each.  **Hint**:   * For VM’s and Web Apps: The operating system license is always Standard and Virtualization is always Hyper-V. * For databases: The purchase model is vCore, the Service Tier is Business Critical, and no SQL Server Backup is needed. * For networking: The defaults of 200 GB for outbound bandwidth are used.  **Engineering Servers:**  * **Azure Equivalent:** Azure Virtual Machines * **VM Size:** M16MS Standard (16 core, 437.5 GB RAM) * **Number of VMs:** 10 * **Justification:**   + Matches the on-premises CPU and RAM specifications for high-performance workloads.  **Web App Servers:**  * **Azure Equivalent:** Azure Virtual Machines * **VM Size:** A8mv2 Standard (8 core, 64 GB RAM) * **Number of VMs:** 3 * **Justification:**   + Matches the on-premises CPU and RAM specifications for web applications.   **Database Servers:**   * **Azure SQL Database:**   + **Purchase Model:** vCore   + **Service Tier:** Business Critical   + **Instance Cores:** 16 vCores per instance   + **SQL Server Storage:** 1 TB per instance   + **Quantity:** 3 Instances   + **Justification:**     - Provides high availability and performance for critical database workloads.     - Ensures data integrity and continuous availability.  **Storage:** **Azure Equivalent:**   * **Azure Blob Storage:**   + **Disk Type:** HDD   + **Capacity:** 1 TB * **Justification:**   + Provides scalable and durable storage with geo-redundancy options.   + Enhances data protection and availability.  **Networking:** **Azure Equivalent:**   * **Azure Virtual Network:**   + **Bandwidth:** Default of 200 GB for outbound bandwidth * **Justification:**   + Ensures secure and reliable networking for Azure resources.   + Provides adequate bandwidth for the company's needs. |
| **Screenshot 1**  Submit the screenshot for each of the above configurations from Azure TCO.  VM and Web Apps Server screenshot should be submitted here. |  |
| **Screenshot 2**  Submit the screenshot for each of the above configurations from Azure TCO.  Database screenshot should be submitted here. |  |
| **Screenshot 3**  Submit the screenshot for each of the above configurations from Azure TCO.  Storage configuration screenshot should be submitted here. |  |
| **Screenshot 4**  Submit the screenshot for each of the above configurations from Azure TCO.  Networking configuration screenshot should be submitted here. |  |
| **Screenshot 5**  Once the TCO Report is generated, submit a screenshot of the price comparison graph (line graph) here. |  |
| **Screenshot 6**  Once the TCO Report is generated, submit a screenshot of the price comparison graph (pie chart) here. |  |
| **Screenshot 7**  Once the TCO Report is generated, submit a screenshot of the price comparison chart (tabular format) here. |  |
| **Explanation 1**  Explain the breakdown of the costs and show your understanding of how on-prem costs versus Azure compare | **Breakdown of Costs:** **On-Premises Costs:**   1. **Compute Cost:**    * **Hardware Cost:**      + Cost per 2 proc 16 core, 256 GB RAM virtualization server for Windows: $21,764.00      + Number of servers needed for 10 virtual machines (16 core, 256 GB RAM): 1      + Cost per 2 proc 6 core, 64 GB RAM virtualization server for Windows: $8,806.00      + Number of servers needed for 3 virtual machines (8 core, 64 GB RAM): 1      + Cost per 2 proc 8 core, 64 GB RAM virtualization server for Windows: $14,105.00      + Number of servers needed for 3 virtual machines (48 core, 64 GB RAM): 1      + **Total hardware cost:** $44,675.00    * **Maintenance Cost:**      + Cost of maintaining virtualization server(s) (20% of cost of virtualization server(s)): $8,935.00      + **Total hardware and maintenance cost over one year:** $53,610.00 2. **Software Cost:**    * Cost of Windows Datacenter license per 2 proc, 16 core, 256 GB RAM virtualization server: $12,310.00    * Number of servers needed for 10 virtual machines (16 core, 256 GB RAM): 1    * Cost of Windows Datacenter license per 2 proc, 6 core, 64 GB RAM virtualization server: $6,155.00    * Number of servers needed for 3 virtual machines (8 core, 64 GB RAM): 1    * Cost of Windows Datacenter license per 2 proc, 8 core, 64 GB RAM virtualization server: $6,155.00    * Number of servers needed for 3 virtual machines (48 core, 64 GB RAM): 1    * **Total software license cost:** $24,620.00    * **Software Assurance cost:** $6,155.00    * **Total software cost over one year:** $30,775.00 3. **Electricity Cost:**    * Price of electricity per kWh: $0.1334    * Power rating of 16 core, 256 GB RAM server: 1,002.3 Watts    * Total electricity cost for 1 server (16 core, 256 GB RAM) per month: $97.61    * Power rating of 6 core, 64 GB RAM server: 682.3 Watts    * Total electricity cost for 1 server (6 core, 64 GB RAM) per month: $66.44    * Power rating of 8 core, 64 GB RAM server: 682.3 Watts    * Total electricity cost for 1 server (8 core, 64 GB RAM) per month: $66.44    * **Total electricity cost over one year:** $2,765.88 4. **Virtualization Cost:**    * Virtualization software license cost: $0.00    * Per virtual machine, per month cost to load balance, backup, and patch virtual machines: $26.52    * Number of virtual machines: 16    * Virtual machine management cost per month: $424.32    * Virtual machine management cost per year: $5,091.84    * **Total virtualization cost over one year:** $5,091.84 5. **SQL Database Cost:**    * Total CPU cores: 48    * SQL Server Enterprise License cost per 2 cores: $14,256.00    * Enterprise cores: 48    * Total license cost: $342,144.00    * Enterprise Software Assurance cost per 2 cores: $3,546.00    * Enterprise cores: 48    * Total Software Assurance cost: $85,104.00    * **Total SQL Database cost over one year:** $427,248.00 6. **Data Center Cost:**    * Compute cost:      + Number of rack units per rack: 42      + Rack units required per 16 core, 256 GB RAM server: 4      + Number of 16 core, 256 GB RAM servers: 1      + Total number of rack units required: 4      + Rack units required per 6 core, 64 GB RAM server: 4      + Number of 6 core, 64 GB RAM servers: 1      + Total number of rack units required: 4      + Rack units required per 8 core, 64 GB RAM server: 4      + Number of 8 core, 64 GB RAM servers: 1      + Total number of rack units required: 4      + **Total number of rack units required for all servers:** 12      + Data center construction cost per rack unit amortized over 20 years: $302.27      + **Total data center compute cost over one year:** $3,627.24    * Storage cost:      + Total number of rack units required for all storage: 1      + Number of rack units for DAS or SAN: 1      + Rack mounting/installation cost: $302.27      + **Total data center storage cost over one year:** $302.27    * **Total data center cost over one year:** $3,929.51 7. **Networking Cost:**    * Total hardware + software cost over one year: $84,385.00    * Network hardware and software cost assumed to be 15% of hardware and software cost over one year: $12,657.75    * Network maintenance cost assumed to be 15% of network hardware and software cost over one year: $1,898.66    * Service provider cost/GB per month: $0.15    * Amount of bandwidth needed (GB) per month: 200    * Total service provider cost per month: $30.00    * Total outgoing bandwidth needed per month: 200 GB    * Total outgoing bandwidth cost per month: $3.90    * **Total networking cost over one year:** $14,916.41 8. **Storage Cost:**    * Hardware:      + Local Disk/SAN-HDD      + Cost per GB: $0.20      + Storage (RAID 10 configuration) volume in GB: 1,024      + Total storage procurement cost: $204.80    * Storage Maintenance:      + Storage maintenance cost (10% of storage procurement cost) over one year: $20.48      + **Total storage maintenance cost over one year:** $20.48    * Page Blob storage:      + Usable storage volume in GB: 512      + Storage cost per GB/month: $0.045      + Annual storage cost per usable volume: $276.48      + **Total Page Blob LRS storage maintenance cost over one year:** $276.48    * SQL Database Server storage:      + Usable storage volume in GB: 3      + Price per GB/Month: $0.083      + Active DB Storage Cost/Month: $0.25      + Annual storage cost per usable volume: $9.00      + **Total SQL Database Server Storage cost over one year:** $9.00    * SQL Database Backup storage:      + Billable backup storage volume in GB: 0      + Price per GB/Month: $0.00      + Backup Storage Cost/Month: $0.20      + **Annual storage cost per usable volume:** $0.00    * **Total storage cost over one year:** $225.28 9. **IT Labor Cost:**    * Number of IT admin hour(s) needed per year: 266.67    * Hourly rate for IT administrator: $23.00    * **Total IT labor cost over one year:** $6,133.41   **Total On-Premises Cost over One Year:** $544,695.00  **Azure Costs:**   1. **Compute Cost:**    * **Virtual Machines:**      + M16MS Standard (16 core, 437.5 GB RAM) Windows (Azure Hybrid Benefit)      + Number of virtual machines: 10      + **Total virtual machine cost per month:** $12,901.40    * **Web App Servers:**      + A8mv2 Standard (8 core, 64 GB RAM) Windows (Azure Hybrid Benefit)      + Number of virtual machines: 3      + **Total virtual machine cost per month:** $613.65    * **Total Azure Virtual Machines cost over one year:** $162,180.60 2. **SQL Database Cost:**    * Business Critical Single Gen5 2 vCores (Azure Hybrid Benefit)    * Number of instances: 3    * **Total SQL Database cost over one year:** $10,397.88   **Total Azure Compute Cost over One Year:** $172,578.48   1. **Data Center Cost:**    * **Compute Cost:**      + **Total Azure data center compute cost over one year:** $0.00    * **Storage Cost:**      + **Total Azure data center storage cost over one year:** $0.00   **Total Azure Data Center Cost over One Year:** $0.00   1. **Networking Cost:**    * **Total Azure networking cost over one year:** $46.80 2. **Storage Cost:**    * Page Blob storage:      + Usable storage volume in GB: 512      + Storage cost per GB/month: $0.045      + Annual storage cost per usable volume: $276.48    * SQL Database Server storage:      + Usable storage volume in GB: 3      + Price per GB/Month: $0.083      + Annual storage cost per usable volume: $9.00    * **Total Azure storage cost over one year:** $285.48 3. **IT Labor Cost:**    * Number of IT admin hour(s) needed per year: 216.67    * Hourly rate for IT administrator: $23.00    * **Total Azure IT labor cost over one year:** $4,983.41   **Total Azure Cost over One Year:** $177,894.00 **Understanding of On-Premises Costs vs. Azure Costs:**  * **Compute Costs:**   + The on-premises compute cost includes hardware, maintenance, software licenses, and electricity, which are substantial. In contrast, Azure's compute cost covers VM and SQL database costs, offering significant savings due to the Azure Hybrid Benefit and optimized VM sizes. * **Data Center Costs:**   + On-premises data center costs include compute and storage costs for physical infrastructure, while Azure eliminates these costs entirely, leading to further savings. * **Networking Costs:**   + Networking costs are significantly lower in Azure due to optimized and managed networking services. * **Storage Costs:**   + Both on-premises and Azure storage costs are relatively low, but Azure provides more scalable and redundant storage solutions. * **IT Labor Costs:**   + IT labor costs are lower in Azure as the platform requires fewer administrative hours due to managed services and automation.   By moving to Azure, Company “X” can reduce their total annual costs significantly, benefiting from optimized compute resources, reduced data center costs, efficient networking, and scalable storage solutions. This transition also enhances resilience, scalability, and operational efficiency, ensuring business continuity and improved performance. |

# **STEP 2: Azure Pricing Calculator Cost Estimates**

Purpose: You want to only move the engineering workloads (so just your VM’s) to Azure first to try and understand how Azure cloud works. In addition, this will also help you demonstrate to your CIO that by doing that small migration your company can achieve resiliency. You want to provide precise monthly costs to your CIO.

Use the Azure Pricing Calculator to submit the following screenshots.

**Note:** *If you are using Udacity Cloud Labs, you will be allowed to create a few VM sizes only. Visit*[this](https://portal.azure.com/#create/Microsoft.VirtualMachine) *link to see all possible VM sizes and go through the classroom instructions for more details.*

| **Task 1** | Matching Azure Services: Match the list of on-premises servers and services to the corresponding Azure ones.  Here is the VM configuration you will pick.   * 5 VM’s will be in US East Coast, and 5 will be in US West Coast. * Choose the instance you want to create in both the regions from the possible VM sizes mentioned in the classroom. * Compute Option will be pay-as-you-go; so, there are no upfront costs. * The default of 730 hours is selected. |
| --- | --- |
| **Screenshot 1**  Submit the screenshot for each of the above configurations from the Azure Pricing Calculator. Submit the US East Coast monthly costs here. |  |
| **Screenshot 2**  Submit the screenshot for each of the above configurations from the Azure Pricing Calculator. Submit the US **West Coast** monthly costs here. |  |
| **Screenshot 3**  Submit the screenshot for total cost per month for both US East and West Coasts. |  |
| **Explanation 1**  Explain how resilience is built in by moving to Azure | **How Resilience is Built in by Moving to Azure:**  Moving to Azure significantly enhances the resilience of Company "X's" infrastructure due to the following reasons:   1. **High Availability:**    * By deploying VMs across two separate regions (US East and US West), the company ensures that its services remain available even if one region experiences downtime. This geographical redundancy minimizes the risk of a single point of failure. 2. **Disaster Recovery:**    * Azure provides built-in disaster recovery capabilities. In the event of a regional outage or catastrophic failure, workloads can be quickly shifted to another region, ensuring business continuity. 3. **Scalability:**    * Azure allows dynamic scaling of resources based on demand. This means that during peak times, additional VMs can be spun up to handle the load, and during off-peak times, resources can be scaled down to save costs. 4. **Managed Services:**    * Azure offers managed services for VMs, databases, and storage, reducing the administrative burden on the IT team. Managed services also include automated patching, updates, and backups, further enhancing the reliability and security of the infrastructure. 5. **Cost Efficiency:**    * The pay-as-you-go model and the use of Azure Hybrid Benefit reduce upfront and operational costs. This allows the company to optimize its budget while benefiting from enterprise-grade infrastructure and services.   By leveraging Azure’s robust cloud platform, Company "X" can achieve a higher level of resilience, ensuring that its services remain operational 24/7/365, regardless of any potential disruptions. |

# **STEP 3: Azure Cost Management + Billing**

| **Background** | You have now configured your Azure Production Workload environment and been using Azure for a few days. You have now been tasked by your CIO to present some metrics on how the costs are being billed within Azure and also what other functionalities Azure has in regards to cost management, which were not previously available. |
| --- | --- |
| **Question 1**  Submit the explanation | What is the purpose of Azure Cost Mgmt + billing Dashboard? |
| **Explanation 1** | The **Azure Cost Management + Billing Dashboard** serves several critical purposes for managing and optimizing costs within the Azure environment. Its functionalities include:   1. **Cost Visibility:**    * **Comprehensive Cost Analysis:** The dashboard provides a detailed view of the costs incurred by various Azure services, resources, and subscriptions. This allows organizations to understand where their budget is being spent and identify high-cost areas.    * **Cost Breakdown:** Users can see a breakdown of costs by resource, resource group, subscription, or service, enabling more granular analysis and better financial oversight. 2. **Budget Management:**    * **Budget Creation and Tracking:** Organizations can set budgets for different departments, projects, or services. The dashboard tracks spending against these budgets in real time, helping to prevent overspending.    * **Alerting:** Users can configure alerts to notify stakeholders when spending approaches or exceeds set budgets, allowing for proactive management and cost control. 3. **Cost Optimization:**    * **Recommendations:** The dashboard provides recommendations for cost-saving opportunities, such as resizing or deallocating underutilized resources, adopting reserved instances, or leveraging Azure Hybrid Benefits.    * **Efficiency Insights:** It offers insights into resource utilization and efficiency, helping organizations optimize their cloud infrastructure to reduce costs without compromising performance. 4. **Forecasting:**    * **Cost Forecasting:** Azure Cost Management can forecast future spending based on historical usage patterns. This helps organizations plan their finances better and make informed decisions about future resource allocation.    * **Trends and Projections:** The dashboard displays spending trends and projections, providing a forward-looking view of costs. 5. **Policy Enforcement:**    * **Cost Management Policies:** Azure Policy can be integrated with cost management to enforce cost-saving policies, such as restricting the deployment of high-cost VM sizes or enforcing the use of specific storage tiers. 6. **Reporting and Exporting:**    * **Custom Reports:** Users can generate custom reports tailored to their specific needs, whether for internal review or external reporting.    * **Data Export:** Cost data can be exported for further analysis in external tools or for integration into broader financial reporting systems. 7. **Multi-Cloud and Hybrid Cloud Management:**    * **Unified Management:** For organizations using a combination of Azure and other cloud services or on-premises infrastructure, the dashboard provides a unified view of costs across all environments, facilitating comprehensive cost management.   By leveraging the Azure Cost Management + Billing Dashboard, organizations can achieve greater transparency, control, and optimization of their cloud spending, ensuring that they maximize the value derived from their Azure investments while staying within budgetary constraints. |
| **Screenshot 2**  Submit the screenshot for main Cost Mgmt + Billing Dashboard. | **Hint:** Navigate to the Cost Management Section on the left and then click “Cost Analysis” to reach this dashboard. Students need to submit the main screenshot of the Billing dashboard |
| **Explanation 2**  Explain the key components of the screenshot submitted. An explanation to be provided for  Scope and Area dropdown from the screenshot submitted. | **Hint**: Make sure the right time period is selected to see the data.    **Key Components of the Submitted Screenshot**  **1. Scope Dropdown:**   * The scope dropdown allows users to select the specific subscription or management group for which they want to analyze costs. This ensures that users can filter and focus on the cost data relevant to a particular set of resources or organizational units. In the provided screenshot, the scope is set to "Pay-As-You-Go," indicating that the cost analysis is being performed for the pay-as-you-go subscription.   **2. Area Dropdown:**   * The area dropdown helps users to choose the specific aspect or dimension of costs they want to analyze. It includes options such as accumulated costs, resource costs, and service costs. This feature provides flexibility in how cost data is presented and analyzed. In the provided screenshot, the view is set to "AccumulatedCosts," indicating that the costs are being viewed cumulatively over the selected period.   **3. Time Period:**   * Ensuring the correct time period is selected is crucial for accurate cost analysis. The screenshot shows data for a specific time range, which helps in understanding cost trends and forecasting future expenses. It is important to select the appropriate time period to capture relevant cost data and trends accurately.   **4. Accumulated Cost and Forecast Cost:**   * The graph displays the accumulated cost over the selected period and includes a forecast cost to project future expenses. This visual representation helps in understanding spending patterns and predicting future costs, enabling better budget management.   **5. Cost Breakdown by Service Name, Location, and Resource Group:**   * The lower part of the dashboard shows pie charts breaking down costs by service name, location, and resource group. This detailed breakdown helps in identifying which services or locations are driving costs, enabling targeted cost optimization efforts. * **Service Name:** Displays costs associated with different Azure services, helping to pinpoint high-cost services. * **Location:** Shows costs incurred in different geographical locations, useful for managing regional spending. * **Resource Group Name:** Breaks down costs by resource groups, aiding in cost management at the project or department level.  **Summary** The Cost Management + Billing Dashboard is a comprehensive tool for tracking and managing Azure costs. By utilizing the scope and area dropdowns, users can focus on specific subscriptions and cost dimensions, while the visual breakdown of accumulated costs and detailed pie charts provide insights into spending patterns. This helps in making informed decisions to optimize costs and manage budgets effectively. |
| **Screenshot 3**  Submit the screenshot for breakdown of costs by Service Name and Location. | **Hint**: Navigate to Cost Management Section on the left, and then click “Cost Analysis” to reach this dashboard. These pie charts are under the above graph submitted. |
| **Explanation 3**  Explain the key components of the screenshot submitted. | **Key Components of the Submitted Screenshot** **1. Service Name Breakdown:**   * The pie chart on the left-hand side breaks down the costs by service name. This allows for an at-a-glance view of which Azure services are consuming the most resources and incurring the highest costs. For example, in this screenshot, Storage is the highest cost at €136.27, followed by Virtual Machines at €7.08, and Virtual Network at €5.73. This helps in identifying high-cost areas and potential targets for cost optimization.   **2. Location Breakdown:**   * The pie chart in the center breaks down costs by geographical location. This helps in understanding where the majority of the costs are coming from based on regional usage. For instance, in this screenshot, US East incurs the highest cost at €137.87, followed by US Central at €14.55, and US East 2 at €6.08. This is crucial for managing costs across different regions and optimizing resource allocation based on regional usage patterns.   **3. Resource Group Name Breakdown:**   * The pie chart on the right-hand side breaks down costs by resource group. This shows which resource groups are driving costs, allowing for better cost management and allocation at the project or department level. For instance, in this screenshot, the 'contoso-rg' resource group incurs the highest cost at €119.67, followed by 'servers-rg' at €18.32, and 'udacity-azure-optim...' at €12.50. This helps in tracking and managing costs associated with specific projects or business units.  **Summary** The Cost Management + Billing Dashboard provides a comprehensive breakdown of Azure costs by service name, location, and resource group. This detailed view helps in identifying high-cost areas, understanding regional cost distribution, and managing costs at the project or department level. By leveraging these insights, organizations can optimize their Azure spending and make informed decisions to reduce costs and improve resource allocation. |
| **Screenshot 4**  Submit the screenshot for breakdown of costs by Service Name and Location. | **Hint**: Navigate to Cost Management Section on the left and then click “Cost Alert” to reach this wizard. Next, click on “Add button” on top left under this tab. This is Part 1 of the wizard (of the 2-part process). |
| **Explanation 4**  Explain the key components of the screenshot submitted. | **Key Components of the Submitted Screenshot** **1. Create Alert Rule Panel:**   * **Alert Type:** Specifies the type of alert being created. In this case, it is set to "Anomaly," which means the alert will be triggered based on an unusual pattern or cost anomaly detected in the specified resource group. * **Condition:** Details the condition that triggers the alert. Here, it is configured to monitor for daily anomalies in the resource group. * **Start On/Until:** Defines the time period for the alert rule to be active. This alert is set to start on July 6, 2024, and remain active until July 6, 2025. * **Subject:** The subject line of the notification email, which will be sent when the alert is triggered. In this case, it is "Cost anomaly detected in Pay-As-You-Go." * **Recipients:** The email addresses of the recipients who will receive the alert notification. The provided email address is aspjscript@hotmail.com. * **Message:** The message body of the notification email, which can be customized to include specific details about the alert. * **Language:** Specifies the language in which the notification will be sent. It is set to English (United States). * **Alert Name:** The name of the alert rule. Here, it is "Daily anomaly by resource group."   **2. Cost Management Section:**   * **Cost Analysis:** Provides tools and views for analyzing cost data, helping to understand and manage spending patterns. * **Cost Alerts:** Allows the creation of alerts to notify when spending thresholds or anomalies are detected. * **Budgets:** Enables the creation and management of budgets to track and control spending.   **3. No Alerts to Display:**   * Indicates that there are currently no alerts set up in this section. Once the alert rule is created, it will be displayed here.  **Summary** The Cost Management + Billing Dashboard's alert feature allows for proactive cost management by setting up alerts based on specific conditions, such as anomalies or spending thresholds. This ensures that any unusual spending patterns are quickly identified and addressed, helping to manage and optimize costs effectively. The screenshot illustrates the configuration of an alert rule to monitor daily cost anomalies in the Pay-As-You-Go subscription, with notifications set to be sent to specified recipients. |
| **Screenshot 5**  Submit the screenshot for breakdown of costs by Service Name and Location | **Hint**: This is Part 2 of the wizard (of the 2-part process). |
| **Explanation 5**  Explain the key components of the screenshot submitted. | **Key Components of the Submitted Screenshot** **1. Alert Rules Panel:**   * **Name:** Displays the name of the alert rule. In this case, it is named "Anomaly Alert." * **Status:** Indicates whether the alert rule is active or inactive. Here, the status is "Active," meaning the alert rule is currently monitoring for the specified conditions. * **Condition:** Describes the condition that triggers the alert. In this instance, the condition is "Anomaly detected," which monitors for any cost anomalies. * **Action:** Specifies the action to be taken when the alert condition is met. Here, the action is to "Email me," sending a notification to the specified email address. * **Scope:** Indicates the scope of the alert rule. In this case, it is set to "Pay-As-You-Go," meaning the alert applies to this particular subscription.   **2. Edit Alert Rule Panel:**   * **Condition:**   + **Alert Type:** The type of alert being created or edited. Here, it is set to "Anomaly."   + **View:** The view that the alert is monitoring. This is set to "Daily anomaly by resource group."   + **Start On/Until:** The date range for which the alert rule is active. This alert starts on July 6, 2024, and will remain active until July 6, 2025. * **Notifications:**   + **Subject:** The subject line of the notification email, which is "Cost anomaly detected in Pay-As-You-Go."   + **Recipients:** The email addresses of the recipients who will receive the alert notification. The provided email address is aspjscript@hotmail.com.   + **Message:** An optional message body for the notification email. This field is currently blank.   + **Language:** Specifies the language for the notification. It is set to English (United States). * **Information:**   + **Alert Name:** The name of the alert rule, which is "Anomaly Alert."  **Summary** The screenshot illustrates the configuration and details of a cost alert rule in the Azure Cost Management + Billing Dashboard. This alert is set up to detect anomalies in daily costs by resource group within the Pay-As-You-Go subscription. When an anomaly is detected, a notification email will be sent to the specified recipient, providing real-time insights into unusual spending patterns. The alert rule is currently active and set to monitor from July 6, 2024, to July 6, 2025, ensuring continuous monitoring and proactive cost management. |
| **Screenshot 6**  Submit the screenshot for breakdown of costs by Service Name and Location. |  |
| **Explanation 6**  Explain the key components of the screenshot submitted. | Azure Cost Management + Billing is a comprehensive suite of tools designed to help you understand, monitor, and optimize your cloud spending. Here are the summarized highlights from this part of the project:   1. **Cost Analysis**:    * The dashboard provides a detailed view of costs, broken down by service, location, and resource groups. This allows you to pinpoint which areas are driving costs and identify any unexpected spikes in spending.    * Visual representations such as pie charts and bar graphs make it easier to interpret the data and communicate it to stakeholders. 2. **Cost Alerts**:    * The ability to set up cost alerts, as shown in the screenshots, helps in proactively managing and controlling cloud expenditure. Alerts can notify you of anomalies or when spending exceeds predefined thresholds, allowing for timely action to prevent cost overruns. 3. **Budgets**:    * Budgets can be created to set spending limits and track expenses against those limits. Alerts can be configured to notify when spending approaches or exceeds the budget, ensuring better financial governance. 4. **Azure Cost Management + Billing Dashboard**:    * The dashboard is a centralized location to access various cost management tools and features, providing a one-stop shop for all cost-related insights and actions.    * It includes options to analyze costs, create budgets, and set up alerts, all aimed at improving cost efficiency and financial transparency.   Overall, Azure Cost Management + Billing tools empower organizations to maintain control over their cloud costs, make informed decisions, and optimize resource usage to achieve cost savings and operational efficiency. |
| **Explanation 7**  Explain the summarized highlights of this part of the project, Azure Cost Mgmt + Billing | **Azure Cost Management + Billing: Summarized Highlights**   1. **Comprehensive Cost Visibility**:    * Azure Cost Management + Billing provides a detailed and comprehensive view of your cloud spending. It breaks down costs by service, resource group, and location, offering deep insights into where your budget is being allocated. This visibility is crucial for understanding and managing cloud expenditures effectively. 2. **Cost Analysis Tools**:    * The cost analysis features allow users to drill down into specific cost drivers and identify trends and anomalies. With visual tools like graphs and pie charts, it is easier to interpret data and communicate findings to stakeholders. This aids in making informed decisions about resource allocation and cost optimization. 3. **Budget Management**:    * The ability to create and manage budgets within Azure helps in setting financial targets and monitoring expenses against those targets. Budgets can be configured to reset on a monthly or yearly basis, providing continuous oversight of spending. Alerts can be set up to notify when spending approaches or exceeds the budget, ensuring that financial controls are maintained. 4. **Proactive Alerts**:    * Setting up cost alerts allows for proactive management of cloud costs. Alerts can be configured for different conditions, such as anomalies in spending patterns or exceeding predefined budget thresholds. These notifications enable timely interventions to prevent cost overruns and optimize spending. 5. **Detailed Reporting**:    * Azure Cost Management + Billing offers detailed reporting capabilities that provide insights into cost distribution across various dimensions like services, resource groups, and geographical locations. This helps in identifying cost-saving opportunities and optimizing resource usage. 6. **Cost Optimization Recommendations**:    * The tool provides recommendations for cost optimization based on your usage patterns. These recommendations can include rightsizing VMs, eliminating unused resources, and adopting reserved instances for savings. Implementing these suggestions can lead to significant cost reductions and improved efficiency. 7. **Integration with Other Azure Services**:    * Azure Cost Management + Billing integrates seamlessly with other Azure services, providing a unified platform for managing resources and costs. This integration ensures that cost management practices are embedded into the overall cloud governance strategy. 8. **User-Friendly Interface**:    * The dashboard and tools are designed with user-friendliness in mind, making it easy for administrators and financial managers to navigate and utilize the features effectively. The intuitive interface helps in quickly accessing critical cost information and taking necessary actions.   Overall, Azure Cost Management + Billing is an essential suite of tools that empowers organizations to gain control over their cloud spending, optimize costs, and ensure financial governance. By leveraging these tools, Company "X" can enhance its cost management practices, achieve greater financial transparency, and drive cost efficiency across its Azure environment. |

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# **STEP 4: Azure Policy to create and enforce policies**

| **Background** | You have now configured your Azure Production Workload environment and been using Azure for a few days. You realize that many infrastructure administrators are creating VM sizes without doing proper due diligence, thus having a direct impact on cost.  You now decide to leverage Azure Policy features to ensure that appropriate controls are put in place. |
| --- | --- |
| **Screenshots 1 through 5**  Submit the screenshots for Azure Policy steps. | **Hint**: Navigate to and select the built-in Azure policy “Allowed virtual machine size SKUs;” then follow the wizard steps. Submit a screenshot for every single step of the wizard so that any mistakes in the final step can be caught by your reviewer.  **Very important note:**   1. Due to lab restrictions, while you go through the wizard, you will not be allowed to create the policy in the final step. Please submit all screenshots though 2. So for the Part 2 of this project to be submitted, a successful policy has already been created in the lab for you, which can be used to test the VM creation scenario. Please ensure to double check which VM series is allowed to be created in the lab and ensure that you do not use the same series for passing this part of the project   **Step 1:**  **Step 2:**    **Step 3**    **Step 4:**    **Step 5:** |
| **Screenshot 6**  Explain through screenshots what happens when you create a VM which is in violation with the policy you just created. | Once the Azure policy creation is complete, try to create a VM which is of a “NOT ALLOWED” size.   **Hint**: pick any size; it doesn’t matter as long as it's not in the allowed list in Azure policy you just created.   Once you go through the wizard, in the final step you will see the following screenshot, which needs to be submitted. |
| **Explanation 1**  Explain the summarized highlights of this part of the project, Azure Policy. | **Purpose of Azure Policy** Azure Policy is a service in Azure that you use to create, assign, and manage policies. These policies enforce different rules and effects over your resources, ensuring those resources stay compliant with your corporate standards and service level agreements (SLAs). Azure Policy's goal is to bring resource governance and compliance to scale across your entire Azure environment. **Key Components of the Policy Assignment Process** **1. Policy Definitions:**   * Policies are defined to set the specific compliance criteria. The policy chosen here is "Allowed virtual machine size SKUs," which restricts the types of VM sizes that can be created within the Azure environment.   **2. Assigning the Policy:**   * The policy definition is assigned to the subscription, in this case, "Pay-As-You-Go." This assignment ensures that the policy is enforced across all resources within the specified scope.   **3. Setting Parameters:**   * Parameters are set within the policy to define which VM sizes are allowed. This step is crucial to customize the policy according to specific organizational needs. For example, only specific VM series like Standard\_B1s, Standard\_B2s, etc., are allowed.   **4. Review and Create:**   * The final step in the policy assignment process is to review all settings and create the policy. This ensures all configurations are as expected before enforcing the policy.   **5. Policy Enforcement:**   * After the policy is created, it is applied to the subscription, and any attempts to create non-compliant VMs will be blocked. This enforcement ensures cost control by preventing the creation of VM sizes that are not within the allowed list.  **Key Benefits and Highlights**  * **Cost Control:** By restricting VM sizes, Azure Policy helps manage costs more effectively, ensuring that only approved VM sizes that align with budget and performance requirements can be created. * **Compliance and Governance:** Azure Policy enforces organizational standards across resources, ensuring compliance with corporate policies and regulatory requirements. * **Automation:** Policy enforcement is automated, reducing the administrative overhead and human error associated with manual compliance checks. * **Scalability:** Azure Policy can be applied at scale across multiple subscriptions and resources, providing a centralized governance mechanism. * **Real-time Monitoring:** Azure Policy provides real-time compliance monitoring and reporting, allowing administrators to quickly identify and remediate non-compliant resources.   This part of the project demonstrates the power of Azure Policy in maintaining control over the Azure environment, ensuring resources are used efficiently and in compliance with organizational standards. |

**STEP 5: Azure Dashboards**

| **Background** | Azure Dashboards are a one stop shop to monitor   * Your logs * Your infrastructure * Your applications |
| --- | --- |
| **Task 1** | You need to create an Azure dashboard that will pull in a few widgets: Percentage CPU, All Resources, Resource Groups & Avg CPU Credits Consumed. Submit the screenshots and explain the key components of the Dashboard. Be sure to include a screenshot of the final Dashboard. |
| **Screenshots1 through 3**  You will submit the screenshots for Overview tab. | **Step 1:**  **Step 2:**  **Step 3 (Final Output):** |

# **STEP 6: Azure Monitor – Metrics**

| **Task 1** | You need to navigate to Azure Monitor > Metrics screen and create a Percentage CPU as a metric and submit screenshot of the graph generated and pin to dashboard. |
| --- | --- |
| **Screenshots 1 through 3**  You will submit the screenshots for Monitor | Metrics screen as you are setting up | **Step 1:**    **Step 2:**    **Step 3:**    **Step 4:** |
| **Screenshot 4**  Now that Azure Metrics Monitor is configured, please set an alert for that metric. The alert is whenever the Avg % CPU is greater than 0.3; then the alert will be triggered. |  |

# **STEP 7: Azure Monitor – Log Analytics**

| **Task 1** | You need to create a Log Analytics workspace and submit step-by-step screenshots. |
| --- | --- |
| **Screenshots 1 through 4**  You will submit the screenshots for Log Analytics workspace creation screens. | **Step 1:**    **Step 2:**  **Step 3:**    **Step 4:** |

# **STEP 8: Azure Insights**

| **Background** | Azure Insights can only be created once you have the Log Analytics workspace completed. |
| --- | --- |
| **Screenshots1 through 6**  You will submit the screenshots for the Monitor | Metrics screen as you are setting up. | **Hint 1:** Navigate to Insights > Applications and then click Add button  **Hint 2:** The Log Analytics workspace you created before will be used here  **Step 1:**  **Step 2:**  **Step 3:**    **Step 4:**  **Step 5:**  **Step 6: Click “Go to resource”** |
| **Screenshots 7 through 12**  **You will submit screenshots of you enabling the VM.** | **Hint 1:** So now that you have created Azure Insights for the Resource group, you need to go to Virtual Machines tab and actually enable it for the VM itself.  **Hint 2:** The key is to select the Log Analytics workspace which you created above in STEP 7:  Azure Monitor – Log Analytics.  **Step 7:**    **Step 8:**  **Step 9:**  **Step 10:**  **Step 11:**  **Step 12:** |

# **STEP 9: Azure Monitor – Smart Alerts**

| **Task 1** | Navigate to Setup Alert & Actions under Azure Monitor >Overview.  The condition name should be CPU units consumed and its value should be greater than 0.3. |
| --- | --- |
| **Screenshots 1 through 8**  You will submit step-by-step screenshots for creating a Setup Alert & Actions. | **Step 1:**    **Step 2:**    **Step 3:**  **Step 4:**  **Step 5:**    **Step 6 (Summary after above steps):**    **Step 7 (Screenshot post-creation of the alert):**  **Step 8 (If you had any alerts, they would be submitted here):** |
| **Explanation 1**  Explain the purpose of Azure Dashboards, Azure Monitor and alerts | **Azure Dashboards** **Purpose:** Azure Dashboards provide a centralized, customizable interface to monitor and manage your Azure resources. These dashboards allow you to aggregate various types of visualizations and metrics in one place, making it easier to track the performance, health, and usage of your infrastructure and applications.  **Key Features:**   1. **Customizable Widgets:** Users can add widgets for various metrics, charts, and graphs to create a personalized view of their Azure environment. 2. **Real-time Monitoring:** Dashboards offer real-time data visualization, helping administrators make timely decisions. 3. **Resource Management:** Provides insights into resource usage, costs, and performance, helping to optimize and manage Azure resources effectively.  **Azure Monitor** **Purpose:** Azure Monitor is a comprehensive monitoring service for collecting, analyzing, and acting on telemetry data from your Azure and on-premises environments. It helps to ensure the availability and performance of your applications and services.  **Key Features:**   1. **Metrics Collection:** Collects and analyzes metrics from various Azure resources. 2. **Log Analytics:** Provides deep analysis of logs and diagnostics data to identify and resolve issues. 3. **Alerts and Actions:** Automatically triggers actions based on pre-defined conditions to respond to critical events.  **Alerts in Azure Monitor** **Purpose:** Alerts in Azure Monitor notify users about critical conditions in their Azure environment. These alerts are set based on specific metrics or logs and help in proactive issue resolution by triggering automated actions or notifications.  **Key Features:**   1. **Condition-based Alerts:** Users can define conditions based on metrics, logs, or other signals to trigger alerts. 2. **Notification Mechanisms:** Supports various notification channels such as email, SMS, and webhooks. 3. **Automated Responses:** Can trigger automated actions like scaling resources or running scripts to mitigate issues.  **Screenshots** **Step 1:**   * Navigate to Azure Monitor from the Azure Portal. * Select "Alerts" from the Azure Monitor overview.   **Step 2:**   * Click on "Create" and select "Alert rule."   **Step 3:**   * Select the resource for which you want to create an alert.   **Step 4:**   * Configure the alert condition by specifying the metric (Percentage CPU) and threshold value (greater than 30%).   **Step 5:**   * Define the action group that will be notified when the alert is triggered.   **Step 6:**   * Review and create the alert rule.   **Step 7:**   * Verify the alert rule creation in the alerts overview.   **Step 8:**   * Monitor active alerts and their conditions in the Azure Monitor alerts dashboard.   These steps help ensure that you are notified of any critical conditions in your Azure environment, allowing for timely intervention and resolution. |

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# **STEP 10: Autoscale In-Out Based on Number of Users per CPU Core**

| **Task 1** | The lab will have a Virtual Machine Scale set already created.  Navigate to Azure Monitor > Settings > Autoscale.  You will create an Autoscale rule as part of this project. |
| --- | --- |
| **Screenshots 1-5**  You will submit step-by-step screenshots for creating an autoscale rule under Azure Monitor. | **Step 1 (Browse to Monitor > Autoscale):**  **Step 2 (Select the option for Custom autoscale and within that Scale based on metric and then click “Add Rule”):**  **Step 3 (Create the scale rule. They key part on this screen is that Percentage CPU metric is selected):**    **Step 4 (Once scale rule is created, submit the summary screenshot):**  **Step 5 (Screenshot for “Autoscale Enabled”):** |
| **Explanation 1**  Explain the key details of autoscale screenshots you have submitted. | **Step 1: Navigate to Monitor > Autoscale** **Details:**   * This screenshot shows the Azure portal navigation to the "Monitor" section. * The "Autoscale" option is selected in the sidebar, indicating the starting point for configuring autoscale settings.  **Step 2: Select Custom Autoscale and Add Rule** **Details:**   * The autoscale settings for a Virtual Machine Scale Set are displayed. * "Custom autoscale" is selected, and the option to "Scale based on a metric" is chosen. * The process to add a new rule is initiated by clicking "Add rule."  **Step 3: Create the Scale Rule** **Details:**   * The "Scale rule" creation pane is open. * The "Metric source" is set to the current resource (the Virtual Machine Scale Set). * The "Percentage CPU" metric is selected from the "Virtual Machine Host" namespace. * A condition is set to scale out (add more instances) when the "Percentage CPU (Average)" exceeds 30% for a duration of 5 minutes. * The "Operator" is set to "Greater than," and the "Action" is to increase the instance count by 1.  **Step 4: Summary of Scale Rule** **Details:**   * A summary of the configured autoscale setting is shown. * The autoscale setting is named "Udacity-Project-Scale-Setautoscale." * It indicates the resource group "Company-X-RG" and shows that the current instance count is 2. * The "Predictive autoscale" mode is disabled. * The rules defined include scaling out when the average CPU usage exceeds 30% or 80% and scaling in when the average CPU usage is below 20%. * The instance limits are set with a minimum of 2 and a maximum of 20.  **Step 5: Verify Autoscale is Enabled** **Details:**   * This final screenshot verifies that autoscale is enabled. * It shows the "Monitor | Autoscale" screen, listing the Virtual Machine Scale Set. * The "Autoscale status" is marked as "Enabled," confirming that the autoscale configuration is active.  **Summary** The screenshots collectively demonstrate the process of configuring autoscale for a Virtual Machine Scale Set in Azure. Key actions include navigating to the autoscale settings, selecting custom autoscale options, defining scale rules based on CPU usage metrics, reviewing the configured rules, and verifying that autoscale is enabled. This ensures that the VM instances automatically scale in or out based on the defined conditions, optimizing resource usage and cost. |