Cost Optimization in cloud costs with FinOps and multi-cloud billing monitoring tool

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Abstract

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This thesis aims to explore how Financial Operations (FinOps) can be integrated with cloud monitoring tools to achieve cost optimization in cloud environments. The thesis examines the techniques and strategies used in FinOps, including cost allocation, budgeting, and forecasting, and how they can be used in combination with cloud monitoring tools to optimize cloud costs. The thesis also addresses the challenges that organizations may encounter when operating in a cloud environment.

Additionally, the thesis provides an overview of a multi-cloud billing monitoring tool that can enhance the cost optimization approach from a modern perspective. The thesis concludes that the integration of FinOps and cloud monitoring tools can provide a comprehensive approach to cost optimization in cloud environments, but effective implementation requires strong data management, tool integration, and team communication.

Through the application of the insights and techniques presented in this thesis, organizations can achieve cost optimization while preserving system performance and functionality.

Key words
FinOps, cost optimization, multi-cloud monitoring tool, cost allocation, budgeting, forecasting

Table of contents

1 Introduction

Modern ICT solutions tend to move and migrate services, applications, and databases into a cloud computing environment in order to enhance profit and reduce capital expenses. One of features driving this migration is cloud computing provider's “pay as you go” payment method which allows companies to reduce capital investment into their own infrastructure. If a company would like to maintain their own infrastructure, it would tie up a significant amount of capital and time before services like ones offered by public cloud providers could be developed. There has been evidence of advantage to use this payment method since it was implemented by different cloud computing vendors. (Cloudcockpit, 13th of November 2020)

The task of selecting the best cloud computing vendor is not an easy one. Besides the cost, businesses will also need to consider how much time you spend on the process. Especially for companies with legacy systems, it can be difficult to determine what migration strategy is best in cloud computing. Before choosing the right vendor, when looking at cost effectiveness, performance, and maintenance, companies must consider not only the initial investment but also the ongoing maintenance costs.

On the other hand, the complex nature of multi-cloud across a variety of pricing structures can lead to excess expenses and redundant or unnecessary cloud computing expenses. It is important to note that cloud computing has a variety of management console interfaces, as well as notification mechanisms. The lack of centralized procurement, the unfamiliar interface of cloud cost management tools, and the lack of financial accountability all contribute losses in operation cost.

The concept of FinOps was born out of the excessive expenses that were affecting different industries. In pursuit of reducing expenses in the cloud and proof of FinOps concept, monitoring cost services are being developed. As a result of these tools, companies tend to improve the situations and problems they are facing and provide a single management interface that facilitates cross-functional collaboration between departments such as Engineering, Finance and Delivery, enabling financial control and predictability to be enhanced and costs to be optimized.

Aim of this thesis is to explore one of the multi-cloud monitor tools Klarity under the FinOps concept and to test the features to prove if they are beneficial to businesses.

1.1 Objectives

The primary objective of this thesis is to explore how FinOps practices can be integrated with cloud monitoring tools to optimize cloud costs. The aim is to achieve a reduction in overall cloud spending while still meeting the business needs.

To accomplish this, the thesis examines the challenges and opportunities of current cloud computing trends and introduces FinOps concepts and principles. It will cover how FinOps principles and lifecycle can be implemented in a multi-cloud environment where organizations use multiple cloud providers, each with different pricing models, services, and tools. A single monitoring tool, specifically the IBM multi-cloud (Klarity core) tool, can provide a unified overview of all cloud costs and is agnostic to the cloud provider.

The thesis will also investigate how to achieve cost optimization without compromising performance and reliability in a multi-cloud environment, where different providers may have varying levels of performance and reliability.

In addition, the thesis highlights the crucial role of FinOps practices and cloud cost monitoring in a multi-cloud environment to align cloud spending with business priorities and how they can be leveraged with cloud monitoring tools to gain insights into cloud resource usage, identify cost-saving opportunities, and ultimately optimize cloud costs.

1.2 Structure of the thesis

This thesis will be presented through five chapters. Chapter 1 introduces an overview of multi cloud management tools and the current situation in cloud computing monitoring, as well as the research questions and objectives for this thesis.

There will be a more extensive discussion of the theoretical background of public cloud computing in chapter 2, as well as the new concept of FinOps and multi cloud strategy. This chapter will also discuss the most widely used clouds in the industry today with their monitor cost services/tools, and multi-cloud monitoring tools for multi-clouds will be discussed.

The content in chapter 3 will demonstrate monitoring tools/services by deploying different applications and resources in the public cloud and continuing to monitor the cost/usage. In chapter 4, research will look more closely at Klarity's core features, including how to set up an account, test them, and generate various reports.

The final chapter of the thesis is devoted to discussion and conclusion. This chapter provides an in-depth analysis of the multi-cloud monitoring tools advantages and disadvantages together with some business aspects and technical aspects.

1.3 Research questions

To achieve the objectives of the thesis, several research questions are identified that indicate the course of the research. The questions are listing below:

- What are the benefits and impacts of multi-cloud monitors in terms of efficiency and centralized resource management for organizations which help them to plan and manage the resources they need in the cloud?
- Is a multi-cloud monitoring tool a future cloud cost monitor tool trend and a necessity for companies?
- What are the benefits of introducing FinOps principles into company practices and how to assess FinOps capabilities within a company?

A detailed discussion of all these research questions will be provided in the last chapter of the thesis and a demonstration will be conducted to clarify how multi-cloud billing monitoring tools can be used with mock data that is equally to real company expenses.

1.4 Key Concepts

- **Cost optimization** - the process of reducing cloud infrastructure costs while maintaining performance and functionality.
- **Compute resource** – Refer to hardware or software infrastructure used for process, manage and store data. Such as virtual machines, servers, containers and cloud-based services.
- **Cloud computing** - Allow user to provision computing resource such as virtual machines and storage with flexible scalability over the internet with pay-as-you-go payment method.
- **Cloud monitoring** - the process of monitoring and collecting data on cloud resource usage and performance to ensure that applications and services run efficiently.
- **Cloud providers** – Companies that provide computing resource over internet. For example, AWS(Amazon Web Services).
- **FinOps** - the practice of using financial management techniques to optimize cloud costs, including cost allocation, budgeting, and forecasting.
- **Cost allocation** - the process of allocating cloud costs to specific teams or departments based on their usage.
- **Data analysis** - the process of analyzing data collected from cloud monitoring tools to gain insights into resource usage and cost optimization opportunities.

- **Overprovisioning** - Compute resources are provisioned beyond the amount that is necessary to handle peak amount of users. Can be necessary sometimes in order to ensure high availability, but it's easy to also overprovision cloud resources by accident, leading to waste.
- **Non-production resources** – Compute resources that do not serve any actual customers that bring in revenue. Typically, this includes everything in cloud environments that are used for testing or development of new features.
- **Optimization strategies** - the techniques used to optimize cloud costs, such as rightsizing, reserved instances, and spot instances.
- **Anomaly data** - Anomaly data refers to data points or patterns that are significantly different or unusual compared to the expected or normal behavior of a system or process.
- **Showback** - Showback in FinOps means tracking and reporting IT costs to internal business units or departments to increase transparency and accountability.

2 Cloud computing background

The concept of cloud computing is generally associated with the process of performing workloads remotely at a technical provider's information center over the Internet. This type of framework is also known as a "commerce cloud." Amazon Web Services (AWS), Salesforce's CRM system, Google Cloud Platform (GCP), and Microsoft Azure are examples of cloud computing. Using cloud computing, users can configure and provision computing resources easily over the Internet using servers, storage, hosting services, and other services. Such services are provided by cloud service providers, with minimal effort on the part of the user. (Wesley Chai & Stephen J. Bigelow November 2022)

Due to the fast development and high demand for information technology these days, cloud computing can be grouped into three commonly deployed categories: public cloud, private cloud, and hybrid cloud. As its name suggests, public cloud offers services for all Internet users who wish to deploy their projects or applications with minimal management required. Unlike a public cloud, a private cloud offers companies or enterprise size companies with restricted access and dedicant data centers and private network to host the services of that business. The hybrid cloud is a combination of public and private cloud services with instrumentation and equipment between the two. The purpose of the Hybrid cloud is to create a unified, automated, scalable environment that takes advantage of all that the public cloud structures will offer, while even keeping control over mission critical data. (Wesley chai 16 December 2021)

Most cloud providers fall under four broad categories: Infrastructure as service (IaaS), Platform as a Service (PaaS), Software/Serverless as a Service (SaaS) and Data as Service (Daas). These are sometimes called this cloud computing “pile” because they make one side of one another. Recognizing what they are and how they’re different makes it easier to achieve job goals. As the demands on the cloud computing sector increase, the services are currently developing into more dynamic connections with modern infrastructure and technology.

Disaster recovery and job continuity have always been important aspects of cloud computing because it provides the cost-effective redundancy needed to protect data against system failures and the private storage space required to access data and applications in the event of a local outage or disaster. The top cloud service companies all offer disaster recovery as a service.

All these service models are currently utilized by numerous industries in their application systems, mobile commerce applications, and everyday operation service applications. Cloud computing service providers make it simple for businesses to choose the service models that best meet their needs.

Most firms are utilizing some form of cloud technology for their IT requirements, from initiatives to small-to-midsize operations. Now that there are more cloud solutions available, prospective adopters want to unbiasedly decide which is best for their organizations. This result depends on a wide range of variables, including system accessibility and usability, safety, cost and return on investment (ROI), cloud provider reputation, etc. The implications of these variables will alter business practices for years to come. (Ryan Oistacher, 19 Jun 2018)

2.1 The current challenges of Cloud

Since the growth of public cloud, the cloud business has been aggressively pushing this hybrid news to enterprises. Capitalizing on the fact that not every work will go to the public cloud, some cloud vendors and system integrators have promised to enter this organization information center seamlessly with the public cloud. However, this on-premises integration with the cloud remains a significant challenge and opportunities.

Current challenges and major topics that organizations are discussing fall into two categories: cost optimization and security. Cloud technology provides some advantages to initiatives, including cost savings and faster growth times. However, some cloud-based applications have inadequate safety protections. Out of 12,000 cloud companies, 80 percent allow vulnerable passwords. The stolen, shared word would so easily give hackers access to the organization’s most important information. (Lisa Vaas, April 19,2022)

Based on the Flexera report like the figure 1 indicates, the top challenges associated with public clouds have been categorized into 9 areas for all organizations, which include security, a lack of resources and expertise, managing cloud spend, governance, managing software licenses, a central cloud team, cloud migration and multi cloud management. A diagram showing each area's percentage is shown below. The issues associated with cost management and FinOps will be the main emphasis of this thesis, which will also attempt to identify their root causes.

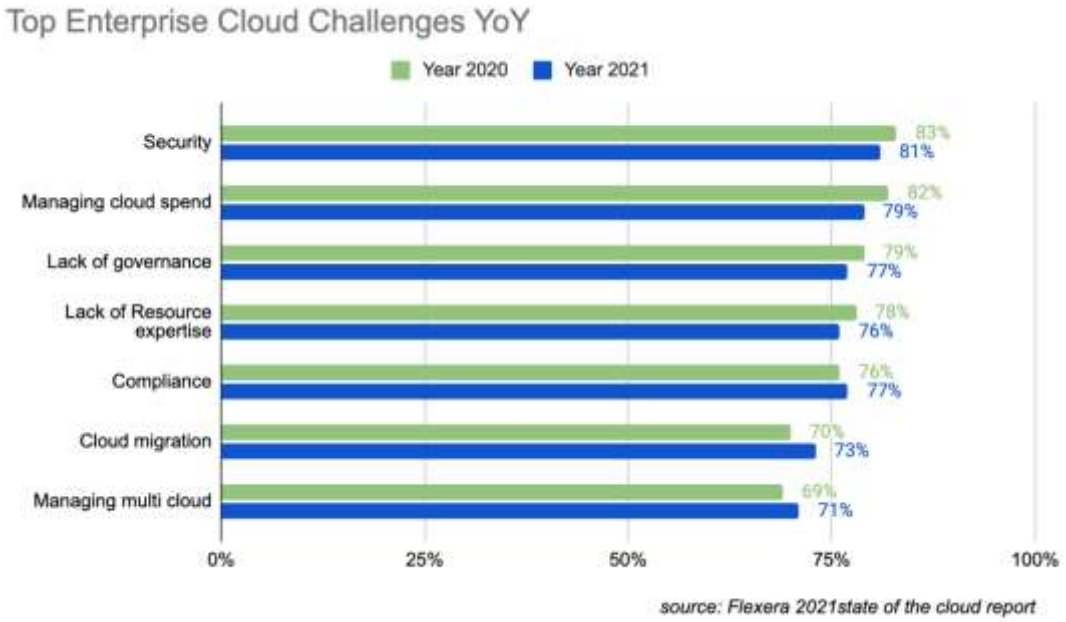


Figure 1 Flexera Top Enterprise cloud challenges YOY (Alan Weissberger, 9 March 2021)

According to cost optimization and FinOps experts, organizations can save money by using the cloud, but the organization does not have the proper training. Adopting the cloud cost optimization mindset and discipline is another challenge that organizations face. (Christy Lee, 13 July 2021)

In the following sections, the thesis attempts to analyze and provide an idea of the most important and easy-to-locate issue from the challenge.

2.2 Waste in cloud cost

Managing many different cloud provider platforms is a constant issue when public cloud strategy is adopted in a business. It is evident that cloud spending is increasing every year and is almost at a tipping point. The table 1 below shows the growth of the market. Based on Gartner's latest fore-cast, the entire market spend on end-users of public cloud services is anticipated to grow by 20.7% in 2023 from $490.3 billion in 2022 to $591.8 billion in 2023. Like the Table below is showing the services and amount of spending worldwide.

	2021	2022	2023
Cloud Business Process Services (BPaaS)	54,953	60,127	65,145
Cloud Application Infrastructure Services (PaaS)	89,910	110,677	136,408
Cloud Application Services (SaaS)	146,326	167,107	195,208
Cloud management and Security Services	28,489	34,143	41,675
Cloud System Infrastructure (IaaS)	90,894	115,740	150,254

Desktop-as- a- Services (DaaS)	2,059	2,539	3,104
Total Market (Billion USD)	**412,631**	**490,333**	**591,794**

Table 1 Worldwide Public Cloud Services End-user Spending Forecast (Millions of U.S. Dollars) (Stamford Conn, 18January 2023)

Several alternative factors can be addressed and identified to identify the root cause of insufficient cost optimization toward enterprises. Cloud cost challenges can include issues such as unexpected or uncontrolled spending, lack of visibility into usage and costs, difficulty in optimizing and managing resources, and difficulty in accurately forecasting and budgeting for future costs.

By knowing where the money has been spent over the cloud services and also knowing if there is any waste and better management systems aligned with the cloud are brought up very quickly and expected. This thesis will highlight the most significant factors contributing to present difficulties.

2.2.1 Pay as you go

The method of pay as you go is not as transparent or predictable as on-premises. The biggest benefit of moving from on-premise to cloud is the freedom from upfront payments and fast provisioning of resources when needed, which convinces organizations to switch from on-premises to cloud services.

While this method provides organizations with the capability to provision resources, it also presents a complex billing issue. The concept of pay as you go allows organizations to provide resources, but it also presents some entrusted issues to the finance department. There are many different teams and products that use different billing models depending on their demands in cloud services. Moreover, the teams do not necessarily need to be well versed in finance to inform the customer about the different pricing options and costs, but merely need a brief understanding of a few common finance concepts related to cloud billing. (Stephen Pritchard, 24Feb 2022)

For instance, computer resources can be increased for important events or busy periods, like the weeks before Black Friday sales or the months leading up to Christmas sales, and then dropped when things are quiet, or the sales campaign is done. When variable consumption models are employed in place of fixed operating costs, cost prediction becomes more challenging. Variables in pay as you go make it feasible for companies to lose track of which resource they have been using more frequently. If the corporation didn't set a timer to lower the quantity of resources after the peak period, it might end up costing more than the savings they had made. (Christy Lee, July 13, 2021)

According to reports from Flexera's State of the Cloud study for 2021, there is a noticeable surge in enterprise cloud spending. The survey found that the annual expenses of cloud services could reach millions, and that only a small percentage of businesses have cloud service costs under millions. Only 38% of enterprise cloud expenses are anticipated to cost millions by 2021, but this percentage will jump to 53% by 2022, according to the Flexera analysis. It is possible that this is one of the reasons why the cloud cost is excessive. (Alan Weissberger, 9 March 2021)

Below is Figure 2, which is the result of Anodot's research conducted, along with interview questions posed to the company to collect data. According to the survey, 53% of respondents agreed that visibility into cloud usage and costs were the top challenges, followed by 50% who agreed that cloud pricing was complex. As can be seen from these figures, cloud pricing methods pose a significant challenge for companies in keeping costs low and efficient. (Anodot, 2022,5)

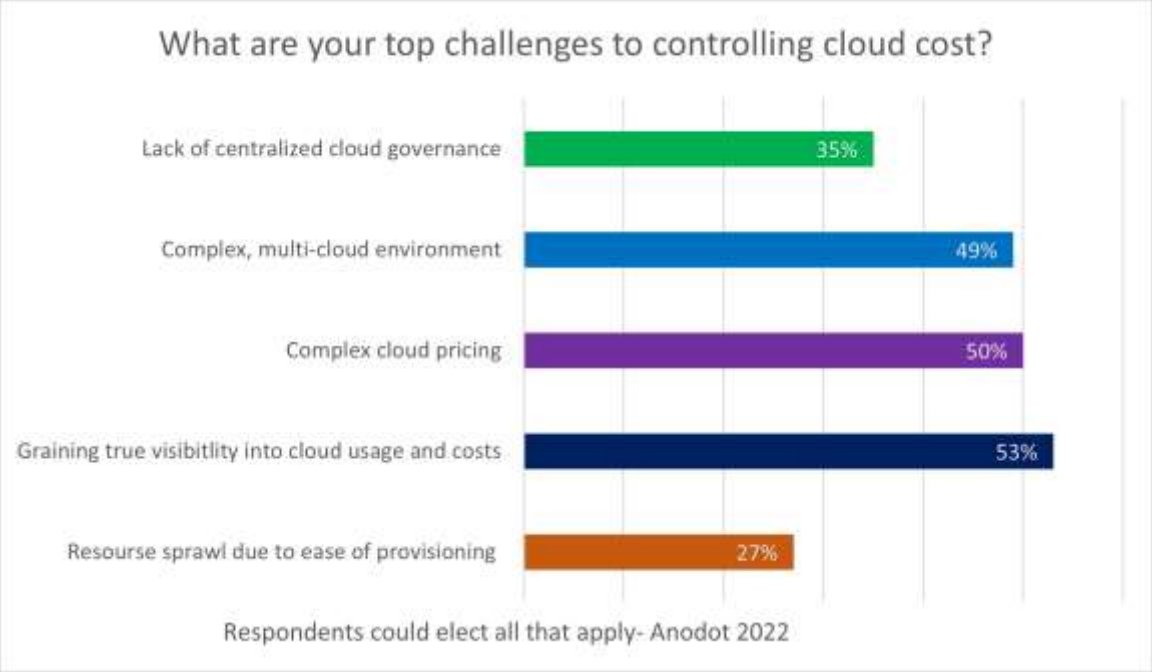


Figure 2 Top challenges to controlling cloud costs. (Anodot, 2022, 5)

2.2.2 Resource overprovisioning and persuasion

It is relatively simple to overprovision cloud resources, which results in enormous expenditures for the entire enterprise. Cloud resource overprovisioning refers to the allocation of more resources (such as CPU, memory, or storage) than are needed for a given workload. This can occur for a variety of reasons, such as a lack of accurate forecasting of resource requirements, or a desire to ensure that resources are always available even during peak usage periods. Overprovisioning can lead to increased costs, as resources are paid for even when they are not being used and can also negatively impact performance if too many resources are allocated to a single workload.

Nevertheless, considering that most businesses are still unfamiliar with the cost optimized best practices, and they don't have a central team to supervise them. In the chart below, it is evident that self-estimate waste accounts for approximately 30% of the cloud cost, and 15% of overprovisioning. This amounts to over 45% of the cloud cost for an enterprise.

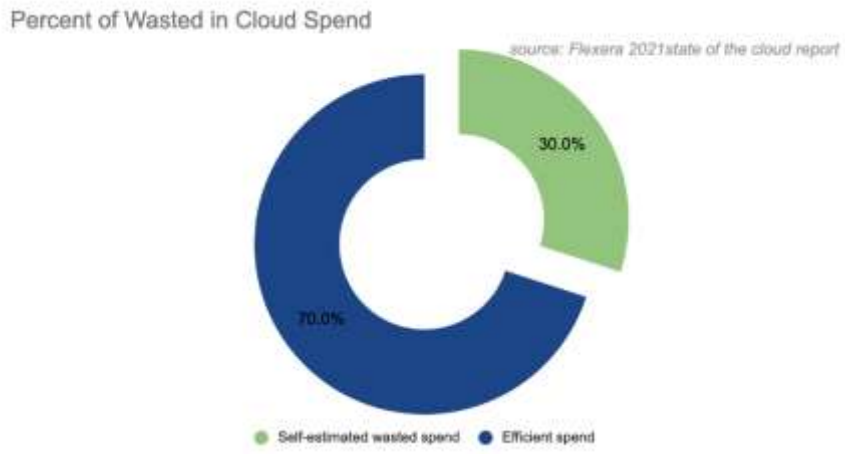


Figure 3 Flexera Percentage of wasted in Cloud spend (Flexera, 2022)

As a matter of fact, many organizations are picking the wrong size for instances to host the applications and miss the idea from cloud vendors about "the more you buy, the better the offer will be." Moreover, there are many types of instances and the developers do not necessarily have the knowledge to choose the correct one, but sometimes they may choose the wrong type that is quite expensive and not necessary. Besides that, the Idle resource is also one of the reasons for the waste of cloud expenditures.

In contrast to overprovision, idle resources mean that the instance is running but is not being used. For example, an organization may have a marketing or sales campaign that is ongoing but forgot to turn off over the weekend afterward and forgot about it. Particularly for instance-based and other serverless services, the pay as you go strategy is based on minutes or seconds. According to Business 2 community studies, they predicted that $14.5 billion in idle resource loss from Gartner IaaS would result in 202. Based on their research, they predict that non-production resources make up 44% of computational resources. (Katy Stalcup, 21 Jan 2021)

As an instance it is one of the most expensive expenses in the cloud services, a misplacement of instance scale to the wrong type of instance can waste almost half of the bill in the cloud. (Kim Wiens, 13 Nov 2017)

2.3 Lacking of governance policies and visibility

Human factors and management-level concerns appear to be the cause of yet another cloud cost issue. This happens primarily since there is no centralized power structure in place to supervise cloud technology in addition to a lack of knowledge regarding administering modern cloud technologies. (Vibhuti Sinha, 16 May 2022)

Governance in cloud can be a significant challenge for organizations. Some specific issues that organizations may face include:

- Ensuring compliance with regulatory requirements, such as data privacy and security laws.
- Maintaining control over data and access to it, especially when it's stored in a multi-tenant environment.
- Managing access and permissions to cloud resources, such as ensuring that only authorized users can access sensitive data.
- Auditing and monitoring cloud usage to ensure compliance with internal policies and procedures.
- Managing data and application lifecycle, such as archiving, backup, and disaster recovery.

An important aspect of the central control team is managing paths that include data privacy, compliance with regulations, resource allocation, cost management, security, and access control. Although this team intends to focus on cloud management, many enterprises lack the necessary knowledge and do not intend to invest in it, so they are putting the cost and security of cloud in a passive position. It’s also important for organizations to have a clear governance model that outlines roles, responsibilities, and decision-making process. At the same time, it is very challenging to achieve transparency and visibility in a cloud environment without a dashboard or budget estimation and documentation. This leads to conflict between the development team, financial team and other stakeholders. These issues are already showing up in many companies migrating to the cloud, where cloud operations cost more without proper governance and are more costly than staying in an on-premises IT environment. (Elizabeth Wallace, 16 January 2023)

2.4 The challenges of multi-cloud

As the name suggests, multi-cloud strategy involves businesses hosting their applications and services on multiple cloud platforms at the same time. Publicly available 2022 Enterprise cloud index figures indicate that 83% of organizations/enterprises subscribe to hybrid multi-cloud as future technology. According to the report, enterprises with more than 5000 employees are committed to multi-cloud implementations with 57% already in place. In addition, the report found that the

pandemic has changed the way many organizations are operating, and multi-cloud fits seamlessly into this new way of doing things. (Nutanix, 2022)

In the figure 4 below, which is derived from Flexera 2022 research, there are organizations who have implemented a multi-cloud strategy, with 9% implementing a single public cloud, 2% implementing a single private cloud, and 89% implementing a multi-cloud strategy. The 89% multi cloud percentage is divided into multi public with 7% and 2% multi private cloud in use, while the remaining 80% is hybrid cloud. A hybrid cloud consists of a multi-public and multi-private cloud used in conjunction with a multi-public and a one-private cloud. (Flexera state report 2022)

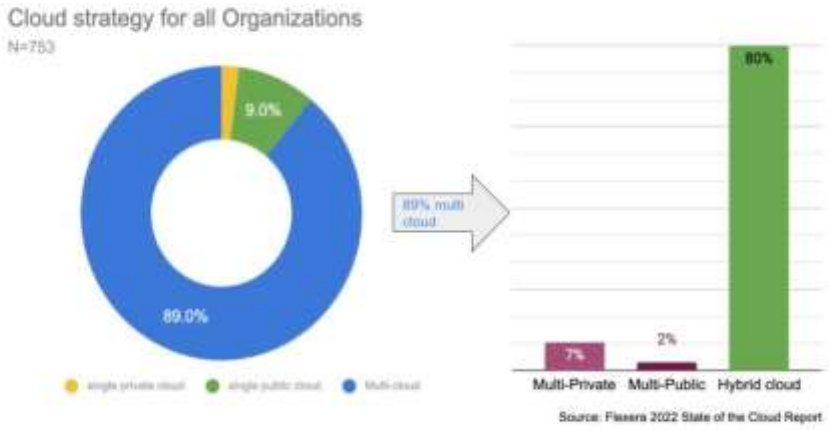


Figure 4 Cloud strategy for all organization (Flexera, 2023)

There are a few other major reasons why the multi cloud demand has risen from the past few years, mainly the impact of pandemic is a major catalyst for it. To avoid transmitting viruses, most companies suggested their employees work from home starting in 2020. The Nutanix ECI 2022 report indicated that 61% of respondents were focused on providing more flexible work setups because of the pandemic. Multi cloud is coming across all companies' minds as a best practice to implement the new way of working, and it is supporting the services that companies need urgently. Due to their agility and flexibility, these cloud platforms distribute data to a variety of geolocations to ensure continuity of service and proximity of users. (Nutanix, 2022)

As part of the need for a multi-cloud, there are restrictions regarding data sovereignty, regularization, and laws within the corporate policies, in addition to geographical constraints. The EU's data protection law and other constraints affected end users, application optimal performance and latency, for example. (Alan R.Earls, 06 Oct 2021)

Meanwhile, reliability is also an important reason why multi cloud strategy is becoming more necessary. In some cases, corporations are still concerned if relying on a single cloud provider is secure enough in case of internet failure the from provider or cyber-attack occurs. Due to this major mindset shift, multi-cloud strategy has become increasingly important and prevalent.

Pricing advantage between different cloud providers is another major factor driving multi-cloud strategy. It is the goal of each cloud provider to develop their unit technology so that their customers can receive different services with a wide range of coverage across different perspectives. Consequently, their prices and offers vary based on the amount of usage and the combination package they offer. To save operation costs, businesses are constantly seeking the cheapest but most effective solution. As a result, a multi-cloud strategy is often implemented across multiple departments and services in a company.

Despite the various advantages of multi-cloud strategy, many businesses still question its necessity. They are concerned about the management overhead and lack of technical competence to fully utilize multiple cloud environments. Even though there are numerous advantages to implementing this type of strategy, many companies still don't know what they can achieve with it.

2.4.1 Managing multi cloud costs across multiple cloud providers

In the chapter, cloud challenges and price complexity issues are discussed, and then multiple cloud environments are discussed, but the amount of money and complexity involved is three to four times higher when it comes to multi-cloud. Organizations may encounter specific challenges in managing cloud costs, allocating cloud resources, and developing budgets that might cost them more than they are expected.

For organizations, managing cloud costs across multiple providers can be a significant challenge since it is difficult to compare cost and usage between providers. Because each cloud provider has different pricing models and usage metrics available, it is difficult to compare cost and usage directly between them. Especially when they provide similar services like instances and storages used in cloud environments. Consequently, there are also issues that may mess up and confuse the strategy for choosing the appropriate cloud providers and services, as well as disrupt the developer's workload when managing multiple cloud providers.

Organizations may also have difficulty allocating costs to specific departments or projects, since usage and expenses may be spread across several cloud providers. As a result, organizations may have difficulty understanding the amount of money each department and project spends on cloud services and making informed decisions about budgeting and cost optimization. Cloud providers provide their users with similar dashboard capabilities. However, different teams and

different users do not necessarily need all the knowledge of each provider. This may result in oversight of resource consumption or incorrect assignment of tags to incorrect projects when there are multiple teams and multiple users.

In addition to managing cloud costs across multiple providers, organizations can find it difficult to consolidate billing when managing cloud costs across multiple providers. A cloud provider can generate its own billing information and invoices when different departments or teams within an organization use different cloud providers. Organizations may find it difficult to forecast budgets accurately due to this difficulty in getting a clear, consolidated picture of their total cloud expenditures. Essentially, the goal of consolidating billing is to consolidate all of the billing information and invoices from various departments within the organization. In order to improve visibility into cloud costs, organizations will be able to identify areas of overspending and take action to reduce costs. As each provider has its own billing method, it will be very difficult for the finance department and developer to keep track of billing when there are multiple providers and some services in the same project overlap. In addition to identifying which areas are driving costs and where resources should be allocated, it will also be difficult to keep track of billing. (Asim Razzaq, 3 November 2021)

3 The FinOps concept

A public cloud structure is discussed in a previous chapter as a future trend in the market. Managing single cloud providers costs could be simple, but problems arise with several cloud service providers. In this case agnostic billing and monitoring tools start to become appealing. The best way to make the most efficient and beneficial technology investments for a business would be to create a tool that could be used across different departments by all end users and no technical background is required. FinOps as a combination of Finance and Ops is introduced to organizations.

Diverse auditors and editions interpret concepts differently. Ultimately, the idea of FinOps is to bring maximum value to businesses by collaborating between technical teams and other teams for organization. (FinOps Foundation, 21 November 2021)

As described in the FinOps October summit presentation 2020, the following definition was suggested:

> "FinOps is a public cloud management discipline that enables organizations to get maximum business value from cloud by helping technology, finance, and business teams to collaborate on data-driven spending decisions."
>
> —J. R. Storment, executive director, FinOps Foundation

FinOps (Financial Operations) is a set of best practices and processes for managing and optimizing cloud costs. By aligning the financial and operational aspects of cloud usage, organizations can maximize the value of their cloud investment and optimize their spending.

As far as FinOps, there is a FinOps Foundation which conducts research and integrates FinOps concepts into a variety of cost management products as part of its mission. Several well-known names in the IT industry are members of the FinOps Foundation, which is a non-profit industry organization. As well as Joseph Daly, director of cloud optimization services at Nationwide, there are other individuals with similar positions at Atlassian, Autodesk, and Spotify.

A FinOps strategy focuses on three areas: cost optimization, cost visibility, and cost governance. In addition, this core focus is applied to monitoring tools published and used in public cloud environments. This is to assist enterprises in reducing costs associated with cloud spending and eliminating waste associated with cloud costs.

Organizations can utilize FinOps as a framework to improve the management of their cloud costs, with the goal of reducing costs, increasing transparency, and enabling improved business decisions. The field of FinOps is still relatively new, but as more companies migrate their workloads to

the cloud, it has gained a growing number of followers. FinOps can provide a framework for companies to optimize cloud costs and maximize returns of their investment.

3.1 FinOps Principles

An organization can apply six FinOps principles in practice by understanding and utilizing them.

Team collaboration: Different teams across the whole organization are encouraged to collaborate with each other. As an example, while development team is delivering a new product or feature to meet business demands, they will also share visibility and responsibility for managing costs the cloud resources they provision as part of their work, instead of delegating this responsibility to a separate cloud team.

- Accessible reports: A pay as you go method allows companies to quickly provision resources when they need them. Unlocated expenses might also occur sometimes with this method. In this case, the Finance team has an uncertain decision to make regarding cloud spending, as a result of which the accessible reports can help developers and finance make an informed decision, as well as establish an accurate estimate of the budget for the project and use that information to update reports as needed.

- Ownership: It is Finops' principle to encourage each member of the team to be responsible for determining the spending of the cloud. With this principle, members can identify cloud waste more effectively and eliminate it by taking responsibility for their own cloud utilization.

- Cloud business value is the basis for decision making: For organizations to understand cloud spending and to review costs, trending and variable analysis are needed to detect anomalies across three component elements: quality, speed, and cost. It is therefore a FinOps principle to measure your project's internal rate of return (IRR), and industry peer-level benchmarking can provide an indication of how your company is doing in comparison to your peers.

- Centralized team: FinOps is governed by a centralized team, this principle encourages companies to collaborate instead of operating independently. It is common for cloud providers to offer discounts to organizations if they purchase a large amount of data storage, volumes, and reserve distances. Furthermore, centralized purchases allow teams and cost

centers to allocate direct and shared costs also shared across available resources with whole organization departments.

- Benefit of variable cost model: Among the benefits of cloud computing is its ability to trade fixed costs for variable costs. A perfect fit for the agile model in the new concept of cloud with iterative planning and small adjustments/changes for the development resources over the cloud usage can help organizations save money. The variable cost model is seen as a way for organizations to save money instead of taking on risk. The major cloud native cost management service/tools.

(J.R. Storment, Mike Fuller. Chapter 1)

3.2 FinOps Lifecycle

In order to structuralize practices into a framework that organizations can adopt, a concept of FinOps Lifecycle has been developed. It's divided into three phases, each of which can procedurally be implemented by real world organizations. This approach allows organizations to tackle the challenges of each phase consecutively instead of trying to force an all at once transformation to their cloud process, in fact it is not suggested to jump into three phases straight away but to crawl through each phase sequentially, since each phase contains its own challenges and requires a different approach. It is vital to practice and contribute with different teams at each of the phases. It is vital to practice and contribute with different teams at each of the phases. As part of each phase, there is a set of activities in which a solution-oriented approach is taken towards identifying the increase in cost issues and how it can be resolved in a more efficient manner. There is no linear order to each phase, and practitioners must plan to iterate them constantly to ensure that the life cycle proceeds as intended. (FinOps Foundation, 2022)

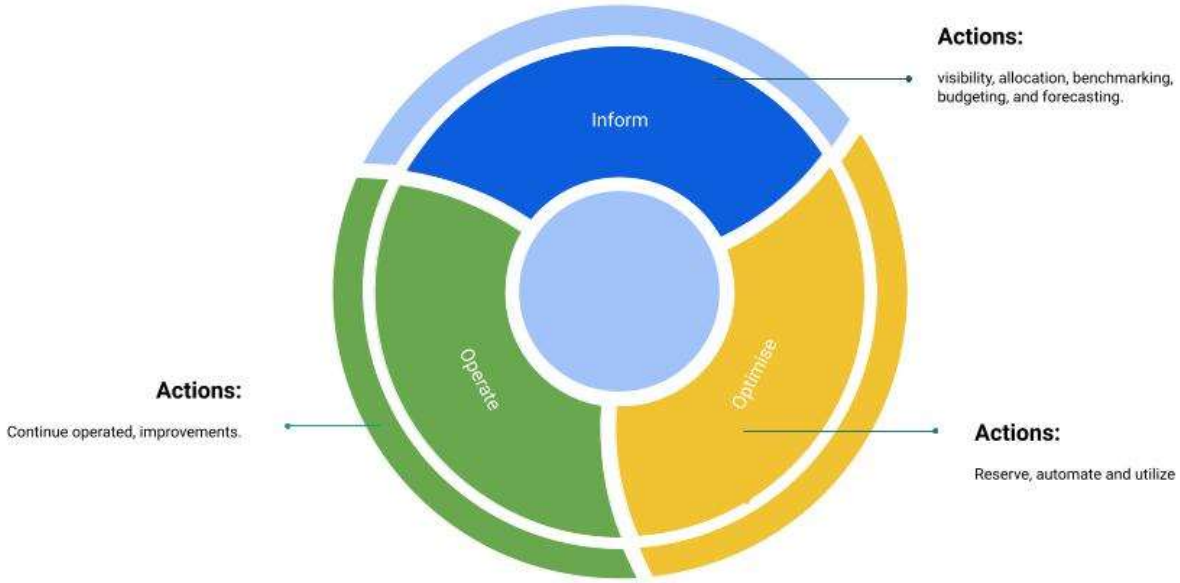


Figure 5 FinOps lifecycle

3.2.1 Inform phase

This phase aids in the introduction of information by giving other teams and their own team insight to find and comprehend where the cost or budget has been spent in the cloud, which entails cost allocation and the reason why it has been spent. It is a complicated aspect that requires plenty of practice, education, and participation with the various cloud platforms and resources. During this phase, FinOps practitioners should question themselves, "What reports, and direction does the organization require?", to serve as a starting point. During this FinOps phase, practitioners should consider what information they require and what reports are necessary to support their business decisions. As a continuation of the previous question, the second question could be “How good is the documentation of tags and cost allocation?” followed by “Is the organization going to do a showback?” The team can grow the query like a tree using these two approaches and determine the issue's fundamental cause. During each phase, the team will be guided through a set of activities along with a sequence of questions, and each step of the activities will facilitate a better understanding of the challenge.

Inform Phase Activities

The key activities in the inform phase are more complicated and more complex at the beginning of the life cycle. These include:

- Data collection: The data collection process begins with creating a data streaming map that shows the flow of data expenditures in each cost center, application, and business unit within an organization hierarchy. The purpose of this is to align tag and view alignments since development teams sometimes do not align with finance teams. Upon completion of the collection process, the team will create a report that will show each group's spending, along with a showback or chargeback. As a result of this action, visibility will be provided within the team and ownership and expenditures will be clearly defined.

- Define budgets, forecasts and account strategy: Activities to be carried out in the future include budget planning and expenditure forecasting. In order to prepare budget proposals, the team should use the data collected to generate forecasts of cloud spending across various projects. Through forecasting and budgeting, each team can benefit from lean optimization and transparency in relation to the budget that has changed. A significant part of the process involves defining the account strategy. This relates to the distribution organization and cloud provider and has a substantial effect on the cost allocation process. The team may spend some time on these activities to develop similar logic and strategy for distributing accounts among cloud providers and establishing cost boundaries.

- Cost allocation strategy and governance: A part of the activities involves planning and establishing best practices for creating tag strategies and compliance. This is in relation to metadata strategy, which relates to the tags and labeling of resources that teams are using. In this series of activities, it is also possible to identify untagged resources, which can help to align resources across departments and teams. Also, the purpose of this is to identify whether the organization already has tags in their cloud account or whether they have not yet used them. Further, these activities may also involve shared cost allocation among accounts belonging to the same organization. A modern cloud environment allows users to share resources among accounts belonging to the same organization. Thus, organizations can reduce waste and achieve better discounts by transferring or assigning unused resources to different accounts within different business units. This makes it pertinent to identify and allocate recurring costs for each business unit as well as benchmark cloud resource costs for each. This will ensure that costs are accurate.

- Dynamically calculate custom rates and amortization metrics: Throughout the activities, the team must identify and recognize discounts from the RIs/CUDs, as well as amortized pre-payments from the RIs/CUDs. This is being done in order to avoid misinterpretations and unmatched bill amounts that might surprise the finance department.

- Implement scorecard: Team members can identify areas for improvement by participating in this activity. In order to determine where improvements can be made, it is necessary to properly allocate resources and benchmark how different teams/projects are performing.

Organizing the activities in a specific sequence is not necessary. The goal is to create familiarity and knowledge of cloud spending in various services, understand the report, and generate the needed report at the end. Through these activities, the team will be able to observe for the first time how their actions are affecting the bill.

(J.R. Storment and Mike Fuller, chapter 10-14)

3.2.2 Optimize phase

A key objective of FinOps is to identify and implement cost-reducing strategies for cloud infrastructure and applications during the optimize phase. Therefore, optimizing involves combining two concepts, namely cost-optimization and cost-avoiding, with cost savings also called cost avoidance being the primary priority. As far as cost optimization is concerned, cloud providers provide their customers with multiple layers of cost optimization services. The purpose of this phase is to analyze cloud usage data and implement cost-saving measures in order to minimize waste and achieve cost optimization objectives.

As an example, Amazon Web Services (AWS) provides reservation capacity services that provide customers with huge discounts to replace heavy demand on-demand capacity, thereby increasing strong customer commitment and engagement.

Optimize Phase Activities

Key activities in the "optimize" phase include:

- Report on underutilized services: Teams need to identify underutilized resources and inefficient deployment strategies by analyzing cloud usage data including anomalies data. When attempting to identify anomalies in data, this is an imperative step. Cloud providers now offer a wide range of variable-priced services, making anomaly detection an imperative part

of the process. Anomaly detection helps organizations locate the needle in the haystack that requires immediate attention.

- KPIs and goal refinement: Team members will be required to review the KPIs and understand what they mean regarding overall achievement. Throughout the process, the team can set interim step goals that can be reached over time. With the process in place, you are prepared to move forward when you are in the operational phase.

- Cost savings validation: It aims to evaluate the commitment-based discounts offered by cloud providers. The team tracked commitments and reservations with different cloud providers, including AWS/Azure RIs, AWS SPs, and Google Cloud CUDs/Flexible CUDs. They investigated whether there was a gap in demand or if the current commitment plan could be reduced/modified. It is imperative to establish a clear account portfolio for the organization as well as to clarify the actual usage and costs that should be avoided. In this way, it is possible to measure and verify the effectiveness of cost optimization strategies on cloud costs in a clean, transparent, and measurable manner.

As part of this phase, organizations need to set up and track their near-real-time business decisions to optimize their cloud capabilities. In order to achieve cost optimization, cost avoidance and enhancement are always of highest priority.

(J.R. Storment and Mike Fuller, chapter 14-17)

3.2.3 Operate phase

In the life cycle, operation represents the final phase. The goal and key performance indicators are determined in the optimization phase, while implementation occurs in the operate phase. There will also be an opportunity to continuously improve the process to optimize costs. Upon implementing automation, management takes a step back to ensure that expenditures are aligned with company objectives. In order to determine whether changes need to be made to a particular project, it is advisable to discuss it with other FinOps team members.

Operate Phase Activities:

Key activities in the "operate" phase include:

- Cost optimization review: Regularly reviewing and assessing cost optimization strategies and adjusting as necessary are essential. Participation in the development team is

required. In most cases, the development team reviews FinOps recommendations and makes the necessary adjustments. As an example, an instance type could be changed to a less powerful and more economical instance, storage sizes could be adjusted, and storage tiers could be adjusted accordingly.

- Reporting: This activity involves delivering a report that contains spending data to stakeholders so that they can continue to track the usage of the data against the budget. The purpose of this report is to provide insight and recommendations for optimizing costs in order to make the most effective business decisions possible. The team should concentrate on the content of the reports and the method of delivering them to stakeholders. To make reports available to stakeholders, they should also set up an automated report generation process.

- Automate resource optimization process: Team members will take some practice in automating resource optimization and set up an alarm or budget alarm to shut down the resource when it becomes overused or to notify stakeholders when the resource is almost used up. Also, it is beneficial to use it in order to clean up underutilized resources.

- Establish governance and policy-driven usage of tags: Tags should be cleaned up according to standardized practice policies. It is imperative to develop and implement standards for the use and application of tags to cloud resources, including naming conventions and data formats. Moreover, the team should continuously evaluate its agreed-upon guardrails to ensure that they do not impede innovation and velocity.

As well as helping organizations optimize their costs, FinOps introduces a cultural shift that affects the way organizations use the cloud. This is one of its many advantages, as it can help organizations reduce their costs in an efficient manner. There are limitations and considerations associated with each tool that cannot be avoided. It will ensure that cloud infrastructure and applications are optimized to support business objectives. It is determined by assessing the organization's culture, its value to the business, economies of scale, and speed of delivery. When the organization reviews these four considerations, it will ask, "Do we understand your business goal/goal at this stage?" It is also helpful to understand the concept of "More is Less".

(J.R. Storment and Mike Fuller, chapter 20-14)

4 Cost management service/tools

Cloud computing providers are creating their own specialized service areas and offering different price combinations to compete on the market. Among the essential services offered by the cloud computing service are the integrated FinOps concept cost management tools, which have the objective of maximizing cost efficiency.

Several FinOps tools are available to help organizations manage and optimize their cloud costs, such as AWS Cost Explorer, Azure Cost Management, Google Cloud Cost Management, CloudCheckr, Cloudability, and Apptio. There are differences in features among FinOps tools, and organizations should choose a tool that adequately suits their requirements.

4.1 The cloud native management tools

In this research, three main cloud providers commonly used in the market are Amazon Web service (AWS) from Amazon, Azure from Microsoft and Google cloud platform from Google. Each of these cloud providers implements the FinOps concept management tool into their customer's subscription, with associated service costs and fees. There is a lot of similarity between the features and functionalities, but with the same purpose of helping customers to monitor and optimize their cloud spending, forecasting cost and control budgets.

4.1.1 Amazon cost management

AWS Cost management is a service offered by Amazon that provides a variety of use cases with budgeting and forecasting ability, as well as optimizing pricing to reduce overall AWS costs. Depending upon the needs of the customer, AWS has different services, targeting different use cases with Report, forecast, inspection, and control functions.

The services are:

- AWS Cost Explorer: All AWS users are entitled to free access to AWS cost explorer. They must configure the management interface. An engineer may access user data programmatically through the Cost Explorer API. Each paginated API request costs $0.01. AWS generates a forecast for the next 12 months based on the data for the current month and the last 12 months. Every 24 hours AWS cost explorer will update/refreshed your usage/cost data within your AWS account.

- AWS Budgets: AWS users can use AWS budget to create budget alerts in their project expenses, enhance cost control, and monitor usage within on-going projects. Users have the option to set up budgets based on their needs. These include Cost budgets, usage

budgets, saving plan utilization, RI utilization budgets, RI coverage budgets, Savings Plans coverage budgets.

- AWS Cost Anomaly Detection: As part of AWS's machine learning solution service, this product continuously monitors costs and usage to detect abnormal spending.

(Managing your costs with AWS Budgets, 2022)

The functionality and key features of the cost management includes:

- AWS Cost Explorer: Analyze and visualize consumer costs and usage on AWS.
- AWS Budgets: To set a budget cloud usage and cost.
- AWS Cost Anomaly Detection: Receive email alerts regarding unusual spends because of monitoring cloud costs and usage over time with machine learning.

This service can be accessed by the business operation team, finance department, and development team through their AWS cloud to monitor cloud expenses and generate reports they need.

4.1.2 Azure cost management

Azure cost management tool provides cost analysis that monitor cloud spending, budgeting, and cost optimization. Additionally, they provide comprehensive documentation and a video to help users get started. The cost management tool is a FinOps tool of Azure, so anyone working in the same company can access it, including the DevOps team and finance force team. The Azure cost management dashboard in Figure 6 is from the Microsoft portal within my own account. You can easily monitor your setting with the left side menu.

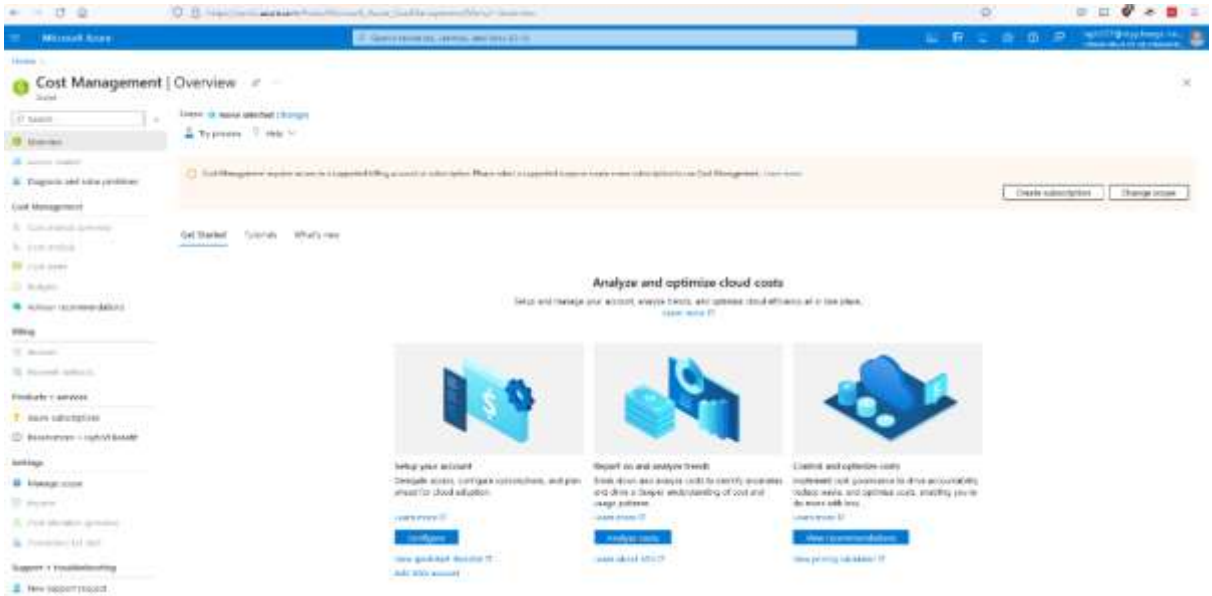


Figure 6 Azure cost management dashboard

The functionality and key features of the cost management includes:

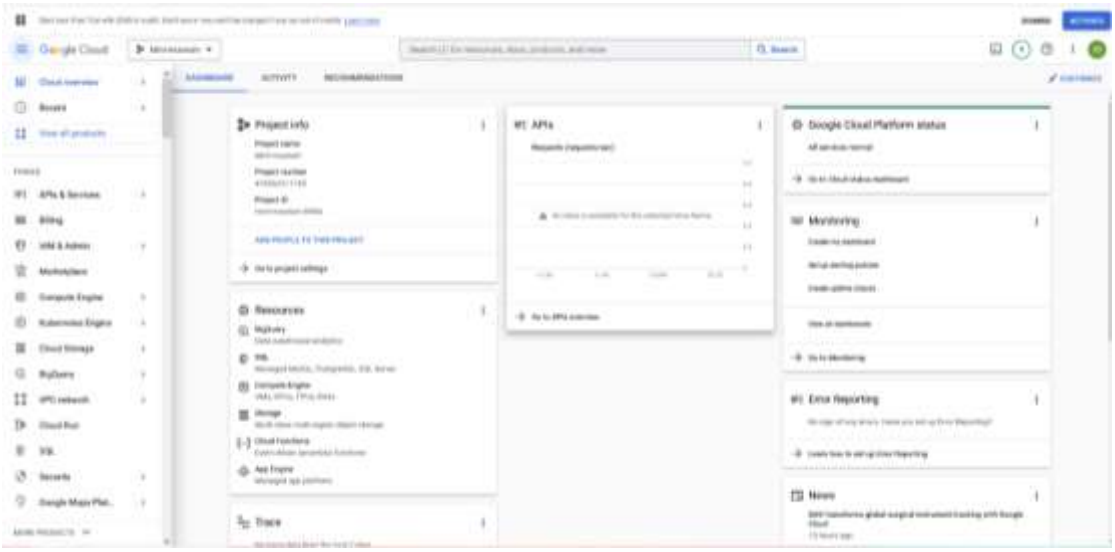
1. Generate reports including cloud spend in Azure portal.
2. Create budgets, payment methods and invoices payment.
3. Billing information regarding legal entity and tax information.
4. Monitor cost, set up cost alert, allocation cost spends.

These features provide organizations with a way to track their cloud expenses and are free of charge for Azure users. AWS cross-management platform connector for AWS is the only feature that requires a fee. This fee amounts to approximately 1% of the total AWS managed spend. (Microsoft, 2023)

4.1.3 Google Cloud Platform cost management

Google Cloud provides its users with a cost management platform. To provide better accountability, Google Cloud uses a flexible hierarchy structure that organizes resources, folders, projects, and resources in a manner that assists in aligning business objectives. Additionally, Google Cloud provides comprehensive guidance documentation and tutorial videos to its users to help them learn and understand how to use the feature to monitor their cloud expenditures and generate reports.

A Google cloud dashboard in figure 7, from the top bar and then configure the billing and other features in the left menu.



The functionality and key features of the cost management includes:

Figure 7 Google cloud dashboard

1. Automatic budget, schedule budget alert.
2. Billing export, billing APIs and billing access control.
3. Generate reports, custom dashboard display.
4. Resources hierarchy, intelligent recommendations.

It is intended that all the features incorporated in the Google cloud cost management service are designed in accordance with the FinOps concepts to assist their customers in identifying their cloud-related expenses and to provide opportunities for them to improve their finance governance practices. This service is free of charge to Google cloud users. (Google Cloud, 2022)

4.2 Multi-cloud billing monitoring tools

Even though this tool is aimed at the same goal as native cloud cost management, its biggest and most unique feature is that it provides real-time monitoring across multiple cloud provider platforms. In terms of multi-cloud billing monitoring tools, they offer organizations the opportunity to avoid missing injustice when faced with multiple cloud platforms at same time with each operating system having different layout settings and tags allocated, in addition to a large volume of logs. Unlike traditional monitoring approaches, which are primarily individual and collective, multi-cloud billing monitoring tools includes a real-time data flow with automation options to facilitate better business decisions and reduce costs rather than being forced to allocate unused time and effort to an ineffective workload. (What Are Cloud Agnostic Tools? (CloudHealth by VMware Suite Staff, March 3, 2020)

Several multi-cloud billing monitoring tools cloud monitoring and billing tools exist in the market today, each naming itself differently. They are all aimed at optimizing and monitoring costs for their end users. Through APIs, the cloud monitoring tools accept data from multiple cloud providers such as Amazon Web Services, Azure, and IBM Cloud and embed it into a dashboard, providing a comprehensive view of current cloud usage, logs from different cloud portals and synthetic monitoring, and the ability to terminate resources in one platform without logging into cloud provider accounts.

4.2.1 Cloudability

Cloudability was established in 2011 to provide enterprises with financial management tools for organizations to track their expenditures on public clouds as well as analyzing cloud usage patterns. In 2019, Apptio acquired Cloudability, since then name as Apptio Cloudability. Cloudability is one of several cloud agnostic tools. As a result of the platform's compatibility with AWS, Microsoft Azure, Google Cloud Platforms, Alibaba cloud, IBM cloud and other cloud portals are supported.

As one of the members of the FinOps Foundation, Cloudability is developing their products and services in line with FinOps approaches and capabilities. It is also one of the SAAS software as a service product offering pay-as-you-go payment solutions through the cloud computing platform. (CloudZero, 5 August 2022)

It offers features such as:

- Dashboard reporting
- Automatic cloud financial management
- Budgeting and forecasting
- Cost allocations for containers and Kubernetes
- Cost anomaly, Optimization

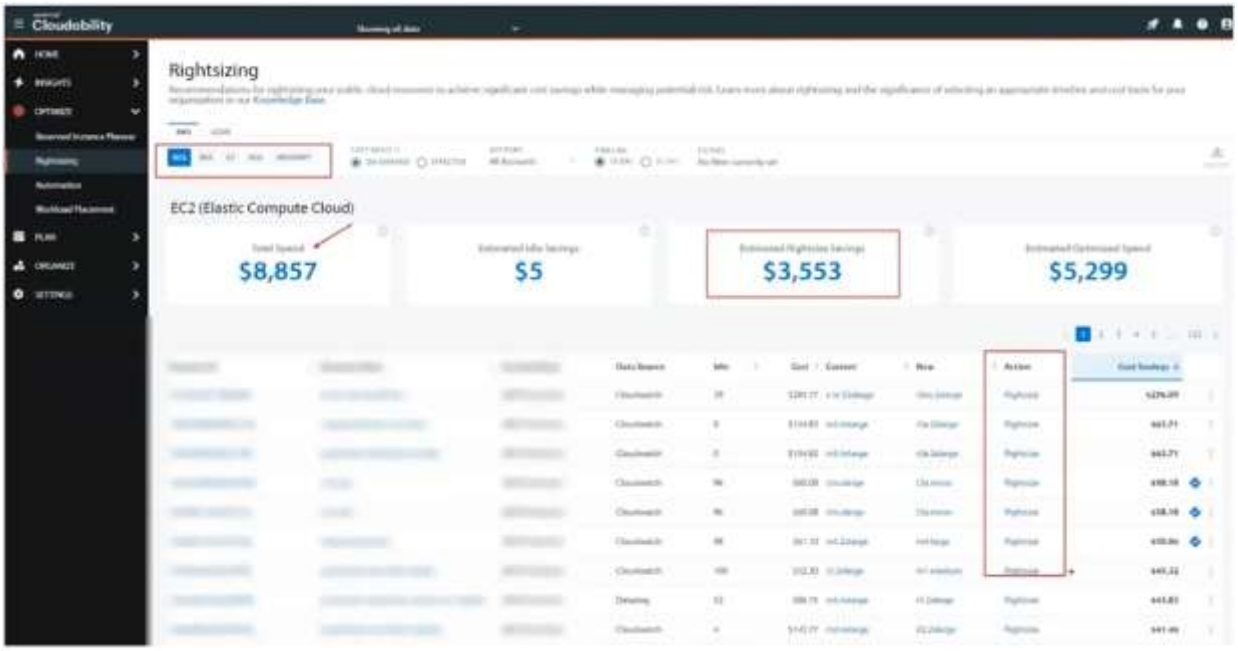
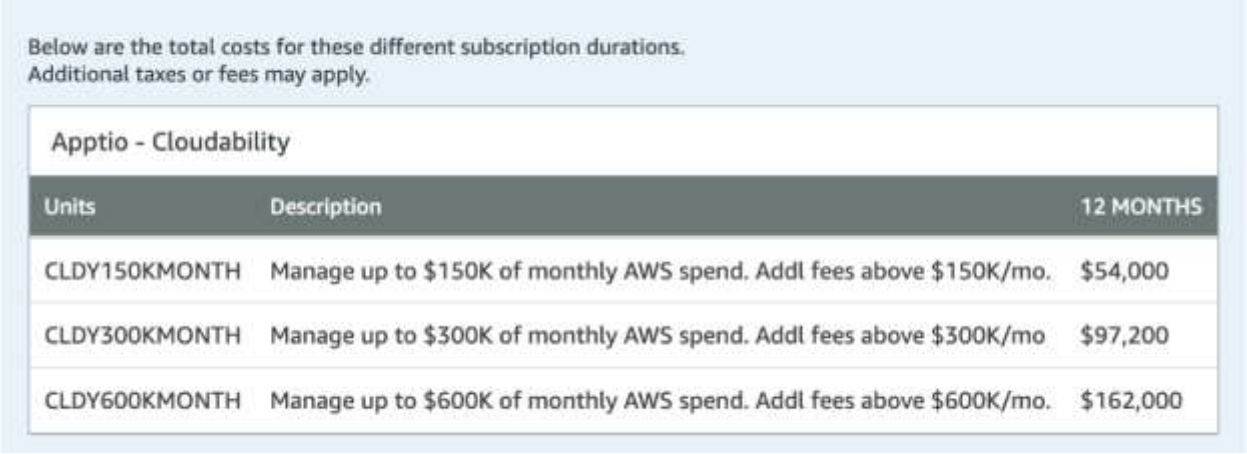


Figure 8 Cloudability rightsizing feature via AWS (CloudZero, 2022)

Figure 8 shows the Optimize feature. It is critical to note that Cloudability is not free when used; the cost is based on individual usage, and each visitor is required to complete a usage form and request a quote tailored to their specific needs.

As stated in the figure 9 AWS Marketplace, Apptio Cloudability offers tiered pricing starting at $54,000 per month for Apptio Cloudability services fees. This is for managing $150,000 in AWS cloud expenditures per month. As of June 2022, Apptio Cloudability services will be charged $97,200 per month for $300,000 in AWS cloud expenditures, and $162,000 per month for $600,000 in AWS cloud expenditures. There is a 12-month commitment required for all prices. Additional taxes and fees may also apply.



Below are the total costs for these different subscription durations.
Additional taxes or fees may apply.

Apptio - Cloudability

Units	Description	12 MONTHS
CLDY150KMONTH	Manage up to $150K of monthly AWS spend. Addl fees above $150K/mo.	$54,000
CLDY300KMONTH	Manage up to $300K of monthly AWS spend. Addl fees above $300K/mo	$97,200
CLDY600KMONTH	Manage up to $600K of monthly AWS spend. Addl fees above $600K/mo.	$162,000

Figure 9 AWS Marketplace Apptio-Cloudability pricing information (AWS marketplace, 2022)

4.2.2 Klarity- IBM Multicloud Accelerator

The Nordcloud Klarity platform integrates all the major cloud providers into one dashboard, such as Microsoft Azure, AWS, Google Cloud Platform and on-prem VMware. It was developed by Nordcloud, an IT consulting company that focuses on cloud migration, application development and managed services. Nordcloud was acquired by IBM in 2021 and became part of the IBM company shortly thereafter. Klarity is also now part of the IBM Multi Cloud product line.

Klarity was founded to offer cost reporting tools to customers. As the project went on, Klarity became clearer about its goal with each small step. Later in 2020, Klarity launched a multicloud management platform that reports cost and usage across multiple clouds in their first minimum viable product suite.

In 2023, the Nordcloud Klarity series has been renamed to IBM equivalents: IBM Multicloud Accelerator (Nordcloud Klarity Core), IBM Multi-cloud Machine Image Toolkit (Nordcloud Klarity Image Factory), IBM Multi-cloud Autopatches (Nordcloud Klarity AutoPatcher), IBM Multicloud Auto-Backup (Nordcloud Klarity, 2022).

The feature 10 is IBM Multicloud Accelerator (Nordcloud Klarity Core):

- Dashboard/ reporting
- Full Cost allocation
- Smart decision making
- Pre-defined KPIs
- Cost analysis

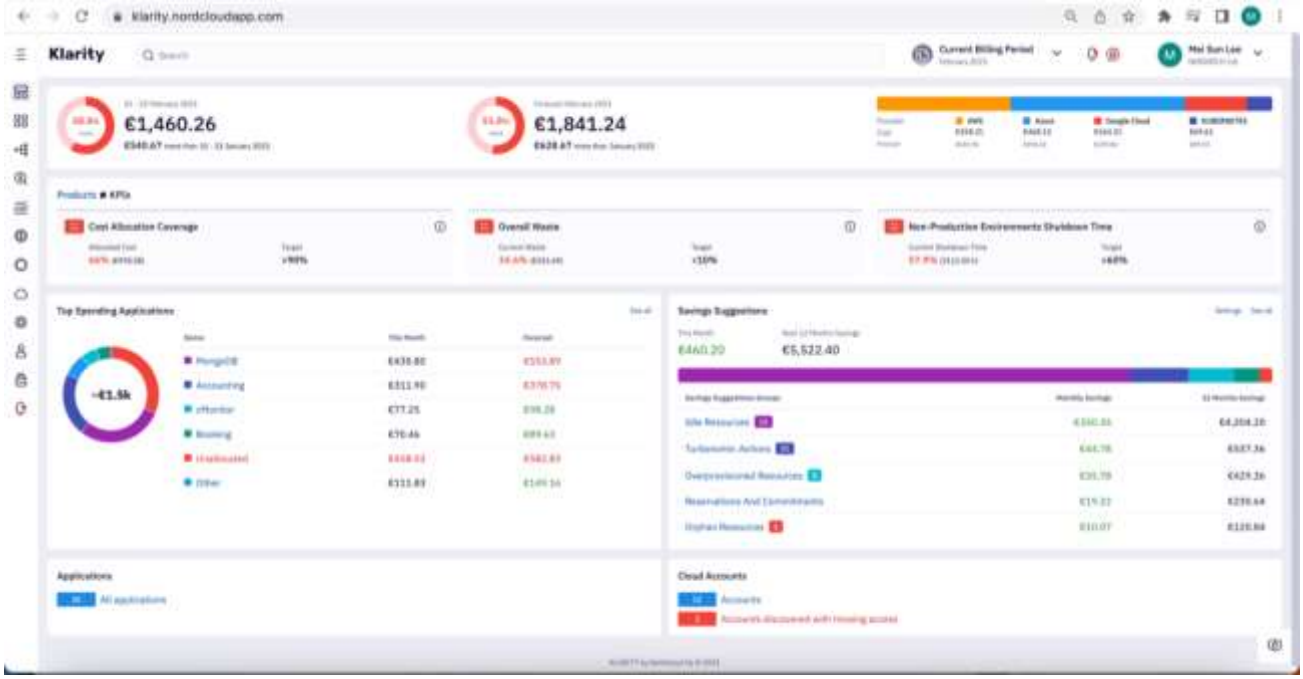


Figure 10 IBM Multicloud Accelerator (Nordcloud Klarity Core) dashboard

A list of IBM Multicloud Accelerator costs is provided on their website, along with various support packages tailored to meet the needs of different types of organizations. As shown in figure 11, there are four packages, and users can choose which package is most suitable for them, based on the need to select the packages. In addition, there are some limitations regarding price differences.

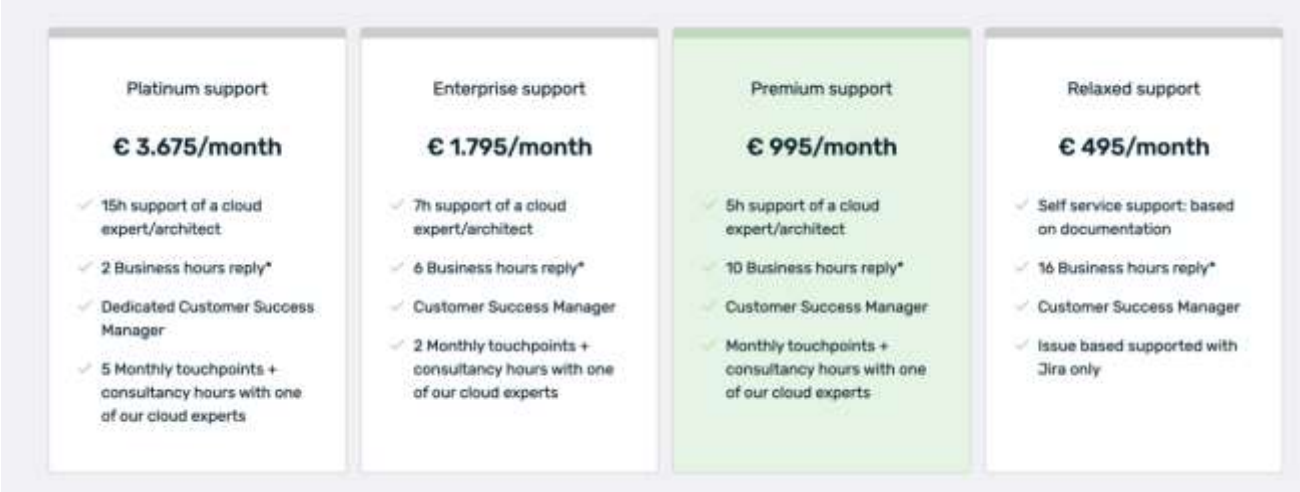


Figure 11 IBM Multicloud Accelerator (Nordcloud Klarity Core) price list (Nordcloud Klarity Core,2022)

5 Cloud resource implementation and cost management features

Previously, the thesis introduced most of the popular cloud cost management tools, including native and multi cloud monitoring tools. This thesis will examine how IBM Multicloud Accelerator (Nordcloud Klarity Core) works from onboarding to the features they provide for customers in this chapter.

The purpose is to demonstrate how multi-cloud cost monitoring can provide a useful and controlled environment to showcase the features and capabilities of multi-cloud cost management tools with mock data that mimics actual data in order to demonstrate the functionality in accordance with the actual usage of a real company. It is important to note that using mock data has limitations, as it may not accurately reflect the real-world complexities and challenges faced by companies in managing their cloud expenses. However, using mock data can still provide valuable insights and demonstrate the functionality of a cloud cost management tool, if it accurately represents the key features and characteristics of actual cloud usage data.

5.1 Klarity- IBM Multicloud Accelerator set up

As part of the Klarity core platform setup, users are required to deploy resources and services on behalf of their cloud providers. This involves onboarding all their cloud accounts with the guidance of Klarity.

5.1.1 Onboarding and configuration

The on boarding and configure are simple to use since the idea is not complex the process of multi cloud monitoring tools idea. Like the figure 12 shown, it is as easy as navigating to the **Menu** and selecting **Cloud account**, then the user will be able to view all the accounts that are onboarding from various providers as well as the **Account ID** details and the owner of each account. In addition to identifying ownership and ensuring it is clearly visible to the finance department, this setting allows the finance department to be informed of budgets and messages sent to the appropriate parties.

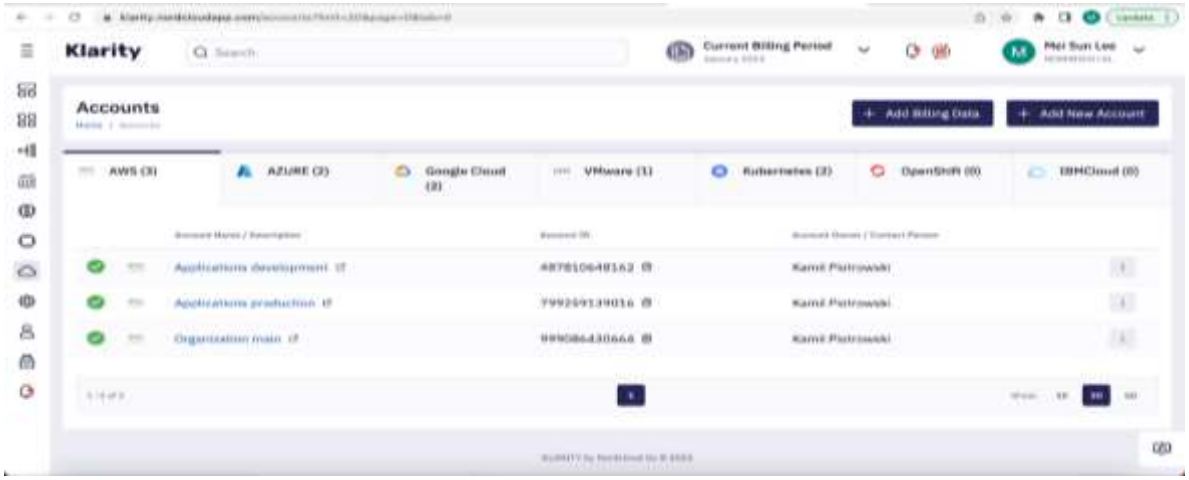


Figure 12 IBM Multicloud Accelerator (Nordcloud Klarity Core) Account details page

To create a new account, the user will select the **+Add new account** button and indicate After selecting the provider, the application will inquire about the **prerequisites and credentials required (FYI)** from the cloud provider. Each provider has a different procedure. Example, an Azure account will use Azure CLI to create a service principle and give it a name, which will authorize and transfer it to Klarity. Figure 13 shows all the account that already onboarding in the Klarity system.

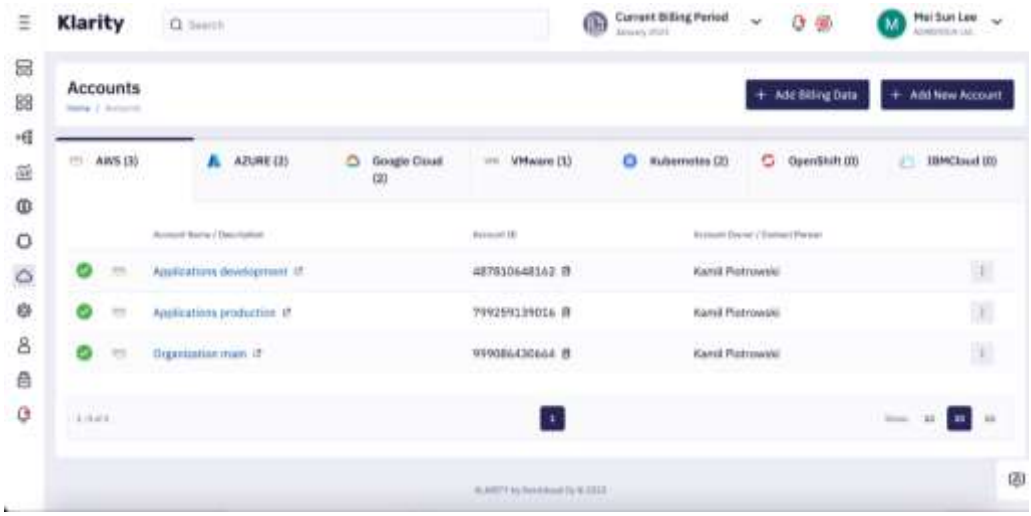


Figure 13 IBM Multicloud Accelerator account detail page

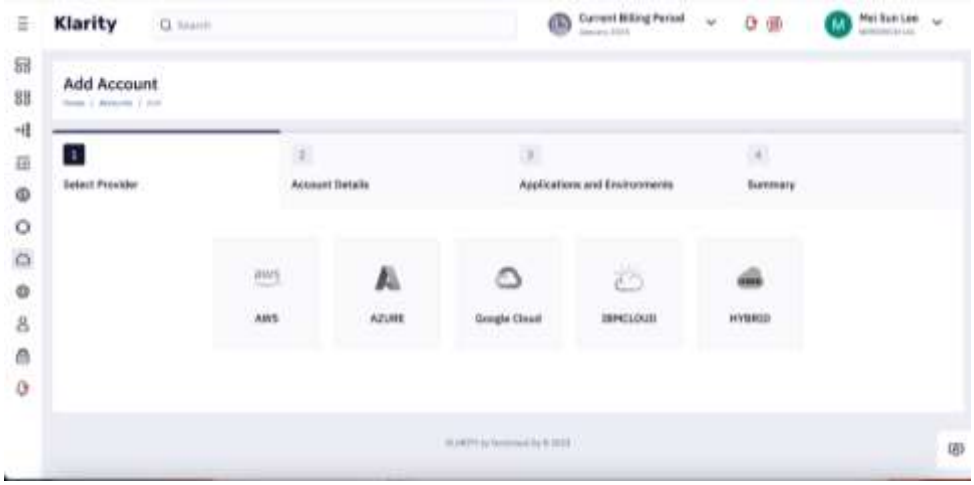


Figure 14 IBM Multicloud Accelerator account set up page

Additionally, billing monitoring can be used to consolidate billing figures that allow enterprises or companies to maintain track of the total usage and expenditure on the cloud environment monthly as well as the billing date and details from all the cloud providers. It is also possible to configure this feature in this application, after the user updates the required information, billing information will be displayed in the dashboard within 48 hours.

5.2 Key features

Thesis' primary objective is to examine the features of multi cloud cost monitoring tools that are being highlighted in this section in order to assist enterprises in improving their cloud optimization. Using to demonstrate cost analysis and cost allocation that facilitates tracking and expenditure of costs and identifying anomalies, as well as KPIs to demonstrate its functionality and usage, as well as reservations and commitments.

5.2.1 Cost Allocation & Cost analysis

User can click on **Application** and the page will navigate to the page will cost allocation for user to track the spending on all the clouds overviews. User can select either 3 months and 12 months option and the chart will generate based on the option user select.

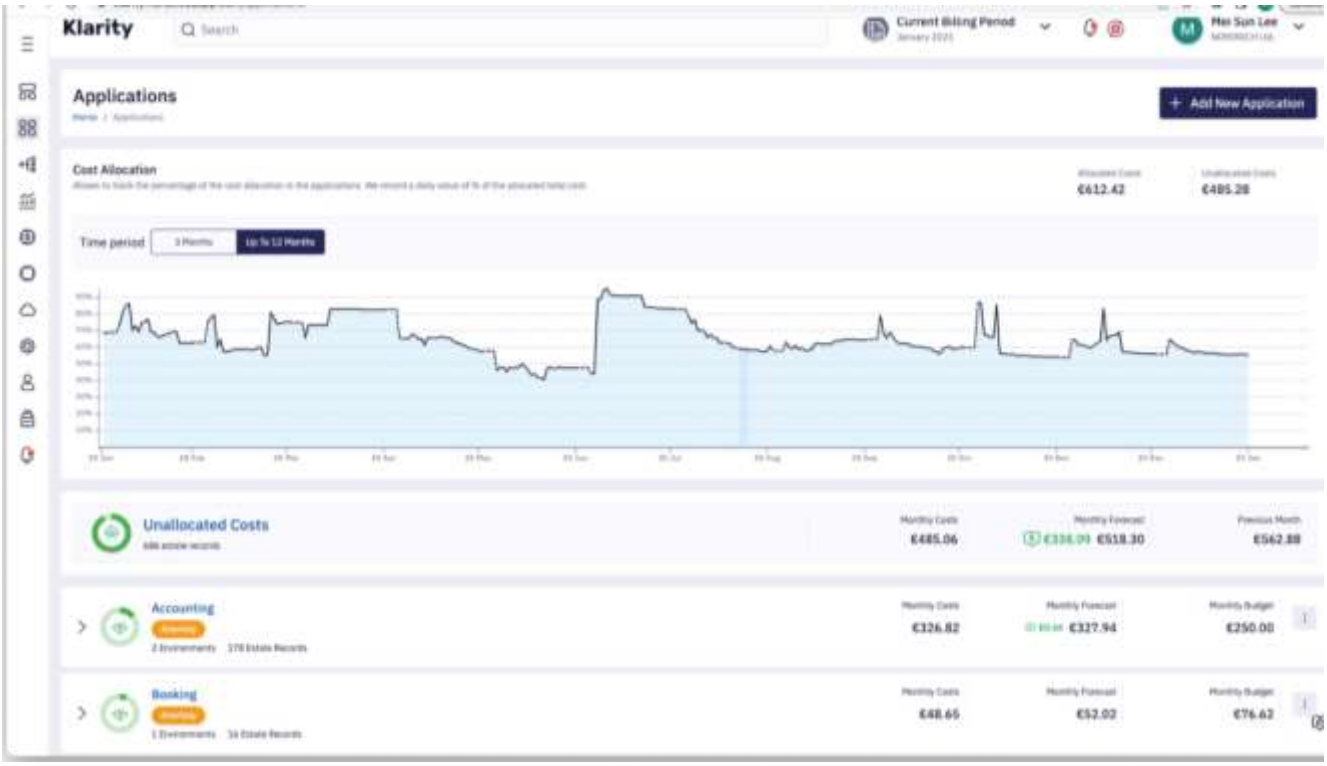


Figure 15 Klarity- IBM Multicloud Accelerator core cost allocation page

Additionally, below the chart, all details regarding unallocated costs will be provided with month-to-month and forecast amounts, as well as a list of sources consumed. There are two features that provide a more comprehensive view for the user, which are the ability to edit the budget as well as view the cost analysis simultaneously. Whenever the user sees an anomaly label, it would be a wise idea to click on it and verify the details, since in the context of cloud expenses, anomaly costs refer to unpredictable or unusual spikes that differ from normal or expected spending patterns.

For example, when the user clicks into the CMiners, it displays a detailed representation of everything the user needs to know. This includes application details, cost, footprint, budget, and saving proposal, along with a graph to illustrate the actual flow and changes within 90 days. As part of the feature, a user can edit the budget directly on the same page, and a user can also see the tags (business context) used to categorize and organize cloud resources, as well as provide a way to track and manage cloud resources at scale. Figure 15, 16 and 17 demonstrate all the details from different purpose such cost details, anomaly cost detail, budget detail.

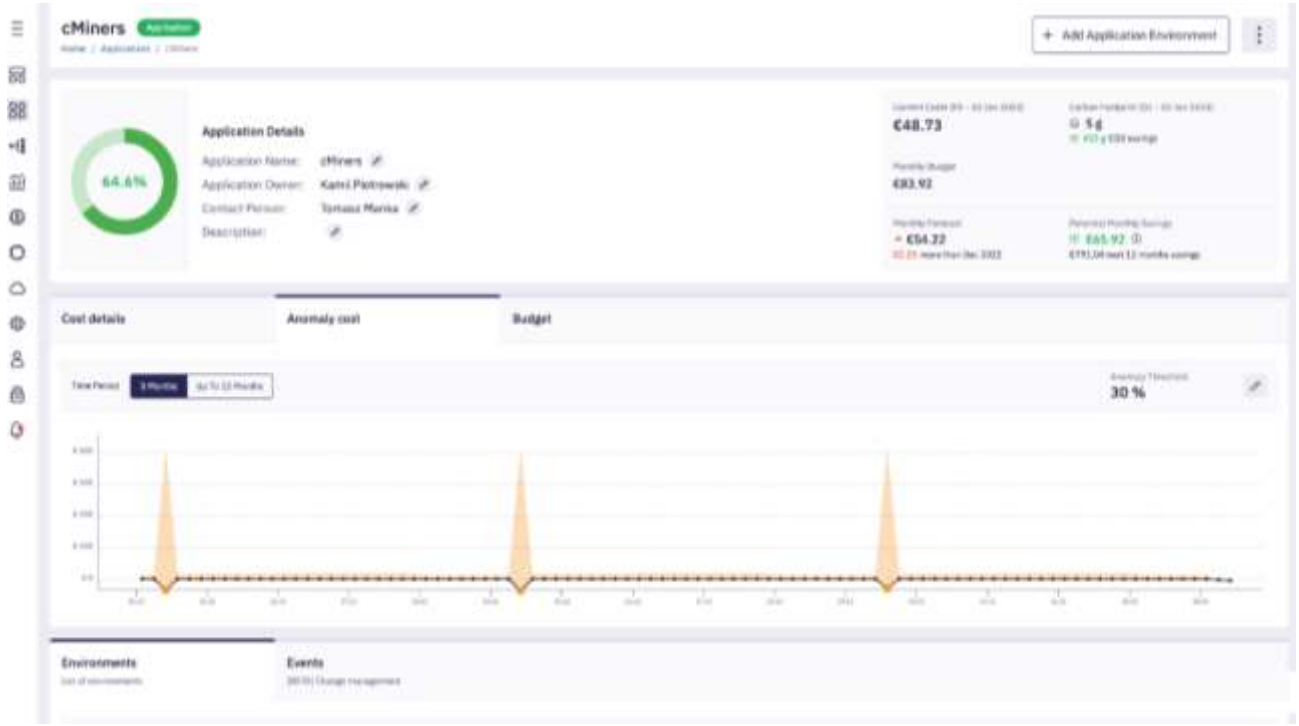


Figure 16 CMiners application anomaly cost detail page

In terms of cost monitoring, this is an extremely helpful feature when users need to determine where most expenditures have been spent. They can also edit the budget directly, as opposed to navigating through various applications with different cloud accounts. Additionally, this design follows the FinOps principle and solves the cost allocation issue in cloud environments.

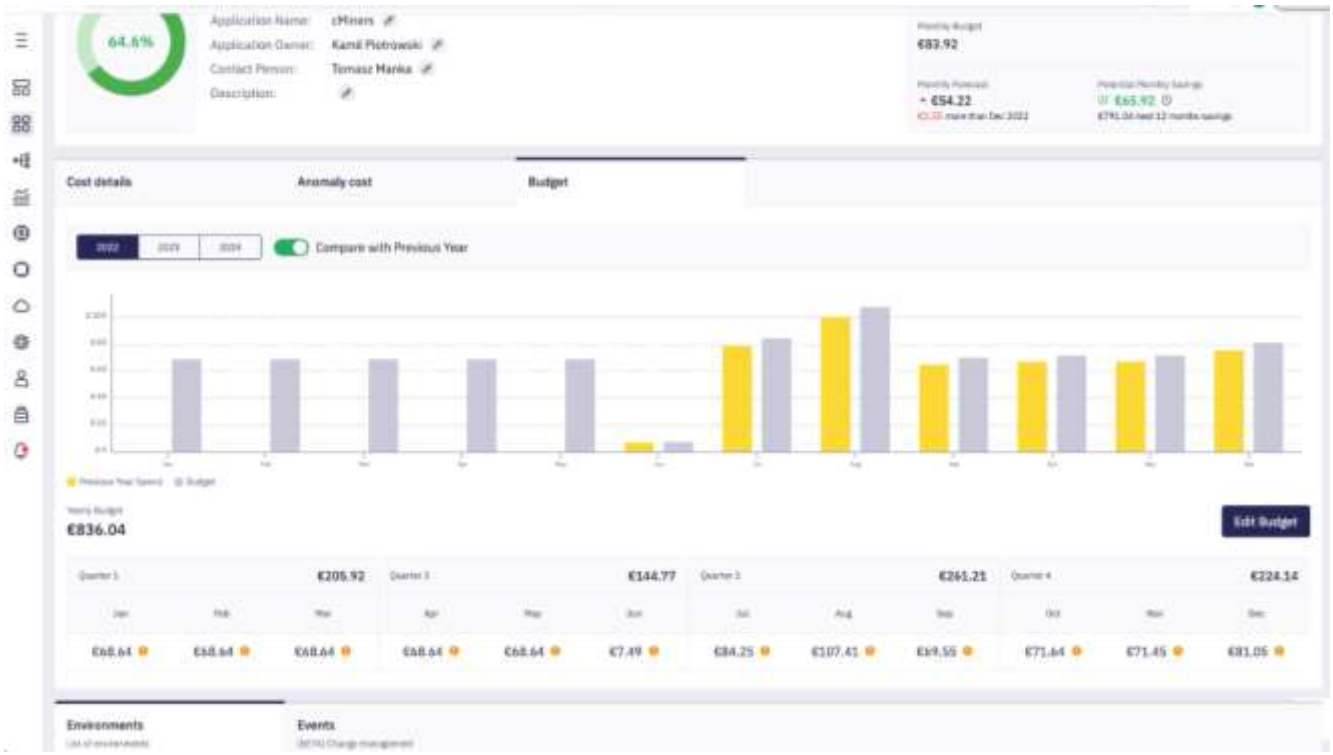


Figure 17 CMiners application Budget details

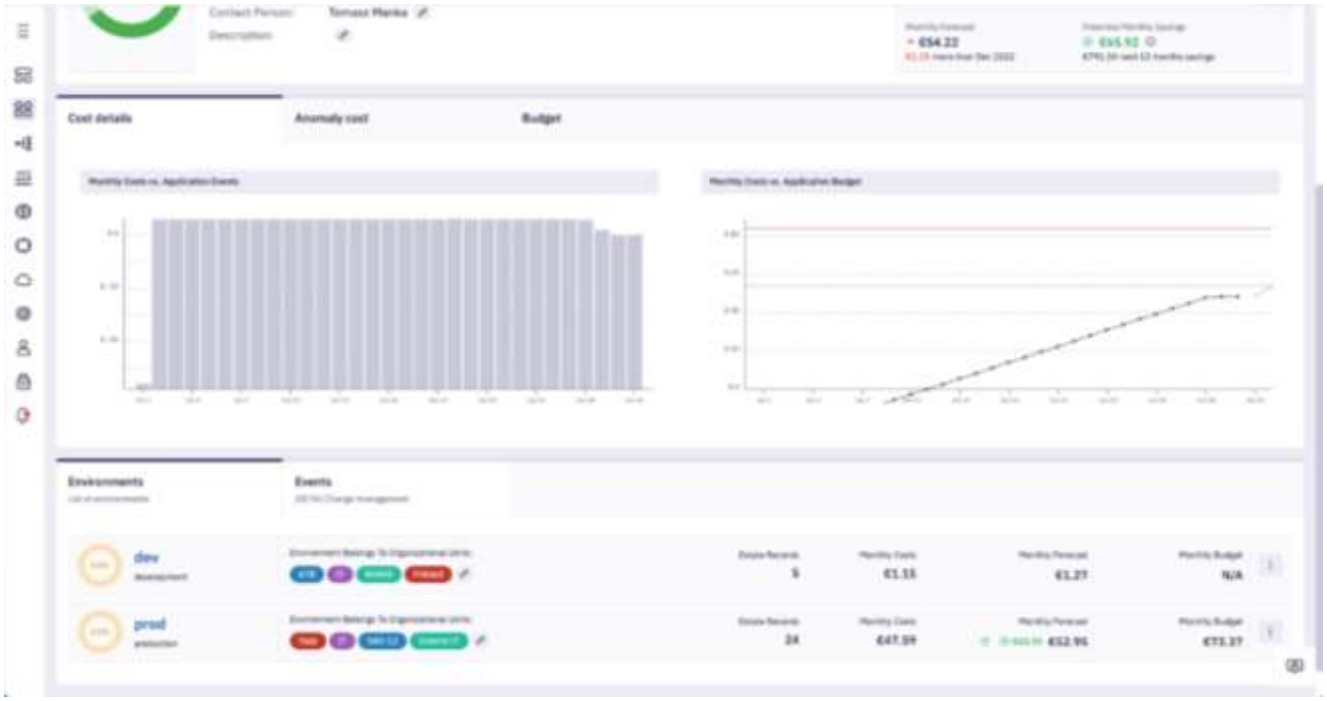


Figure 18 CMiners application Cost details page

Figure 19 shows the Klarity- IBM Multicloud Accelerator cost analysis feature, which can be used to have a clear idea of how much money is being spent in each application by filtering it with data

ranges and granules with a monthly or daily option. This is also a feature that can be used for FinOps practices.

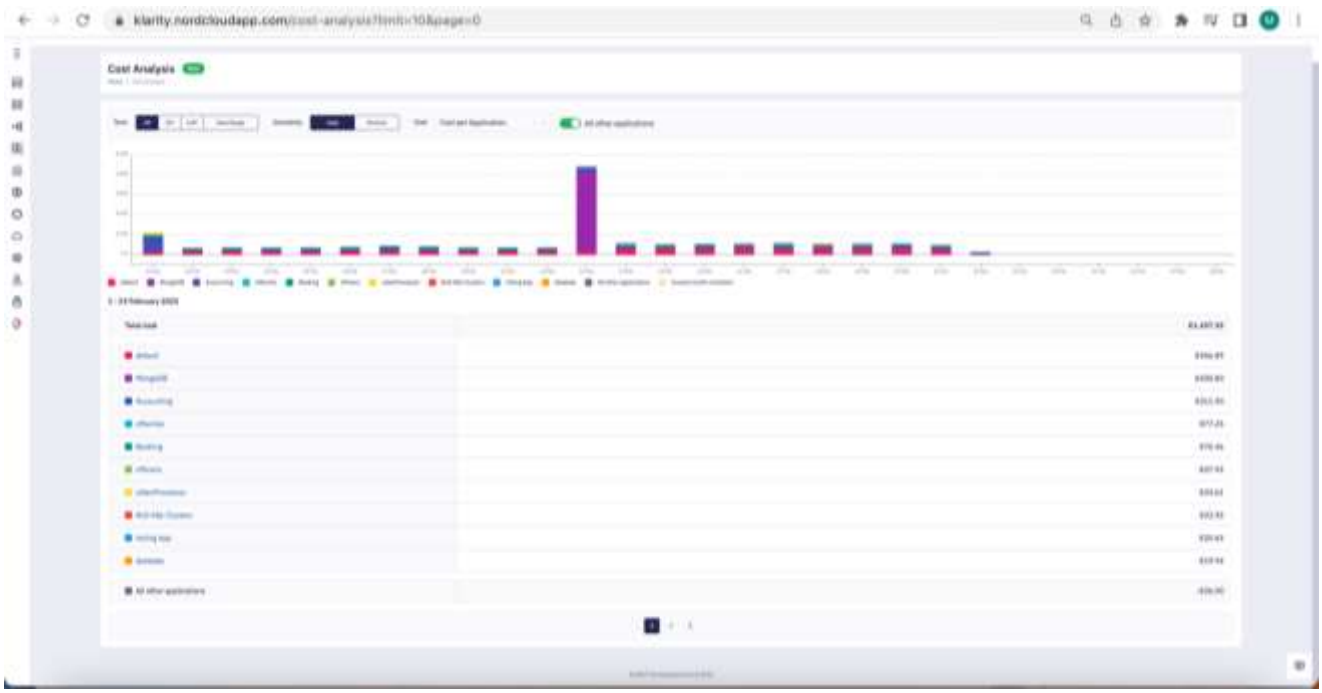


Figure 19 Klarity- IBM Multicloud Accelerator cost analysis page

5.2.2 KPI

The next feature this thesis will examine is KPI. The main reason for including this feature is since it provides measurable values that demonstrate how effectively a company implements key business objectives. Using this feature, the user can track the progress of the planned goals, and the KPI target design aligns well with the FinOps lifecycle and principles. It can be assigned to the relevant teams based on the information and data they collect from different cloud services and costs.

In Figure 20, pages are display with three types of focus paths in this feature, which are cost allocation coverage, overall waste reduction, and shutdown time for non-production environments.

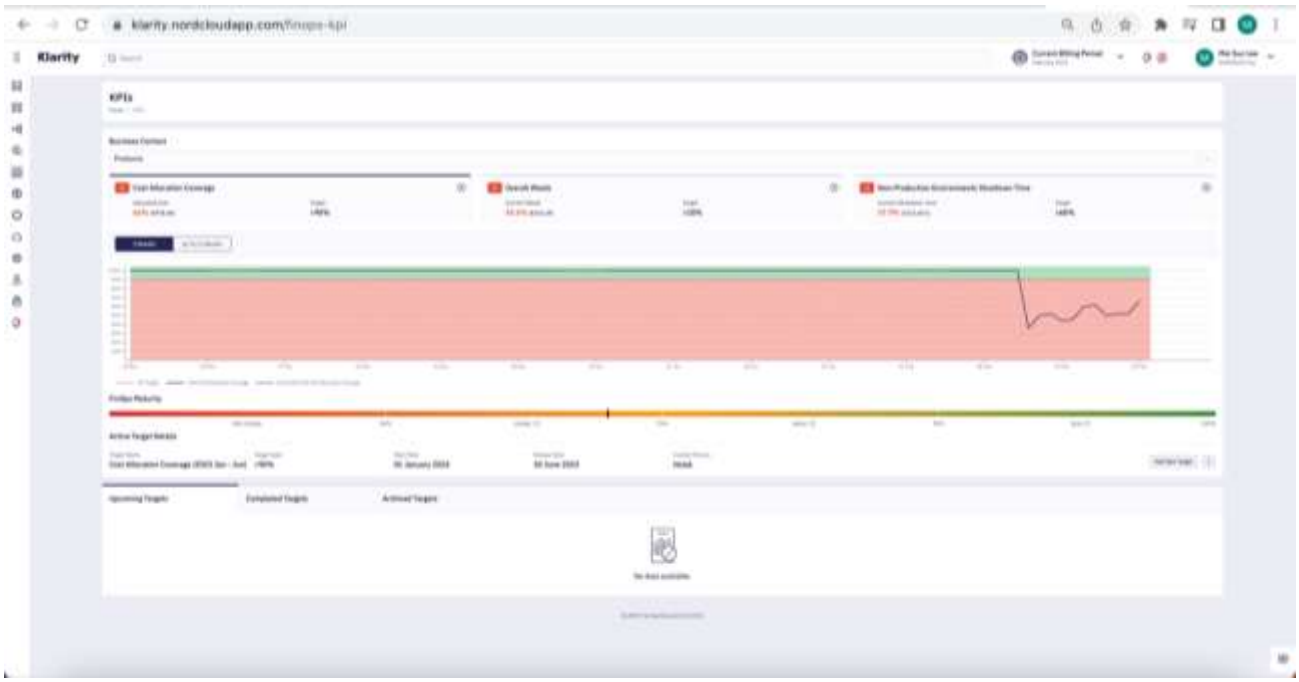


Figure 20 Klarity- IBM Multicloud Accelerator KPIs page- Cost allocation coverage

As depicted in Figure 21, the overall waste is displayed along with the units that have waste and the ranking of the units so that the team can be alerted to take action. It is also possible to find further details when a point on the chart is highlighted.

Figure 21 Klarity- IBM Multicloud Accelerator KPIs page- Overall waste

As depicted in figure 22, the non-production environments are shown shut down time to provide information on which team is shutting down the non-production environments to reduce waste and

oversupply. This metric is typically tracked usage, which provides visibility into cloud usage across multiple cloud providers and environments. As these environments are typically used only during specific periods and are not required to be available 24 hours a day, shutting them down when they are not in use can result in significant cost savings.

Figure 22 Klarity- IBM Multicloud Accelerator KPIs- Non-production environments shutdown time

Overall, KPIs are focusing on tracking the financial impact of cloud usage and optimization efforts, as well as evaluating the ROI of cloud investments. To achieve the best possible return on their cloud investments, organizations should monitor these KPIs regularly to optimize their cloud costs more effectively. In addition to serving this purpose, the FinOps feature also plays an important role in FinOps.

5.2.3 Reservation & Commitment

The following features are used to provide recommendations for cost-saving protection plans by selecting appropriate tiers, packages, and offers. This feature is intended to provide a more comprehensive package instead of blindly purchasing packages that overprovision and create waste. Since cloud service providers offer a discount on their cloud resources if customers commit to using them for a specific period.

In figure 23, the suggestion reservation and coverage analysis are demonstrated, enabling users to determine how much capacity they require for the cloud resource based on data gathered from

different applications.

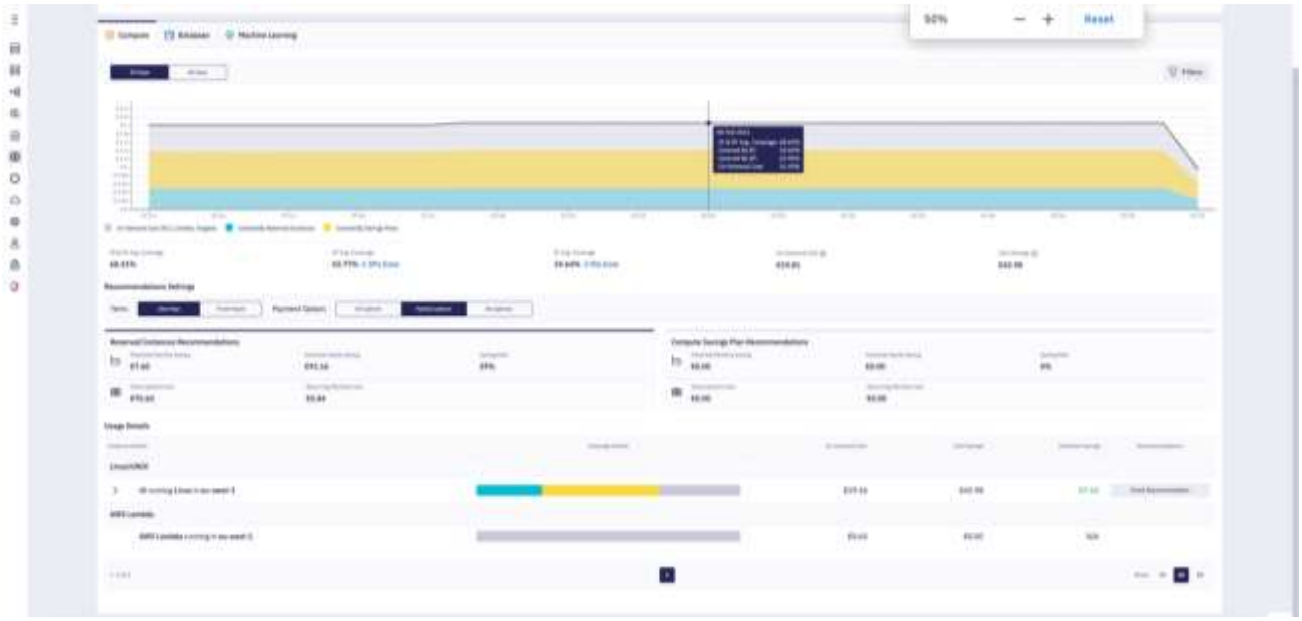


Figure 23 Klarity- IBM Multicloud Accelerator Reservation and Commitment for compute

The functionality of Figure 24 is similar to that of compute except when it comes to utilizing databases.

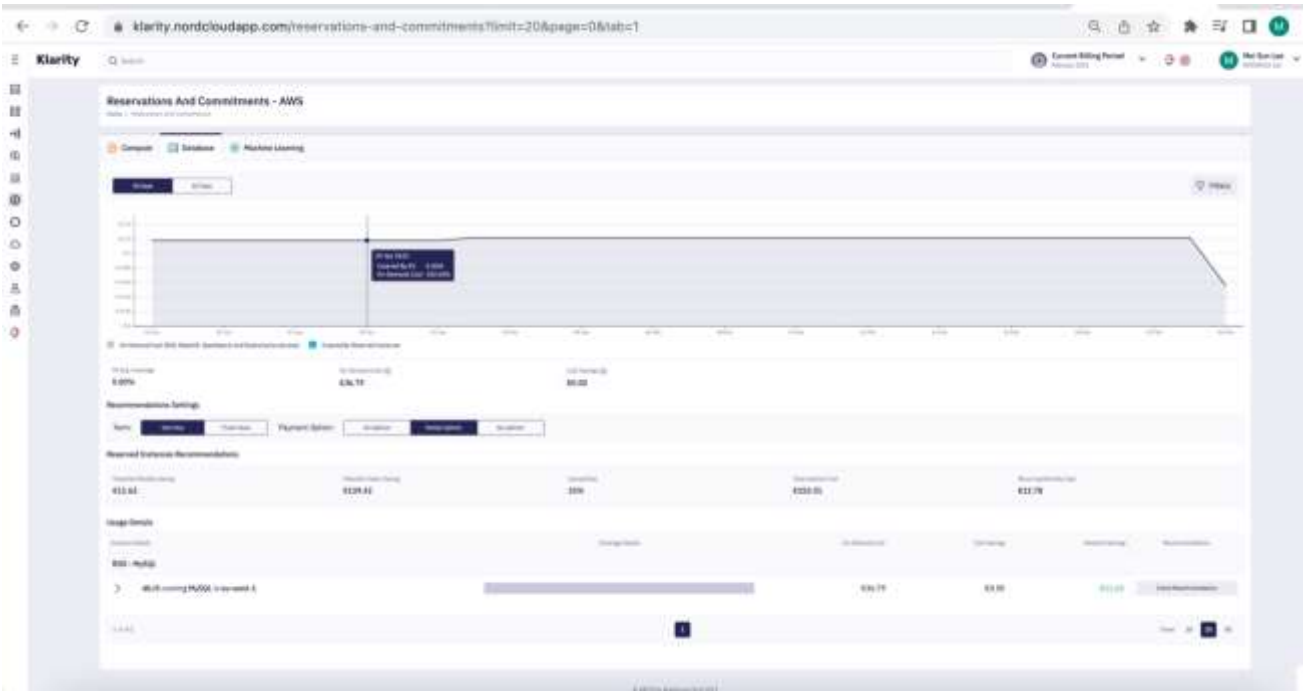


Figure 24 Klarity- IBM Multicloud Accelerator Reservation and Commitment for Database

In summary with Klarity- IBM Multicloud Accelerator, organizations can optimize their cloud costs using several features. Among the features provided by Klarity are cost allocation, cost analysis,

reservations, and commitments, and KPI tracking, which will provide organizations with greater insight into their cloud usage and allow them to optimize their costs more effectively.

6 Conclusion

Considering the research question if multi-cloud monitoring tools provide benefits to their users, there is strong consensus in research reports from different companies and research centres that suggest that multi-cloud monitoring tools can be beneficial to enterprises, and enterprise monitoring tools will be more needed in the future when all workloads and products will be conducted through a cloud environment.

The size of a company influences the selection of multi cloud monitoring tools. Larger organizations often require more complex cloud infrastructures as well as stricter compliance, security, and cost management requirements. Considering this, they may require more robust multi-cloud monitoring tools that provide a centralized view of cloud costs and usage, as well as support advanced cost optimization techniques.

In contrast, smaller organizations may have more straightforward cloud infrastructures and have fewer stringent requirements for cost management, compliance, and security due to their smaller size. In this case, they may be able to manage their cloud costs and usage more easily by using less robust multi-cloud monitoring tools that are easier to use or even their own cloud service providers native management tools.

Other factors that can influence the choice of multi-cloud monitoring tools include the types of cloud services being used, the complexity of cloud deployments, and the specific cost optimization objectives of the organization. Typically, complex cloud deployments involving many interconnected services and resources will require advanced multi-cloud monitoring tools that can provide a comprehensive view of cloud costs and usage, as well as offer support for more sophisticated cost optimization strategies. Alternatively, simple cloud deployments may not require as much monitoring functionality and may be able to utilize simpler multi-cloud monitoring tools that are easier to operate and provide a more straightforward picture of cloud costs and usage.

For small companies to achieve cost optimization in their cloud deployments, FinOps and using cloud native monitoring tool can be an alternative solution. FinOps provides a framework for managing cloud costs and ensuring the effective use of cloud resources by providing principles and best practices. In addition to being applicable to large and medium cloud deployments, this framework can also be applied to small businesses.

To reduce costs and minimize waste, small companies can optimize their cloud usage by following the FinOps lifecycle. This is done by gaining insight into their cloud costs, improving their cost management processes, and reducing their cloud expenses. FinOps can also assist small

companies in ensuring their cloud deployments are compliant with company policies and cost optimization objectives, in addition to increasing efficiency and security. By setting budgets, tagging resources, and implementing cost optimization strategies such as rightsizing and reserving instances, this can be accomplished.

Additionally, such tools are typically expensive, require additional resources to manage, and may not be available to small organizations. Small organizations may eventually reach a point where the benefits of multi-cloud billing monitoring tools outweigh the costs as they grow and use more cloud services. For example, if they begin to use multiple cloud providers, have complex cost structures, or require increased visibility into their cloud costs. By investing in a cost monitoring tool at this stage, they can better understand and manage their cloud costs across different providers and ensure that they are making the most cost-effective decisions possible.

Although larger organizations may have more complex cloud infrastructures and more stringent requirements for cost management, compliance, and security, FinOps principles and best practices can still be applied to achieve cost optimization in smaller cloud deployments. Cost optimization goals for small companies should be achieved through careful evaluation of their specific needs and requirements. To do this, the tools and strategies that are most appropriate for their needs should be carefully selected.

The meanwhile FinOps principles and monitoring tools can benefit enterprises in reducing their cloud costs with:

- Improved cost visibility: Adopting FinOps practices can lead to improved visibility into cloud costs, enabling organizations to better understand their spending and identify areas for cost optimization.
- Cost savings: By following the FinOps lifecycle, organizations can reduce cloud costs by up to 30% or more through improved cost management and optimization practices.
- Better alignment of IT and business goals: FinOps can help organizations align IT and business goals by providing a framework for managing cloud costs and optimizing cloud usage in a way that supports both technical and business objectives.
- Improved resource utilization: Adopting FinOps practices can lead to improved resource utilization, reducing waste and increasing the efficiency of cloud deployments.
- Increased agility: By following the FinOps lifecycle, organizations can become more agile in their cloud usage, enabling them to respond more quickly to changing business needs and opportunities.
- Anomaly detection: FinOps helps organizations detect anomalous costs, enabling them to quickly identify and resolve unexpected spikes in cloud expenses.

By implementing FinOps principles and using cost monitoring tools, enterprises can gain better control over their cloud expenses, optimize their cloud usage, and realize cost savings. However, it's important for organizations to continuously monitor and optimize their cloud costs, as cloud expenses can change rapidly due to factors such as resource utilization, pricing changes, and evolving business needs.

Flexera's research indicates that more and more organizations are using multi cloud tools. From figure 25, Multi cloud cost management tools account for 31% of all organizations, whereas multi cloud management tools account for 25%. The number of organizations that require both together continues to increase, resulting in FinOps concepts and principles emerging to meet and design the tools they require.

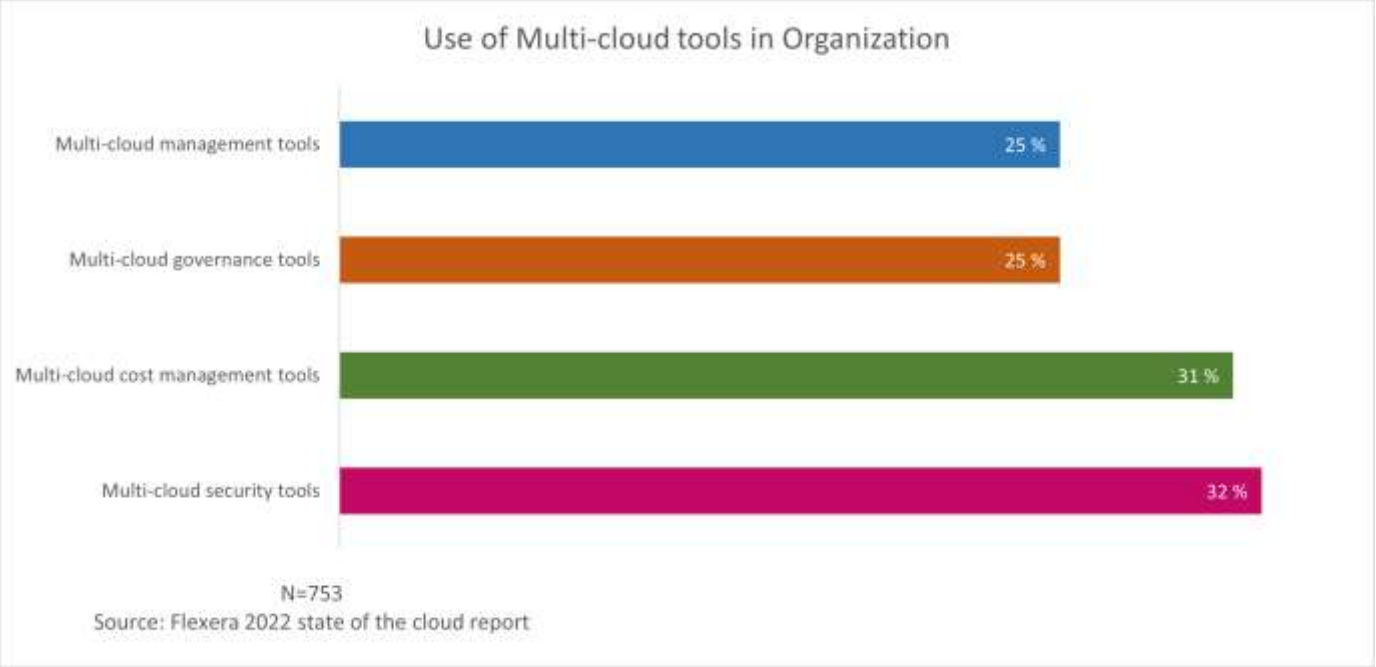


Figure 25 Use of multi-cloud tools in organization (Flexera, 2023)

Also, in Flexera’s research, more multi-cloud tools are being used, and some research indicates that overbudgets are decreasing since FinOps began to be implemented within enterprises between 2021 and 2022.

According to figure 26 below based upon Flexera research, public cloud spend was over budget by approximately 13 percent, down from 24 percent year-over-year.

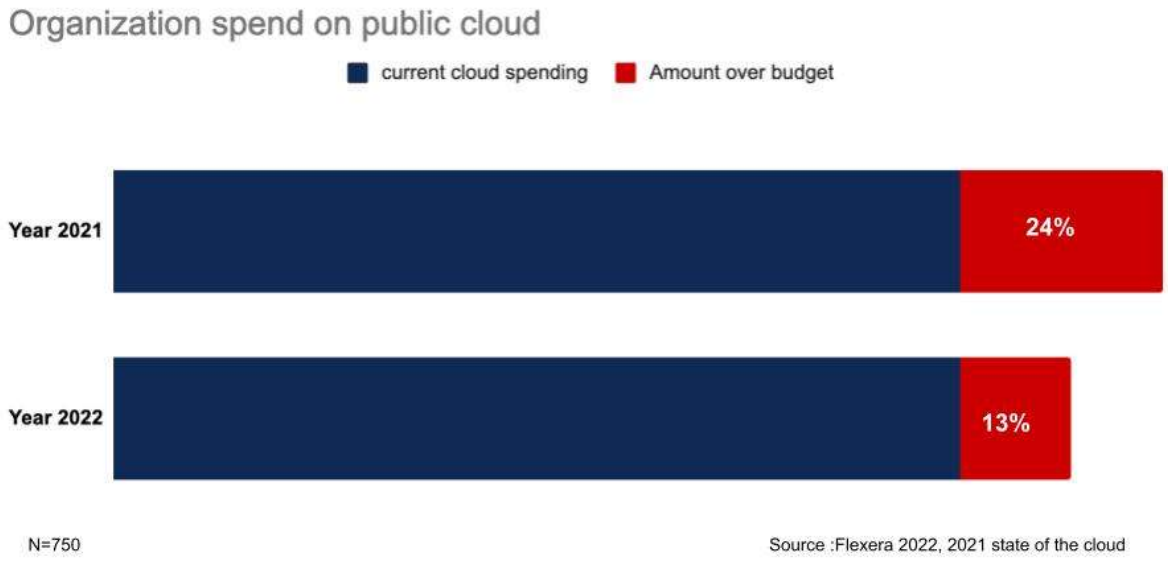


Figure 26 Organization spends on public cloud (Flexera, 2023)

Over provisioning has been found to contribute approximately thirty percent to the overall cost of cloud computing. This is described throughout the challenge chapter and based on research based on a number of reports. Anodot published a report in 2022 stating that one third or more of cloud computing costs are likely to be accounted for as cloud cost waste, as stated in the report. (Anodot, 2022, 8). Due to the wasteful use of cloud resources and the need for optimization, FinOps is becoming increasingly important tools and concepts. Optimizing the use of existing cloud services in order to reduce costs is an urgent need.

In conclusion, the decision to adopt FinOps practices or multi-cloud billing monitoring tools for managing cloud costs depends on the unique needs and circumstances of an organization. Large enterprises with complex cloud infrastructures and multiple cloud providers may benefit from multi-cloud billing monitoring tools, which provide granular visibility into cloud usage and costs across different cloud providers. However, even with these tools in place, it is crucial to continue practicing FinOps principles to optimize cloud costs, ensure accountability, and prevent cloud waste. As the FinOps foundation published report indicate that FinOps teams are also expected to grow by 47% from last year to 75% in the following year. (FinOps Foundation, 2022)

For small organizations with simpler cloud infrastructures, multi-cloud monitoring tools may not be necessary at first. Instead, FinOps practices can help them manage their cloud costs more effectively. In order to optimize costs effectively, companies may need a monitoring tool that is multi-cloud billing monitoring tools as their cloud usage increases and becomes more complex. The

management of cloud costs should be viewed as an ongoing process that requires continual evaluation and optimization to achieve cost-effectiveness and efficiency.

Ultimately, the goal of managing cloud costs is to achieve the best possible return on investment for cloud resources while ensuring that organizations are meeting their business objectives. Therefore, regardless of the approach chosen, organizations must continually evaluate and optimize their cloud usage to achieve these goals effectively. With the right mix of FinOps practices and multi-cloud billing monitoring tools, organizations can gain better visibility and control over their cloud costs, thereby optimizing their cloud usage and maximizing the value of their cloud investments.

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