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The impact of Cloud adoption on ICT Financial Management: how to address emerging challenges

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Author: **Raffaele Donatello Sannino**

Student ID: 10567472
Advisor: Prof. Mariano Corso
Co-advisor: Marina Natalucci, Ivan Antozzi
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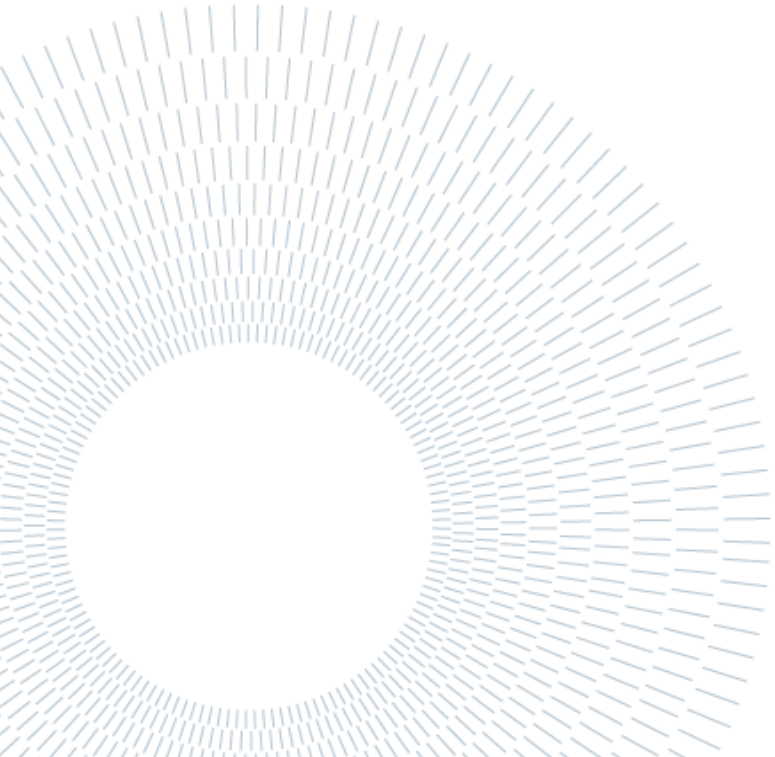

Abstract

More and more companies these days are embarking on a Cloud transformation journey or consolidating their position on the cloud in order to take advantage of the business scalability, flexibility and efficiency benefits offered by this technological paradigm. It often happens, however, that the implications that the variable pay-as-you-go cost model, typically employed by cloud service providers, has on typical ICT Financial Management processes are overlooked. Increased spending delegations to business users, direct users of cloud services, risk reducing the Finance department's visibility into the costs generated, in turn challenging the accuracy of spending forecasts. These challenges, coupled with a number of critical issues due to Cloud Service Providers' offerings, such as the extreme granularity of invoices, constantly changing pricing models, and lack of standardization across different provider platforms, confront organizations with the need to take steps to ensure that Cloud costs do not exceed promised benefits. Through academic research and the collection of empirical evidence, this thesis work identifies four main levers on which an organization needs to act jointly and consistently in order to contain and optimize its Cloud spending, namely resources and skills, culture and organization, processes and policies, and IT tools. Finally, a qualitative model is proposed for assessing the maturity of Cloud Financial Management practices, commensurate with the complexity of the Cloud Transformation path undertaken and enabling organizations to identify any gaps and target them with appropriate improvement actions.

Key-words: ICT Financial Management, Cloud Computing, FinOps

Abstract in italiano

Sempre più aziende, al giorno d'oggi, stanno intraprendendo un percorso di Cloud transformation o consolidando il proprio posizionamento sulla nuvola, al fine di sfruttare i benefici di scalabilità del business, flessibilità ed efficienza offerti da questo paradigma tecnologico. Accade spesso, tuttavia, che vengano trascurate le implicazioni che il modello variabile di costo *pay-as-you-go*, tipicamente impiegato dai fornitori di servizi cloud, ha sui processi tipici di ICT Financial Management. Le maggiori deleghe di spesa agli utenti di business, utilizzatori diretti dei servizi cloud, rischiano di ridurre la visibilità del dipartimento Finance sui costi generati, mettendo in discussione a loro volta l'accuratezza delle previsioni di spesa. Queste sfide, congiuntamente con una serie di criticità dovute all'offerta dei Cloud Service Providers, come l'estrema granularità delle fatture, i modelli di pricing in costante cambiamento e la mancanza di standardizzazione tra piattaforme di provider differenti, pongono le organizzazioni davanti alla necessità di adottare delle misure per far sì che i costi del Cloud non superino i benefici promessi. Attraverso la ricerca accademica e la raccolta di evidenze empiriche, questo lavoro di tesi identifica quattro principali leve su cui un'organizzazione necessita di agire congiuntamente e coerentemente, per contenere e ottimizzare la propria spesa Cloud, ovvero risorse e competenze, cultura e organizzazione, processi e policy e strumenti informatici. Viene da ultimo proposto un modello qualitativo per l'assessment della maturità delle prassi di Cloud Financial Management, commisuratamente alla complessità del percorso di Cloud Transformation intrapreso e che permetta alle organizzazioni di identificare eventuali lacune e indirizzarle con opportune azioni di miglioramento.

Parole chiave: ICT Financial Management, Cloud Computing, FinOps

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1 Introduction

1.1. Problem statement

The Information and Communication Technology (ICT) department, in recent years and in an increasing number of industries, has grown in terms of its strategic importance as an enabler of many business processes and guarantor of both day-by-day operations and the achievement of long-term goals. Because of this indispensable support role and its transversal nature, however, IT traditionally ends up absorbing many of the company's costs, even those that would not be strictly attributable to it. This is even more true, and it threatens to reach unacceptable levels of economic risk, with the advent of Cloud computing in the enterprise. Moving part of the infrastructural technology stack or application fleet to the Cloud, in fact, forgoing traditional on-premises management, has a number of implications in terms of financial management that statistically prove to be quite complex for practitioners to understand, but are often overlooked while organizations are instead blindly lured by the promises of flexibility and scalability of the cloud.

1.2. Aim of the thesis' work

This academical thesis proposes to explore how the ICT Financial Management process is generally structured within an organization and to understand to what extent it is impacted and needs to be revised after a company embarks on a journey towards a partial or total Cloud adoption. Once the financial implications of cloud computing are understood, the intention is to identify what levers an organization can invest in in order to meet these challenges and consciously and consistently manage the costs that this technological paradigm entails.

The ultimate goal of the thesis work is to build a qualitative model to determine, based on the levers used in response to variability in cloud spending, how mature the company is in relation to the extensiveness of adoption, how consistent this positioning is with respect to the strategic goals pursued with this path, and what the potential development paths are.

In summary, the questions the thesis aims to answer are therefore as follows:

1. *What dimensions and processes within financial management are being impacted by the advent of cloud computing and how?*
2. *What is the current level of understanding and implementation of the cloud financial management discipline in Italian enterprises?*

3. *What are the levers to be acted on or actions to be implemented to meet the challenges to cloud financial management, and thus determine a company's level of maturity in this regard?*

4. *Is it possible to create a model that assesses financial management maturity with respect to the complexity of the cloud configuration, also considering the adoption strategy?*

1.3. Thesis workflow

First, existing literature on the topics in question is collected and analysed. Within this chapter, some data on the diffusion of cloud computing in Italy are also provided, in order to put the topics in context. Next, empirical evidence is gathered on the application of Cloud Financial Management, both through a survey and by conducting four case studies. The key findings that emerged from the research are then presented in summary. Finally, a qualitative model is proposed for assessing the maturity of Cloud Financial Management practices, through the two stages of constructing and then applying the model to the case studies.

2 Literature review

The literature review section aims to summarize the body of knowledge on the topic at hand, put it in context, and offer reference points to the reader. First, the ICT financial management macro-process is examined in detail, in order to learn what the accounting principles are, how costs can be categorized and classified, what a budget draft consists of, and how IT services are remunerated internally within the company. With this purpose, extensive use is made of ITIL, as the most widely recognized reference framework for the IT Service Management, providing guidance on the processes, functions and other capabilities needed to support IT quality services. The literature review then proceeds with a collection of descriptive and taxonomic information regarding the Cloud computing paradigm. Following, some data regarding the cloud diffusion in Italy are provided, in order to put the topic into context. Intersecting the process dimension with the technology dimension, then, the paper proceeds with an analysis of the impact that the Cloud adoption has on financial management and the means the company possesses to meet the challenges that this shift presents. Since the latter topic is rather innovative and sparsely covered in the academic literature, the sources used are mainly technical and managerial, for instance information was gathered from manuals or guides to Cloud financial management provided by the cloud providers themselves (such as AWS or Azure) or third parties recognized as best practice collectors such as Gartner.

2.1. ICT Financial Management

Over the years, the importance of the role of Information & Communication Technology (ICT) in the execution of business processes has grown dramatically, gradually making it a crucial element for the provision of services to customers. This emerging strategical relevance of ICT and the growing investments associated with it make it necessary to adopt methods and tools capable of managing and tracking ICT costs, for the definition of the pricing of services and the attribution of costs to the business.

ICT Financial Management arises from the application of planning and control techniques to monitor ICT costs. The adoption of a structured approach to ICT

Financial Management is necessary in order to face problems such as a poor integration with other business processes, the poor knowledge of the services provided by the ICT department, the difficulty in finding reliable data on the costs of the services provided and in correctly attributing IT costs to the business. [1]

The ITIL (Information Technology Infrastructure Library, globally recognized framework as a collector of best practices for IT Service Management and more generally for the governance of the IT Infrastructure), in the module of the third edition dedicated to Service Strategy [2], defines Financial Management for IT Services as "*the process responsible for managing an IT service provider's budgeting, accounting and charging requirements*" and "*used to quantify the value that IT services contribute to the business*".

ICT Financial Management strategic relevance stays in the fact that this process helps determining the value IT bring to the organization, by quantifying the contribute of specific IT services to the organization's performances, in financial terms.

The purpose of this ICT Financial Management, according to ITIL, is to "*secure the appropriate level of funding to design, develop and deliver services that meet the strategy of the organization*". Another key role played by the process is to maintain the balance between cost and quality of service, as well as between service provider supply and customer demand.

According to ITIL Service Strategy, Financial Management – at IT level in a way that mirrors what happens at the enterprise level - is composed of three main processes:

- **Accounting**, that is keeping track of the costs the IT organization bears and being able to trace them back, for instance, to specific customers or services;
- **Budgeting**, consisting in periodically (usually on an annual basis) forecasting and consequently monitoring the organization's income and expenditure, with the aim of setting the budgets;
- **Charging**, essentially consisting in billing customers, being them external or internal to the enterprise, for the services supplied to them. [2]

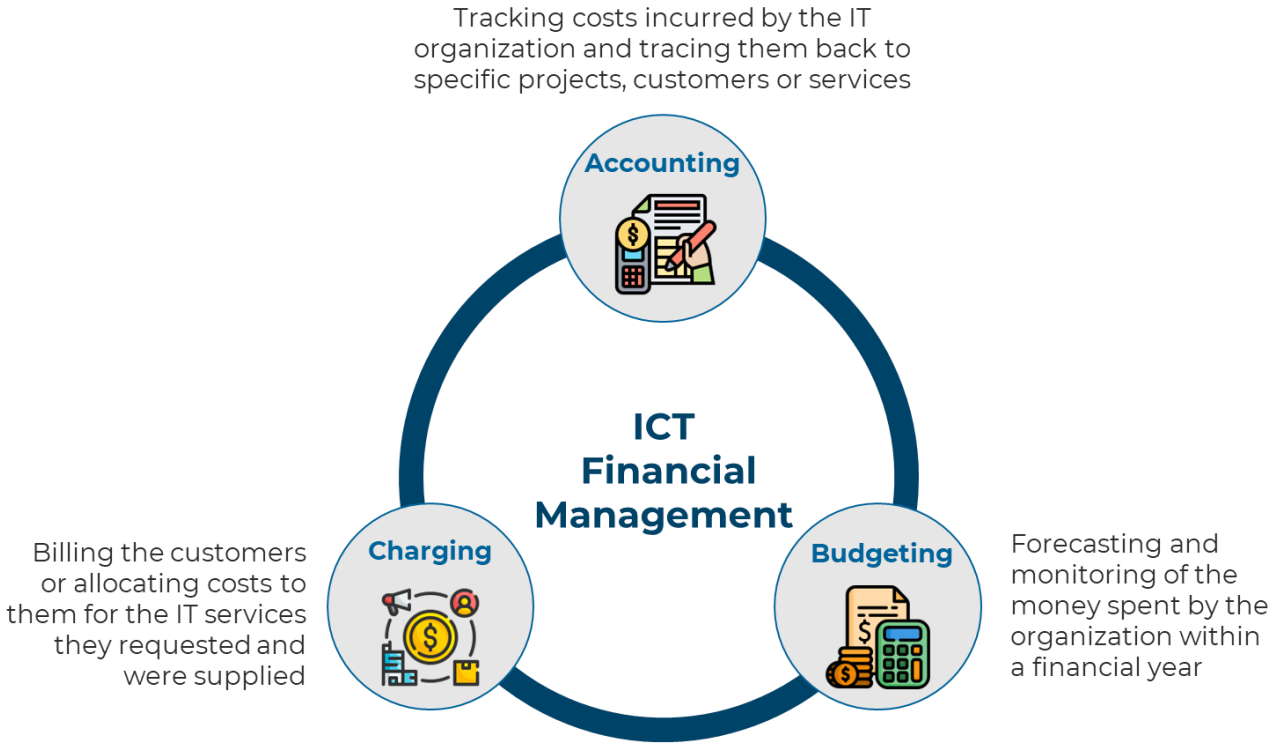


Figure 1. The three main processes that make up ICT Financial Management

2.1.1. Accounting

The accounting process consists in bringing to the final balance the actual costs for the delivery of IT services, compare them with those estimated in the budgeting process and manage any deviations. [2]

Through accounting, an organization is able not only to track actual costs against budget, but also to inform strategic decision making, thus reaching significant improvements in the development and execution of service strategy. More specifically, a correct management of this process allows to provide cost targets for service performance and delivery, to coherently prioritize resource usage, to know the consequences of decisions in terms of costs and risks and to potentially support the charging for IT services. In other terms, it enables a service provider to track financial information according to a service logic rather than a cost one.

The keystone of the process is the definition of a cost model, a framework enabling the estimation of the cost for services provision, the correct allocation of the expenditures

and a greater awareness of the financial impact of changes to the services and customer agreements in place.

Practically, through the definition of policies and practices - such as how expenditure items are tracked and classified in accounting terms, how costs are allocated to services and/or customers and structured into reports to inform decision making – the ultimate goal of a cost model is to provide a standard format for structuring financial information so to support the organization on a strategic, tactic and operational level.

Typical challenges, when dealing with the draft of a cost model for accounting, are the substantial differences among types of costs – this is particularly true in the case of Cloud Services costs, as will be thoroughly discussed later on in the paper – and the fact that most IT investments are not univocally attributable to a single service or customer, being shared among several of them. Only by facing and solving this kind of issues, a service provider can be able to make accurate forecast about its expenditure, gain a greater comprehension of the cost of a service on one hand and the value perceived by the customer on the other, thus formulating a proper service pricing and communicating effectively with the customer about the contractual agreements under which the services are delivered. [2]

Without entering a level of detail beyond the scope of this literature review, it is worth mentioning that some common cost models used by companies are cost by IT organization, by service, by customer, by location and hybrid models that combines part of or all of the previous criteria.

2.1.1.1. Cost centers and cost breakdown

Fundamental elements that need to be defined when structuring a cost model are how cost are allocated and how they are classified.

In an accounting system connotation (as explained below, this term can have two different meanings), a cost center is defined in ITIL Service Strategy as "*anything to which a cost can be allocated – for example , a service, location, department, business unit, etc…"* [2]. The definition of what will be considered a cost center within a company has several implications, such as on the charging and billing policies (described later on in the *Charging* process), on the classification of costs as direct or indirect and on the breakdown of costs into categories. Fundamentally, cost centers represent the basic unit of analysis and the starting point for a company aiming at reducing its costs.

Once defined the cost centers, a cost categorization is needed in order to establish how to account expenditures. A meaningful cost breakdown, that considers the type of services provided and the resources used for their provision, can really facilitate accountants' job and streamline the process of recording and tracking expenses. A hierarchical categorization is usually made with this purpose, with at least two levels

called *cost types* and *cost elements* The first ones are a first, gross allocation of costs, while the second ones are sub-categories, which can be further broken down if needed. The following picture represents a concrete example of a cost breakdown according to a "*cost type-cost element*" logic:

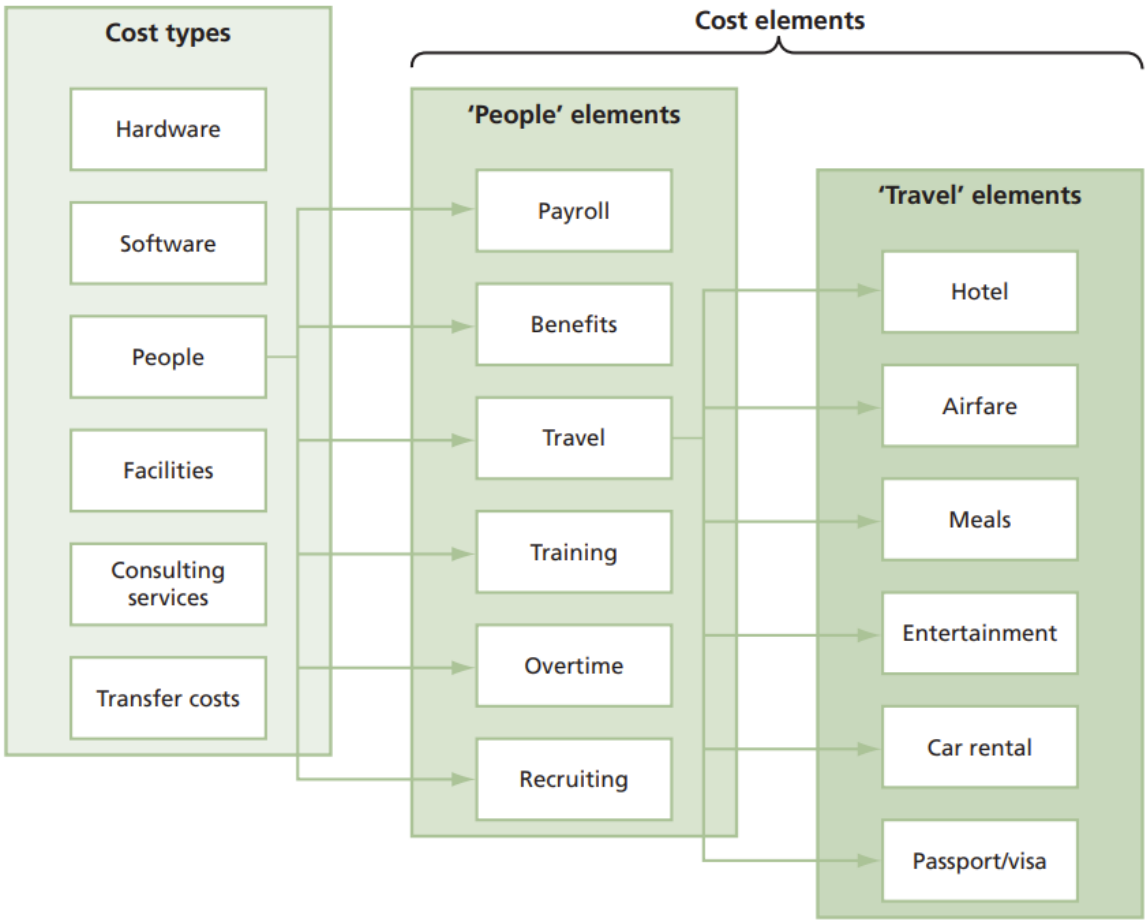


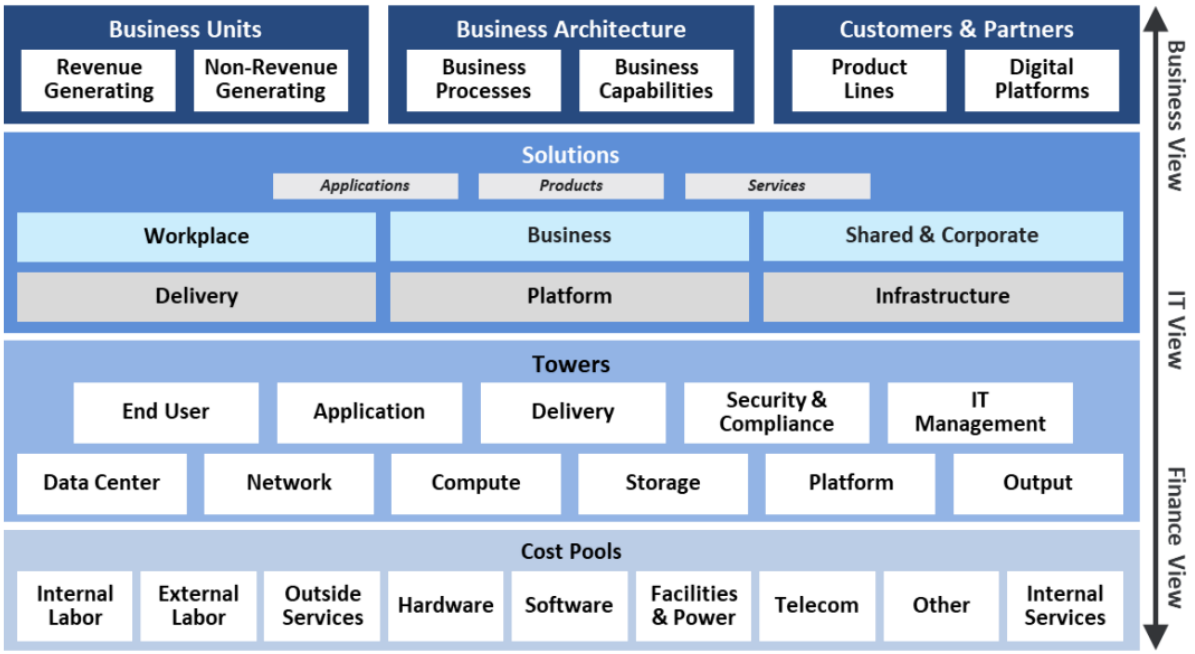
Figure 2. Example of Cost breakdown

The TBM Taxonomy

Among the frameworks commonly used by companies for the breakdown of costs, particularly relevant is the Technology Business Management (TBM) taxonomy, developed by the homonymous Council together with CIOs, CTOs and other technology leaders, to grant a shared glossary, thus allowing a proper dialogue and communication between IT, Finance and Business Unit leaders, aimed at aligning them on business and technological decisions [3]. More in detail, the common language provided by the taxonomy gives the opportunity to CIOs and technology

leaders to show to the business how the users' demand for services influences the cost of IT components they exploit while commonly running the business (as applications, networks, storage, for instance) and offers the opportunity to business leaders, in turn, to leverage this information to shape their consumption of these resources in order to optimize the spending.

As shown in the picture below, the TBM taxonomy has four layers underlying the three views of Finance, IT, and Business.



The lowest layer, corresponding to the Finance department view, provides a standard set of cost pools, usually generalizable to all types of companies, that facilitate cost allocation and improve reporting, since all the elements in the higher level can be broken down into these basic components, allowing for punctual comparisons. For instance, the total cost of ownership (TCO) [4] of different applications can be confronted in their founding cost pools such as hardware, software, facilities required and so on.

The IT view allegedly encompasses the middle layer of towers and the technical solutions, such as delivery, infrastructure and platform services (the grey blocks in the solutions layer). Towers, such as applications, networks, storage or servers are as well common among different firms, being the fundamental building blocks of solutions, although they can appear in different declinations, depending on the sourcing modalities.

Finally, the Business view comprehend a generic set of solution categories (applications, services and products, or in other terms what the IT delivers to business users, being them internal or external actors) and the top layer business units, business architecture and customers and partners. Differently from the lower layers, the highest one encompasses elements like business processes and product lines that necessarily cannot be standard and equal for all types of companies but rather differentiated according to industry specificities.

Overall, the important value of the TBM taxonomy as a framework for cost breakdown and management, besides putting the groundwork for a transparent and common language, comprehensible by IT and non-IT stakeholders, stays also in the possibility it offers to compare technologies and solutions both internally (over time) and with third parties offerings, thus allowing benchmarking, supporting sourcing decisions and the trend analysis of IT costs.

The taxonomy however is just a basis with the aim of supporting the construction of a model for costs and other metrics. A TBM *model* is an instrument that essentially maps resource consumption and its costs from their sources (the cost pools, such as hardware, software, internal and external labor, …) to their uses (the solutions that technology leaders develop, deliver or support and their business implications) translating among the different layers of the taxonomy and enabling the aforementioned value adding conversation between actors belonging to different departments. In addition to the layers, objects and roles included by the taxonomy, a TBM model also considers data, allocation rules, the reporting standards and the metrics deemed relevant to create transparency, monitor costs and optimize the spending.

It is worth noticing that, coherently with what defined in the ITIL Service Strategy module, so similarly with cost types and elements, the TBM model breaks down cost pools and towers in the respective sub-categories, detailing the building blocks in order to allow a full comprehension of the full cost of solutions the business purchases and potential comparisons among them.

2.1.1.2. Cost classification

Apart from breaking them down in categories for accounting and budgeting purposes, it is as well helpful to classify costs, with the aim of framing those with "behavioral analogies" and lead them back to patterns that simplify their comprehension. Several criteria of classification can be used; for the purpose of this paper, the following ones have been deemed meaningful.

Capex vs OpEx

An operating expenditure (OpEx) is a cost paid by the company for granting the continuous running of business operations, for instance employees' wages, utilities, insurance and taxes. Talking about quarterly or annual financial statements, OpEx figure in the income statement thus affecting negatively the net income

A capital expenditure (CapEx) is a cost incurred when making a purchase that will result either in a financial asset (for instance, when talking about the IT world, computer equipment, software licenses or a physical property data center), a renewal or improvement of an existing asset useful life. Moreover, a key difference with OpEx is that suffer depreciation (in case of tangible asset) or get amortized (for intangible ones) over a given accounting lifespan [2] [3]. These are exactly the reasons why it is said that these expenditures get capitalized. The main reason for signing a capital expenditure is increase somehow the scope of the organization's operations.

Direct vs indirect

According to ITIL, in the service management domain, direct costs are those costs incurred when providing an IT service which are univocally attributable to a specific cost center [2] as previously given definition as of "anything to which a cost can be allocated", so a service, customer, project or initiative.

Conversely, costs are defined as indirect where not being fully allocated to a single cost center. Possible examples of indirect costs are related to services or assets such as networks, licenses and servers who get shared among different departments or actors according to momentaneous needs. Another name for indirect costs is "overheads" [5]; they are usually allocated through methods like Job Order Costing (JOC) [6] or Activity Based Costing (ABC) [7].

Fixed vs variable

Fixed costs are those which do not suffer variations tied to an IT service usage but are incurred usually ex ante independently. Conversely, variable costs depend in their amount on the actual utilization of the service or resource, the number of users or nodes connected to a network. Anyhow, something that would be impossible to precisely estimate in advance [2].

2.1.2. Budgeting

Budgeting is the process consisting in the prediction and monitoring of the money spent by the organization within a financial year. Basically, it is a periodic negotiation cycle carried out according to organization-wide policies defined from the above Enterprise Financial Management. Despite being practically executed by all managers in charge of a part of the organization, according to their knowledge over it, these figures do now own the overall budgeting process, they rather just commit to a target of performance consistent with the budget they formulate to execute their plans. The IT department and its manager (the CIO, usually) do not make any exception. Usually budgeting starts with the Chief Financial Officer (CFO) providing guidelines, growth targets and spend constraints to each department or business unit in order to allow them to formulate a draft of the budget, which will be then assessed and subjected to possible revisions with the aim of granting consistency with the overall enterprise strategy [2].

This mechanism enables the forecast and consequently lays the foundation for a proper management of the resources needed for reaching the strategical and tactical objectives of the organization. Once set the resources required for meeting the yearly objectives, indeed, it can be assessed whether the organization owns them already or whether it needs to procure them instead. Other fundamental business questions that the budgeting process allows to answer regard the commitment the organization can expect from every business unit to meet the objectives, the intermediate milestones during the financial year and the potential areas for cost increases or decreases in relation to performances.

The budgeting cycle generally encompasses two macro-phases. The first one is the analysis of the previous year budget, with the aim of critically reviewing any variances with respect to the former forecasts, identifying the causes and potential trends of expenditure or income and avoiding repeating the same mistakes during the budget planning. The second phase consists in the actual preparation of the next financial year budget. This implies accurately assessing the plans and initiatives the IT will put in place and their impact on the budget and considering possible changes not yet considered in formal plans, such as revisions of the existing contracts, modifications to the accounting or charging policies, changes to customers' service utilization expectations. Compiling the budget means listing in a spreadsheet all the cost items, the estimated amounts and when the expenditure will occur. Additionally, where directly and easily traceable, the budget may include a specification of one or more services to which the cost item is attributable. It is worth mentioning that some costs will possibly vary from the predictions, depending on the actual usage of the resources. As will be seen below, prominent among these types of costs are those associated with cloud services.

2.1.3. Charging

Charging is the process by which IT services provided are remunerated, through a request for payment. It is important to note that, when providing IT services internally to other business units of the organization, charging is facultative and depends on a choice to do so by the CFO [2]. This is the first of some relevant decisions the person in charge of Finance has to deal with in this context.

A relevant premise to make when talking about charging is that concerning, at the corporate policy level (the decision is thus made by executives and not by IT managers themselves) the distinction between an IT department seen as a cost center or a profit center. A cost center, within a charging context (here is the different meaning with respect to the cost center from an accounting perspective) is a business unit or department to which costs are assigned, but which does not charge in turn other internal business units for the services it provides them. This means that the IT department is asked to account for its monetary expenditures but does not respond to the business in terms of profit goals, as is the case when it is considered a profit center, precisely. In this latter situation, the department is instead allowed to charge other business units for the provision of services [2]. This distinction will come in particularly handy when it comes to cloud services, where spending decisions, albeit regarding IT resource consumption, are by their very nature deferred to developer teams rather than Finance or Procurement [8]. Having the possibility to charge other business units within the organization implies gaining a greater control over the cost of service provision and being able to improve the mechanism that traces back IT costs to the external customers.

Pros of implementing charging can be envisioned on one hand, in greater awareness and control over the IT spend on behalf of the customer, on the other in a possibility for the IT to work with increased transparency and accountability. The customer is indeed provided with a greater understanding of the financial implications of its resource consumption and its requests for specific types or level of service, that in turn means making more informed decisions about the exploitation of IT services and having a more comprehensive perception of the value of the services they use. The IT, in exchange for being remunerated for the service provision, is requested to fully disclose the metrics and information used to quantify the value offered and the price set for its delivery. Furthermore, the IT can leverage the charging mechanism to drive and rationalize, with the information in its possession, users' consumption behaviors, in order to maximize value for the business and limit the waste of resources. In short, it should not be forgotten that although internal transactions occur between business units, the ultimate goal remains to support the goals of the organization as a whole. The main downside to consider when deciding whether to apply charging relates to

the complexity and the bureaucratic nature of the process, which often bring with it the need to use expensive accounting tools [2].

2.1.3.1. Chargeable items

For the charging process to work smoothly, it is a primary necessity that the customer fully understands what he is being charged for, through a precise and quantitative measure of the value of the service he is purchasing. This allows a dialogue with the IT aimed at properly balancing the cost and the quality of the provision, thus setting proper levels of service. The so-called *chargeable items* must be defined according to the criteria of being directly controllable by the customer through demand shaping and being as closely relatable as possible to the organization's business deliverables, rather than being a mere resource usage difficult to comprehend by a user who does not "speak the IT language". Difficulties in the setting of chargeable items comes when the resources underlying the business deliverable are fragmented and the measurement results too cumbersome or expensive, or when the business deliverables are not univocally attributable to a process or application. These instances have to be discussed ad hoc between the IT and the customer and a typical outcome is to charge the service as a whole after a phase of negotiation between the parties [2].

2.1.3.2. Charging policies and pricing

Another essential decision the CFO or otherwise the person in head of Finance has to make, besides the essential one regarding whether to charge, is about the level of cost recovery to be attained, that ends up being strictly related to the establishment of the price that customers will be charged for the service.

In case the objective for the IT department is just a cost recovery, otherwise called reaching the break-even point, the chargeable item is priced at the actual cost, so not to make any profit or loss. This approach meets its limitation in the case of volatile demand. For example, when the price is set on an estimate of demand that turns out in hindsight to be undersized, the IT would end up making a profit. This misalignment can be managed by adjusting the price in the process, monitoring the consumption rate trend, or reinvesting the profit to meet the increased demand.

Another possibility is that the IT seeks to recover more than the actual costs it bears to provide the service, so to charge the customer an additional margin. Such a choice could be motivated by the need to cover unforeseen costs or the desire to offset the cost of a technology investment in the near future. It is however worth underlying that this money do not represent a profit for the organization as a whole since they are exchanged internally.

Other pricing options for chargeable items consist in setting the price:

- at the level set by similar internal service providers in comparable organizations (*going rate*);
- at the price charged by external suppliers (*market price*);
- at a *fixed price* negotiated with the customer covering a predicted consumption within a given period;
- according to different service package options (*tiered subscription*).

A special mention, finally, is deserved by *differential charging*, being a pricing option useful to influence user behavior and strategically reduce total costs for the organization. Charging different prices for same or similar services according to different usage conditions, indeed, can be a way of rewarding some behaviors that facilitate the service provider in the management of demand for capacity. A possible example of differential charging is applying a higher rate for the consumption of a service during the peak daytime, in order to foster customers to use the service during off-peak hours, resulting in a more efficient usage of technological resources and reduced overall costs [2].

2.1.3.3. Billing

In the broader understanding of charging as the process of generally recovering money spent on the provision of a service directly from the customer, billing is the subprocess of preparing and presenting an actual invoice to the customer for this purpose.

Billing typically follows one of the following three alternative declinations [2]:

- **No billing**: the IT department merely allocates the costs incurred to provide the service to the appropriate business unit, without actually issuing any type of invoice;
- **Informational billing** (also referred as **notional charging** or **showback** [9]): the service provider produces an invoice, the purpose of which, however, is not to actually collect revenue but rather to disclose to the internal customer the expense they would incur if they were paying directly for the services consumed. In other terms, it provides visibility without actually involving any transfer of money. A showback policy is usually implemented either to create awareness on the expenses and affect user behavior in order to contain them or as an intermediate solution, in preparation for a future scenario in which actual charging will be put in place;
- **Billing and collection (actual charging)**: the customer compensates the IT through the payment an internal transfer. Among the options this one is the

most complex because it implies the need for a financial tool able that can manage invoices, money transfers, payables and receivables.

2.2. The Cloud Computing paradigm

2.2.1. Definition and main characteristics

According to the National Institute of Standards and Tehcnology (NIST) the Cloud Computing is defined as follows:

"Cloud computing is a model for enabling ubiquitous, convenient, on-demand network access to a shared pool of configurable computing resources (e.g., networks, servers, storage, applications, and services) that can be rapidly provisioned and released with minimal management effort or service provider interaction. This cloud model is composed of five essential characteristics, three service models, and four deployment models" [10].

From this definition, five essential characteristics can be inferred:

1) **On demand self-service**: users can obtain resources such as server time or storage space independently (unilaterally, without the need for human interaction with the service provider) and quickly. The user himself can provision and manage the resource, usually trough a web-based or application-based console [10] [11]. For example, the availability of a virtual machine can be obtained through a few clicks on a portal and within seconds;

2) **Ubiquitous network access**: users can use standard networks, generally over the internet, and protocols and devices suitable for access through these protocols to access cloud resources; similarly, within the boundaries of the organization, private cloud services can be easily accessible over heterogeneous devices (thin or thick client platforms, such as mobile phones, laptops or tablets) [10];

3) **Resource pooling and multi tenancy**: the providers' resources are pooled (spread across multiple servers) in order to serve multiple consumers according to a multi-tenant model, with a dynamic allocation of physical and virtual resources according to the demand. The user usually does not know and is not interested in knowing where the resources are precisely located. While customers can share an application, a physical infrastructure, storage or

network bandwidth, the resources are separated on a logical level, that grants the retention of data security and privacy [10] [11];

4) **Rapid elasticity and scalability**: resource capabilities can be elastically provisioned and released, in some occasion automatically, in order to meet consumers' immediate demand. In the same way, they can be scaled down when not required anymore. This characteristic has a double functionality: on one hand, it grants the capacity necessary for the resource at any time, on the other, it relieves the client from the burden of estimating in advance its demand for the resource ;

5) **Measured service**: the utilization of resources is automatically monitored and optimized, by leveraging a metering capability of the cloud system, thus transparency is granted for both the provider and the consumer. Consequently, the cost of cloud resources is commensurate with actual resource consumption (*pay-per-use*) [10].

Alternatively, the popular technological research and consulting firm Gartner defines Cloud computing as "*a style of computing in which scalable and elastic IT-enabled capabilities are delivered as a service using internet technologies*" [12].

This second definition further put emphasis on the scalability and elasticity of the Cloud paradigm. With respect to the NIST one, it highlights how the capabilities are *IT-enabled* and uses the words *as a service*, referring to the fact that resources that were traditionally accessed in a physical way get now virtualized.

Benefits usually pursued when adopting Cloud, with respect to the traditional on-premises IT, are:

- **Reduction of IT costs**: the cloud allows organizations to eliminate or at least substantially reduce some or most of the cost and effort necessary for purchasing, installing, configuring, and managing a proprietary on-premise infrastructure.
- **Improved agility and time-to-value**: the possibility of immediately and autonomously provisioning an IT resource, instead of having to wait long time for IT to process and fulfil a request, purchase and configure supporting hardware, and install software is an enormous advantage when aiming at being flexible and achieving as rapidly as possible the effectiveness of an investment.
- **Easy and cost-effective scalability**: Cloud provides customers with the opportunity of scaling capacity up and down in response to peaks and troughs

of the demand, avoiding the risk to buy excess capacity that goes unused during slack periods.
- **Geographic extension:** cloud provider's global network can be exploited by customers to spread applications closer to users around the world [13].

Given the characteristics of the cloud computing paradigm, Armbrust et al. [14] envisioned three relevant cases in which it could be favorable for companies with respect to conventional hosting:

- When the demand for a given service is variable over time, that could cause inefficiencies for instance if a resource provided is then subject to underutilization;
- When the demand for the service is totally unknown in advance, that could be the case of a startup that does not know when its demand will skyrocket;
- For organizations in need to perform batch analytics and can exploit the "cost associativity" propriety of cloud computing in order to run the computation faster.

2.2.2. Service models

Cloud service models are prepackaged combinations of IT resources offered by a cloud provider. The *NIST Definition of Cloud Computing,* dated September 2011 [10], originally encompassed and detailed three main service models:

- **Software as a Service (SaaS)**. The model involves delivering applications without requiring any installation effort from the user. The user indeed uses a software physically located on infrastructure owned by the Cloud provider. The applications are accessible from various client devices through a web browser or a program interface, allowing them to be enjoyed transparently with respect to the device. Every underlying cloud infrastructural element such as network, servers, operating systems, storage is managed by the cloud vendor, with few possible exceptions as could be the configuration settings of an application [10] [15].
  Typical examples of SaaS could be licenses as Office365 or Salesforce or web-based mail services as Gmail.

- **Platform as a Service (PaaS)**. The model provides to the consumer development and operating environments as a service. The Cloud infrastructure provided includes programming languages, libraries, services,

and tools to allow the consumer to code and deploy rapidly and efficiently. Within a PaaS model, the customer is thus freed from the burden of installing and manage on-premises hardware and software to delevop and run a new application. The control over the underlying cloud infrastructure including network, servers, operating systems, or storage, is left to the cloud provider, while the customer retain control over the deployed applications and possibly configuration settings for the application-hosting environment. A suitable use case for PaaS is that of a development company willing to implement agile methodologies [10] [15].
Examples of PaaS include Amazon Web Services (AWS), Microsoft Azure and Google App Engine.

- **Infrastructure as a Service (IaaS)**. This one could be defined as the "lightest" cloud service model, in terms of components delegated to the cloud provider. Within IaaS, the consumer is provided with virtualized computing resources as processing, storage and networks, while left the freedom to deploy and run arbitrary software, which can include operating systems and applications. The consumer does not manage the underlying cloud infrastructure but controls operating systems, storage, deployed applications and possibly has limited control of selected networking components such as host firewalls [10] [15].
  In other words, Infrastructure as a Service offers virtualization platform, as an development of the previously existing virtual private service offerings [16].
  Enterprises that do not have a proprietary data center can rely on IaaS to obtain a fast and cost-effective infrastructure that can be expanded or discontinued according to the variability of their business requirements. A typical use case for IaaS adoption is that of a traditional business in need for computing power to run variable workloads on a limited budget, as it will benefit from the pay-per-use dynamic [15].
  Possible instances of IaaS are EC2 by Amazon and Google Compute Engine (GCE).

Below, an image to help visualizing the distribution of ownership on components within the three main service models, comparing them also with the traditional *on-premise* configuration. The blue bricks represent what the customer manages, while the yellow ones represent what is managed by the Cloud Service Provider:

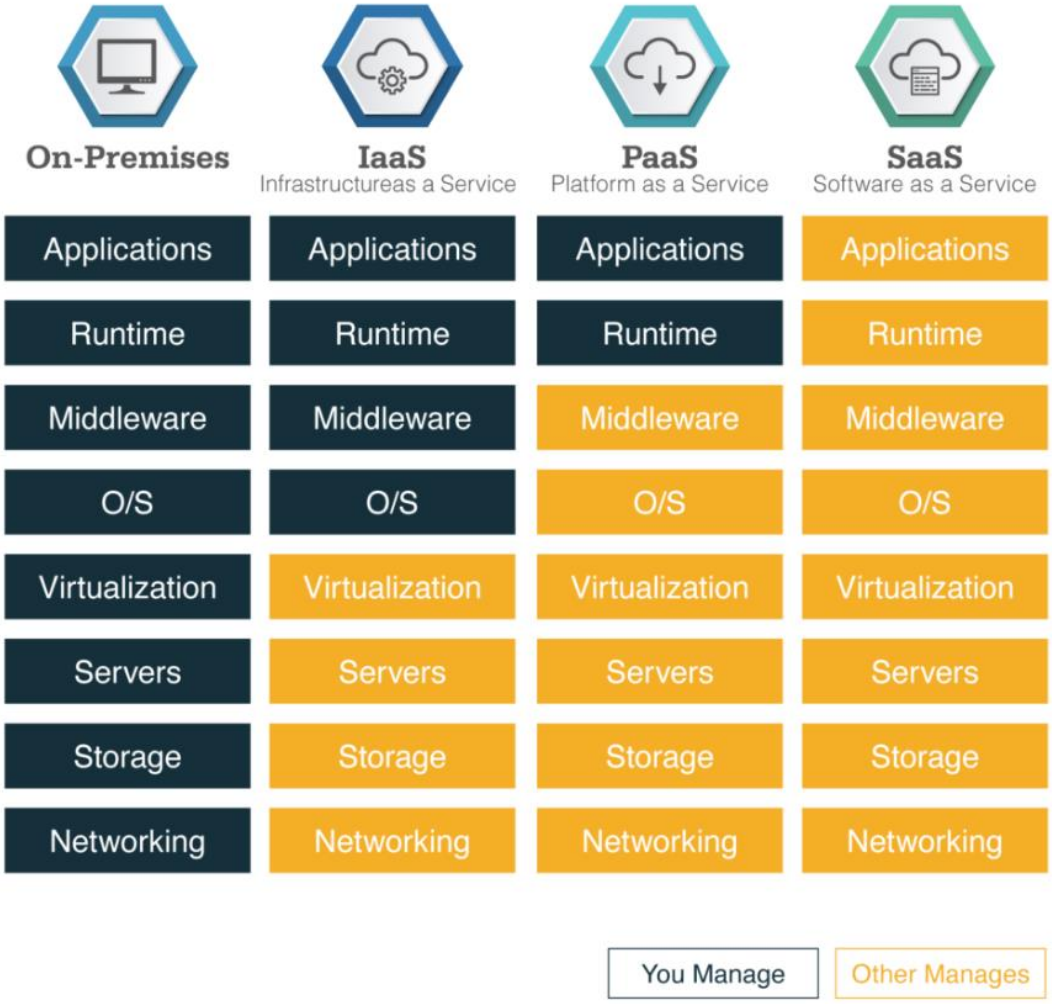


Figure 3. Schematic representation of the three main cloud service models compared with on-premises

With respect to the three original service models listed by the NIST, several other service models have become formally offered by cloud providers, as:

- **Storage as a Service (STaaS)**, through which a Cloud provider makes available, in exchange for an upfront fee payment, its storage infrastructure, allowing the customer to manage backups (copies of its files, for instance) and to save costs related to hardware and physical space. It is worth noticing that, with respect to other service models, STaaS is largely enjoyed by individuals, as well as firms. The service model is usually provisioned through a remote, web-based API (Application Programming Interface) communicating with the customers'

in-house cloud storage infrastructure, so that, if the customer loses its physical copy of a file, he can contact the cloud provider to request its remote copy.
Widely known examples of STaaS offerings are Dropbox, OneDrive by Microsoft, Google Drive and iCloud by Apple;

- **Data as a Service (DaaS)**, an advanced instance of STaaS, that makes possible for the customer to have a direct and instant, on demand access to its data through a Cloud-based platform, without the need and the associated cost of maintaining them personally within on-premise databases. Data are therefore viewable and editable by multiple users through a single point of update, regardless of their geographical location. Furthermore, attached with the data storage functionality, the provider usually offers tools to ease and optimize the exploration and manipulation of such data.
  Among the most known providers of DaaS, Oracle's Data Cloud, Amazon DynamoDB and Microsoft SQL Database can be counted.

- **Function as a Service (FaaS)**, providing a serverless platform that allows developers to deploy and run individual functionalities, actions, or pieces of business logic rather than developing and launching a complete application. Individual requests are processed within milliseconds and the customer gets billed based on consumption and executions, rather than server instance size. [15]

The image below sums up all the mentioned service models, putting them in a pyramid where from the bottom to the top the amount of cloud architectural components managed by the cloud vendor increases. Several examples are provided as well for each instance of service model.

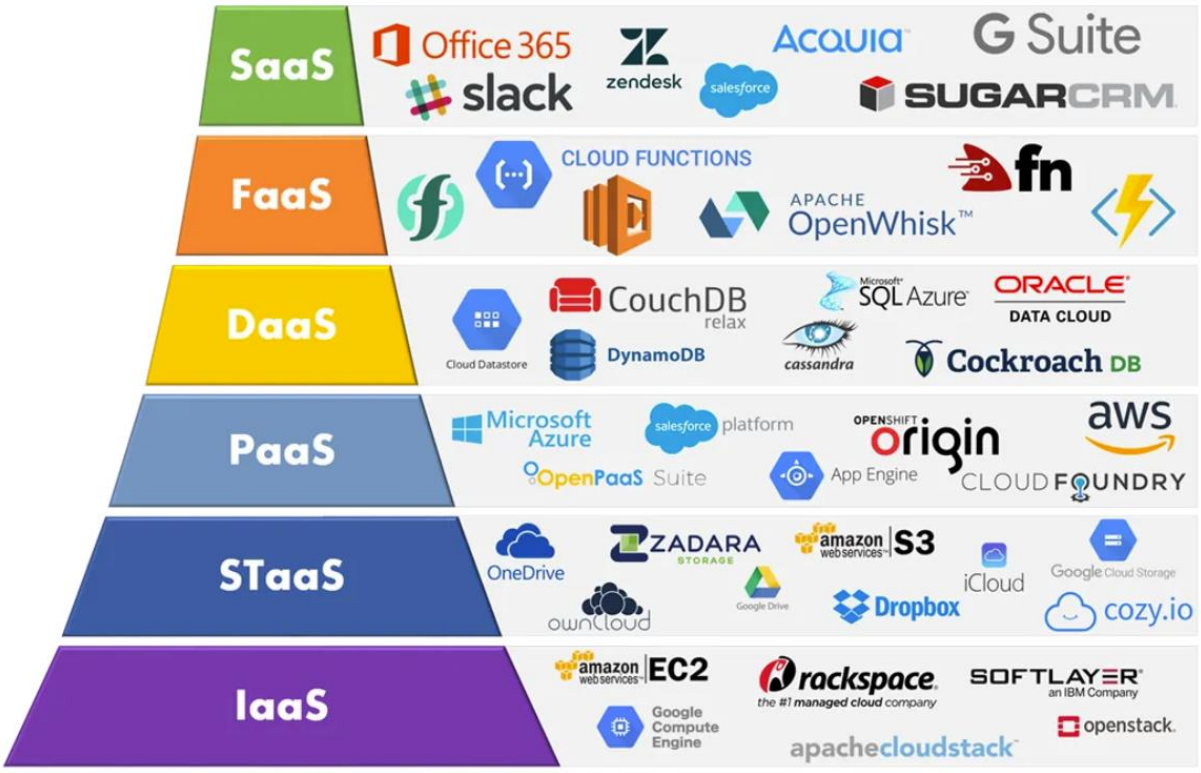


Figure 4. Extensive representation of service models with related examples

2.2.3. Deployment models

- *Private cloud.* The cloud infrastructure is provisioned for exclusive use by a single organization encompassing multiple internal consumers (e.g., business units). It may be owned, managed, and operated by the organization itself, by a third party, or a combination of them, and it may exist on or off premises.

- *Community cloud.* The cloud infrastructure is provisioned for exclusive use by a community of organizations that have shared interests or needs (e.g., mission, security requirements, policy, and compliance considerations). As for the private deployment model, the infrastructure may be owned, managed, and operated by one or more of the organizations in the community, by a third party, or some combination of them, and it may exist on or off premises.

- *Public cloud.* Cloud infrastructure is made available to the public for open use. The subject owning, managing and operating the infrastructure may be a business, academic, or government organization, or some combination of them. The infrastructure resides on the premises of the cloud provider.

- *Hybrid cloud.* The cloud infrastructure is a composition of two or more of the previously described models, which remain unique entities, but are linked together by standardized or proprietary technology that enables portability of data and applications.

The image below helps visualizing the differences among the different deployment models:

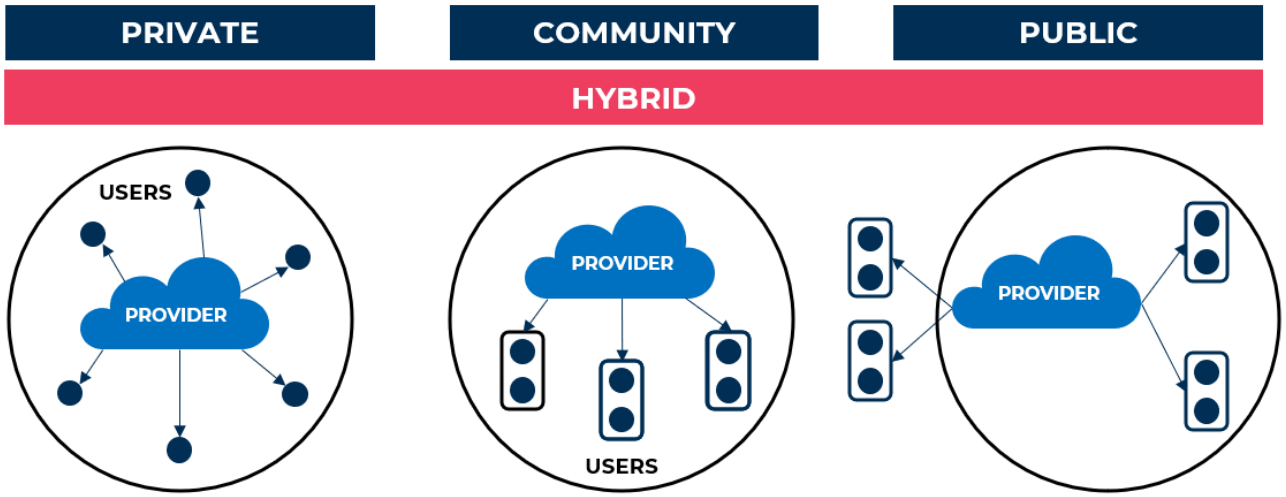


Figure 5. Representative diagram of cloud deployment models

Multi-cloud

A fith deployment model, not originally considered by the NIST in its taxonomy, is the *multi-cloud* one. "Multi-cloud" is a term used to refer to an environment where multiple public clouds are sourced by distinct providers. Therefore, this means that storage, data or the application stack can be distributed among several cloud vendors rather than a single one. It is actually a quite widespread configuration.

The reasons behind such a choice may lie in:

- the will of having redundancy and system backups, otherwise called avoiding "putting all the eggs in one basket", thus reducing the vulnerability with respect to failures or unplanned downtimes. This usefulness had already been recognized by Armbrust et al. (2009) [14];
- the flexibility of switching provider based on a combination of criteria like pricing, performance and security requirements;

- adopt a "best-of-breed" approach in the purchasing process and leveraging the core competences and assets of each provider;
- sourcing different services from different cloud vendors in order to avoid potential lock-in situations.

It is important to underline this difference: while "hybrid" cloud refers to the combination of a private cloud and/or an on-premises data center with a public cloud, "multi-cloud" refers to the combination of several public clouds, generally not including a private cloud instead. [17] [18]

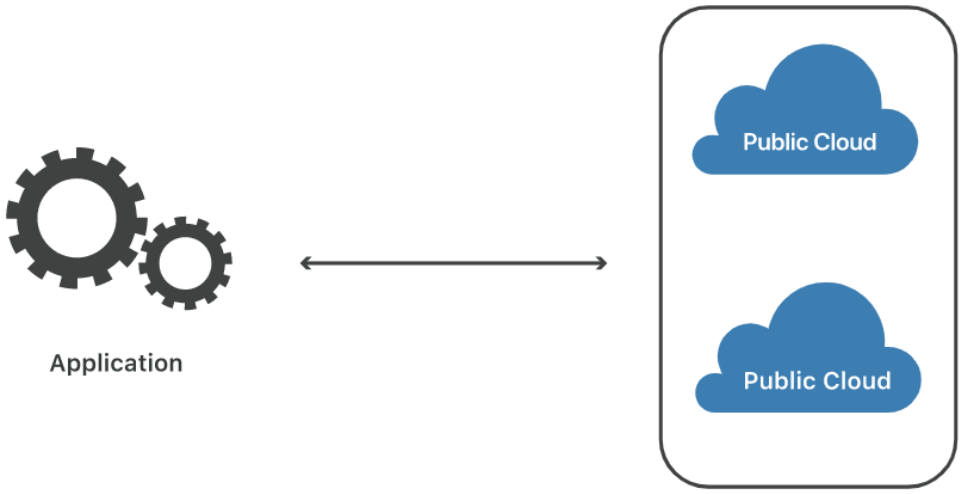


Figure 6. Representative diagram of a multicloud environment

2.3. Cloud diffusion in Italy

In this paragraph, in order to contextualize the topic in question on the Italian landscape and emphasize the importance of dealing with cloud financial management issues given the growing pervasiveness of this technological paradigm, some data regarding the cloud computing paradigm diffusion in Italian companies are displayed.

The data must be framed within the pronounced uncertainty in domestic and international markets that characterized 2022, given by factors as the delicate geopolitical situation generated by the Russian-Ukrainian conflict, the energy crisis and the difficulties faced by several supply chains, including the semiconductor one, which is critical to technology development. The soaring inflation, which diminishes the purchasing power of businesses, and the concomitant increase in cloud service fees will very likely, according to the Cloud Transformation Observatory of Politecnico di Milano [19] affect the Cloud market, relying on energy-intensive infrastructure,

threatening to slow down the sustained growth that has been an established and unstoppable trend for years now.

Despite the aforementioned factors of uncertainty, the Observatory data record a

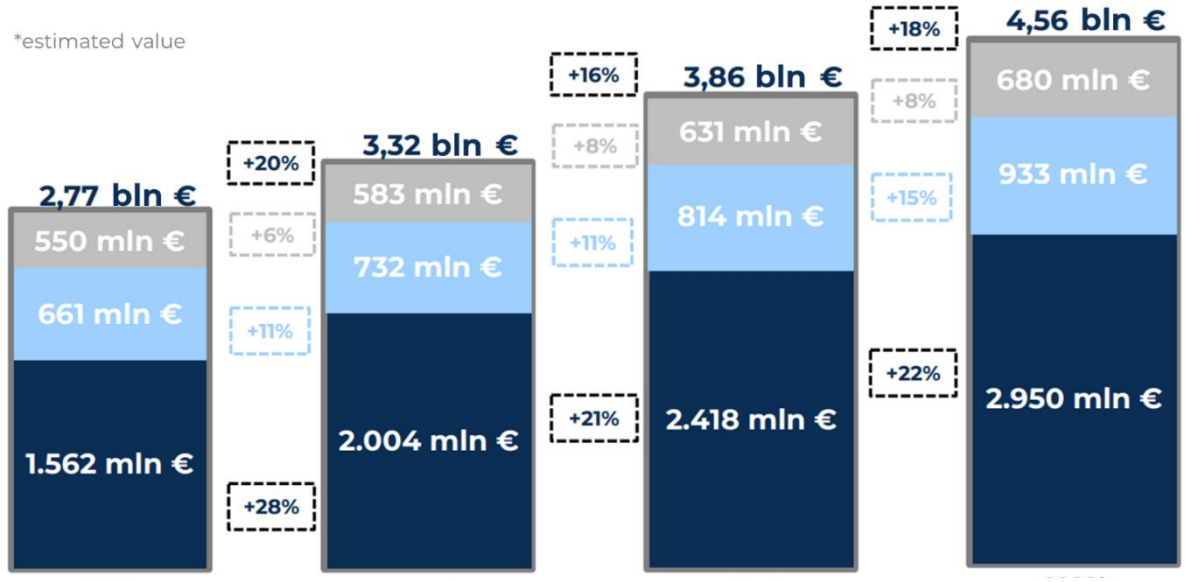


Figure 7. Growth of Italian Cloud spending over the years

consolidation of the overall market, with an absolute value of 4,56 billion of euros and a growth rate of 18% from 2021, with this percentage being decomposed between a 15% of organic growth and an estimated 3% attributable to the forecasted rise in cloud services' price by the end of 2022. [19]

Overall, the market value estimates for 2022 thus show a consolidation of investments, showing how the Cloud computing trend is increasingly establishing itself as one of the founding elements for the digitization of enterprises, which have strengthened awareness of its strategic relevance over the years. It happens more and more often that new applications are born within the Cloud, while existing ones embark on a path of evolution and modernization toward native Cloud logics, resulting in an increasingly heterogeneous IT environment that drives companies to invest in governance and integration.

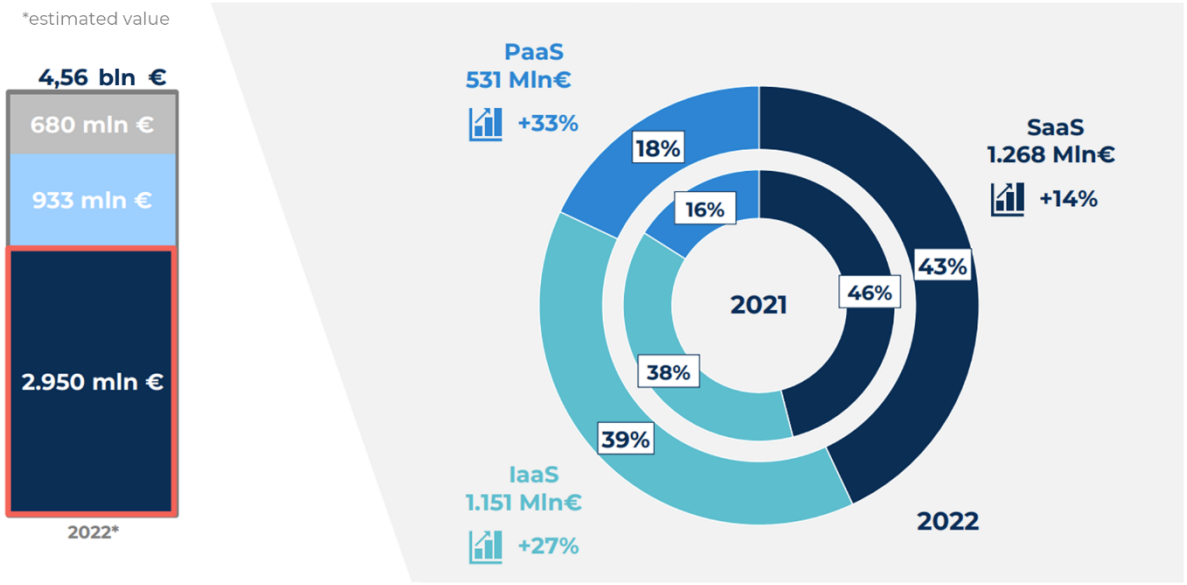


Figure 8. Distribution among service models of Italian 2022 spending forecasts in Public & Hybrid Cloud

Focusing on the "Public & Hybrid Cloud" portion of the market, characterized by the most consistent growth dynamics (+22% with respect to 2021) the Observatory's data highlight how Software as a Service is confirmed in absolute terms as the predominant Cloud service component from the investment perspective of Italian companies, with a value of 1,268 million euros and occupying 43% of the mix of the top 3 service models. At the same time, on the other hand, it is evident how year-on-year growth rates are favouring PaaS and IaaS (+33% and +27% respectively), which are progressively taking percentage points in the mix away from SaaS. [19]

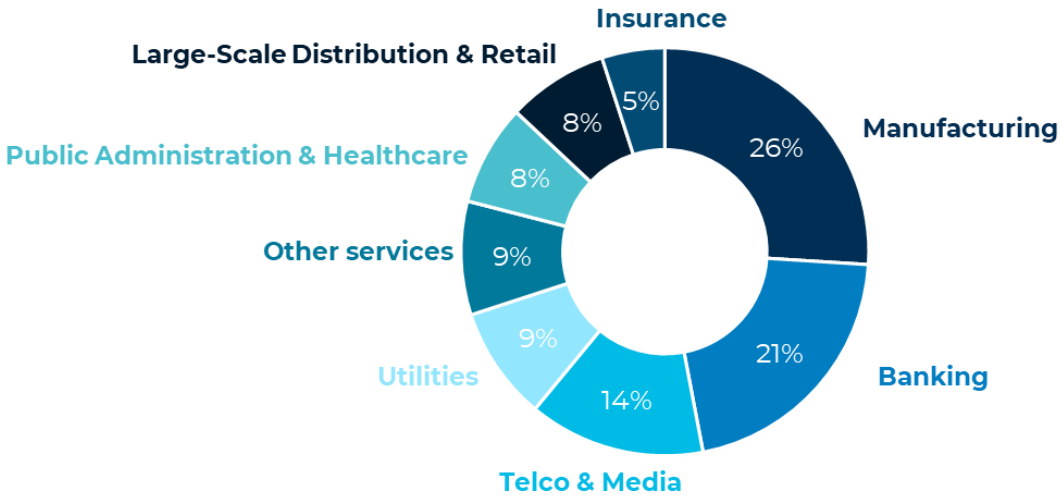


Figure 9. Distribution by sector of Italian spending forecasts for 2022

Wanting to analyze Italian Cloud spending by sector, Manufacturing is confirmed in first place by size of spending (26%), consolidating its market share within the mix. This is followed by Banking (21%), Telco & Media (14%), Utilities (9%), Other Services (9%), Public Administration & Healthcare (8%), Large-Scale Distribution & Retail (8%) and Insurance (5%). As for the Public Administration and Healthcare sector, the relevance to the total could increase significantly over the next few years as a result of the entry into the market of funds from the *Piano Nazionale di Ripresa e Resilienza (PNRR)* intended to "implement a support and incentive program to migrate local government systems, data and applications to qualified cloud services" [20], generating a direct impact on overall spending values and initiating a series of indirect expenditures in migration-related project services [19].

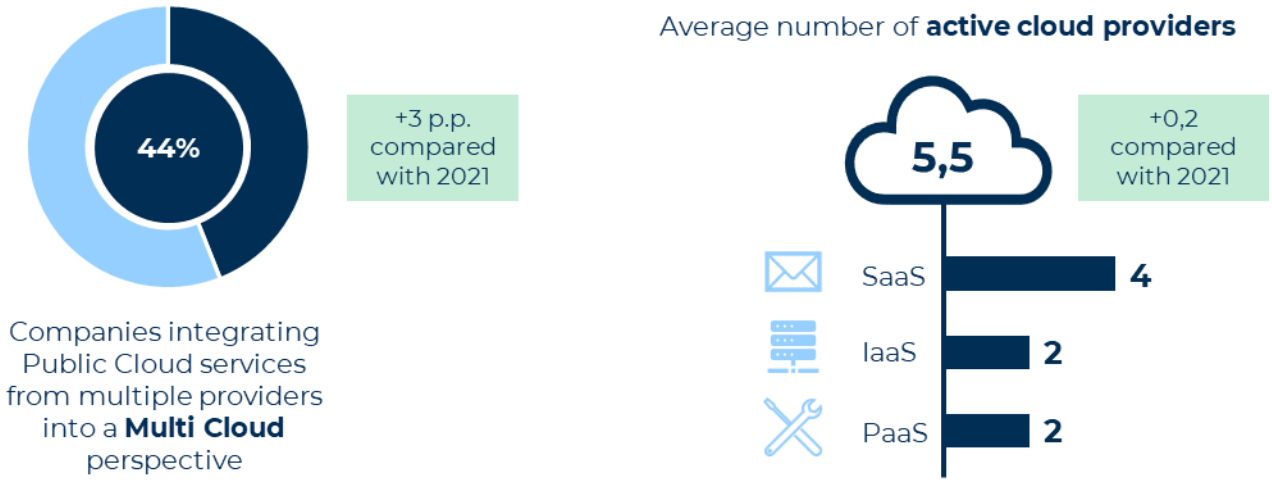


Figure 10. Multi Cloud diffusion and average number of active Cloud providers in Italy

Other interesting data comes from the spread of the multi-cloud approach to sourcing. Based on a survey of 120 large Italian enterprises, 44% of companies are integrating Public Cloud services from multiple Providers with a Multi Cloud perspective, with a growth of 3 percentage points over 2021. The average number of simultaneously active cloud providers rises to 5.5 (from 5.3 in 2021), specifically settling on 4 for SaaS and 2 for PaaS and SaaS services [19] [21]. This difference between the service models is explained by the fact that, while for SaaS there are proliferating players capable of responding with application solutions to functional business needs, the supply market for IaaS and PaaS solutions is dominated by a few large players such as Amazon, IBM, Google and Microsoft [22].

2.4. Cloud Financial Management

Embarking on a cloud adoption path has become a rather convenient choice for a CIO when looking at strategic objectives such as reaching greater flexibility, scalability and productivity. However, on the other hand, cloud introduces several challenges, pertaining to different areas ranging from the processes of accounting, planning and charging to the organizational implications in terms of role and competences needed and collaboration and integration among different departments, to the reflections in terms of the tools used.

2.4.1. Impact on ICT Financial Management

Within a traditional on-premises IT model, it is Finance responsibility to approve budgets, while Procurement teams are in charge of purchasing resources and properly implement the vendor strategy, while technology teams work on the installation and provision of the underlying infrastructure. The main innovation introduced in this regard by the cloud is the possibility for end users, whatever their department, to purchase IT resources independently from the Procurement and without the need of an explicit approval. As a natural consequence of this increased freedom to purchase, IT teams have a renewed concern to operate with real-time visibility and constant monitoring over the IT spend, in order to spot potential opportunities for cost savings. With an on-premises infrastructure, this need was not perceived as teams were not moved by the perspective of optimizing the cost of a resource that has been already purchased up-front. [8]

Finance, in turn, has its own repercussions in different processes, as:

- When dealing with an extensive use of public cloud IaaS and PaaS, organizations are not billed on a one time, as is the case when they have data center capacity on their own, but rather on an ongoing basis, as consumption occurs; a typical issue fronted by companies is receiving an invoice from the cloud service provider whose amount is inexplicable due to the enormous complexity of identifying the cost items responsible for the costs;
- Making accurate forecasts results in being very difficult as a consequence of the greater responsibility delegated to end users of IT services; furthermore, traditional budgeting and monitoring mechanisms fail in understanding the complexity of Cloud, thus making it difficult to reconcile cloud investments with business objectives. Without a purpose-built-tool, it is very likely that the margin of error in the consumption forecast will be too wide;
- In an on-premises solution most of the costs are Capital Expenditures and related to the purchase of hardware and software, while the Operating Expenditures are generally related mostly to personnel cost and the training and management of the same. With the Cloud some purchases (as software licenses, for instance) turn into "subscription" instead, thus implying a significant shift from CapEx to OpEx. The resulting difficulty in reconciling the two components of the budget can be critical for the company's financial results, as most of the cloud expenditures constitute an investment that cannot be amortized over several years and related to actual revenues spurring from it. In other words, the unbalance between CapEx and OpEx is due to the fact that

Cloud represents a whole different consumption paradigm, as it implies the utilization of services and not an actual purchase of assets.

Further factors increasing the complexity of managing costs of public cloud and causing the aforementioned issues for the Finance, Procurement and IT department are:

- The complex and **multifaceted pricing** applied by cloud service providers: CSPs like AWS or Azure use billing models and pricing structures with a wide range of options and combinations, that can make finance's life hard in choosing the pricing option that suits the organization best;
- **Constant change in cloud offerings**: besides pricing models, cloud vendors yearly update their offerings catalogue through the introduction of new services, features or instance types. Finance struggles to cope with the innovation pace and often fails in comprehending the impact of these novelties on the company's financials;
- The **extreme granularity of cloud bills**: even when consumption is not peak, the invoices issued to request a payment can easily reach thousands of line items and this extreme level of detail considerably complicates the attribution to cost centers, fundamental to enable charging mechanisms;
- **Excess of alternative architectures**: another area characterized by the paradox of choice, which this time afflicts more technical teams and systems engineers is the architectural layer of the Cloud, as each application can be built using many different architectures, services and components that can in turn affect significantly the spend. Individuating the cheapest alternative is a time-consuming and labor-intensive task;
- **Lack of standardization between cloud platforms**: There is no legislation requiring standardization of billing models, invoice formats, APIs or services. The result is an even more complicated scenario for companies operating according to a multi-cloud strategy, as they face the difficulty of reconciling the services purchased from different providers and the respective bills. [9]

The following pictures attempts at summarizing the main issues that Cloud computing introduces to the discipline of ICT Financial Management, highlighting the departments affected by each factor as well. Although the factors are affected by causal relationships and the boundaries of responsibility are rather blurred, the color of the

box and the text within it stands to indicate, in the case of factors that cut across multiple areas, which stakeholder is most affected by the criticality in question.

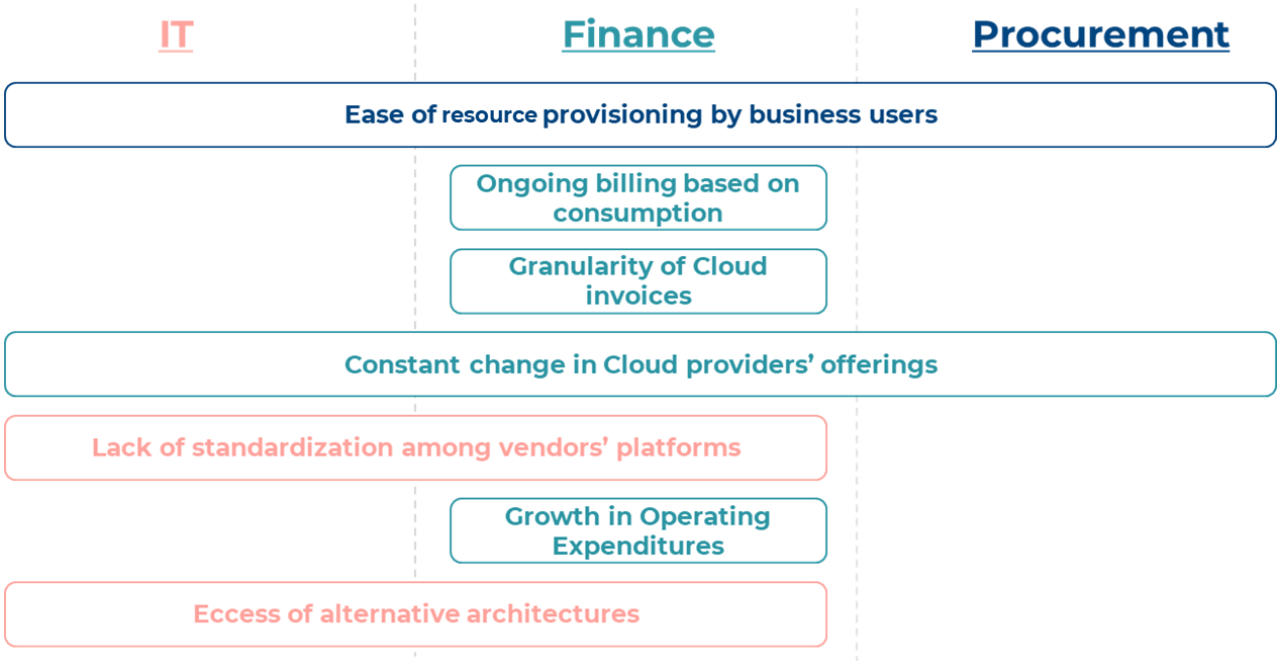


Figure 11. Criticalities of Cloud Financial Management and impacted stakeholders

According to Lin et al. (2009) the main mechanism used to manage the relationship with Cloud vendors are Service Level Agreements (SLA) [23], that define through technical measures, as uptime for instance, the level and quality of service that the customer can expect and that, if not met, legitimate him to ask for compensation [24].

Regarding cost monitoring, as Makhlouf [25] points out, this must be conducted in parallel on two fronts: on the one hand, it is necessary for the IT department to monitor the performance of the Cloud vendor, evaluating it against the service level agreements signed in the contract; on the other hand, internally, IT must monitor consumption by business users, through the definition and enforcement of policies that limit and keep it under control through the use of alerts.

According to Williamson's (1985) definition of asset specificity as "durable investments that are undertaken in support of particular transactions, the opportunity cost of which investments is much lower in best alternative uses or by alternative users should the original transaction be prematurely terminated" [26], Makhlouf also stresses that the high asset specificity of the Cloud calls for specific monitoring tools and dedicated human resources for monitoring the cloud vendor. The former, since the providers' native features alert the client only when the client overruns the entire

set budget and not, for instance, when a single account overuses the service. The latter, since the compliance with contracted service agreements should be kept under control by an experienced figure. This means, in other words, that as critical as monitoring is to keeping costs under control, it is a source of cost itself, since investments are required both to acquire or develop a software for monitoring and to recruit or train a person to be permanently assigned to the vendor and contract management process, with the peculiarities of cloud [25].

2.4.2. Pricing models and factors

As mentioned before, cloud services generally share some common characteristics, when talking about pricing models, such as usage-based pricing, meaning that customers incur costs depending on the actual usage of the services and elasticity, that in other terms means means that cloud customers can dynamically consume more or less resources according to their needs [27]. However, several pricing models are usually available for customers when purchasing services from cloud providers. [28]

An instance or resource may be bought according to:

- a *pay-as-you-go* or *pay-per-use* model, according to which there are fixed price values associated with each resource unit;
- a *dynamic* or *variable pricing* model, in which the price is set according to the supply and demand of market for the resource;
- a *plan of consumption* over an annual or multi-year time horizon, according to which the customer commits for an amount of cloud resources that are provided upfront, at a *discounted rate*, for a fixed monthly cost. [29]

The selection of the pricing model may have several significant implications, such as the service levels in the delivery, the manner and timing of billing and the relevance of having the most accurate cost estimates possible. [9]

According to Gartner, a typical behavior for organizations is to commit for longer time periods for their base demand and to exploit the pay-as-you-go model for spikes in demand that are recognized as temporary [9]. According to Hsu et al. (2014), there is a positive correlation between a company's IT Capability, summarized as the number of IT employees and annual IT department budget, and the likelihood of choosing pay-as-you-go as a pricing mechanism [30].

The final price of cloud computing may vary according to an enormous number of factors. Attributes determining the cloud provider pricing models may include the following:

- Term based commitments: commitment duration for a cloud service and price are inversely proportional. On the other hand, making a commitment implies for all intents and purposes giving up on-demand consumption of the cloud and going to pay the full fee at the end of the period regardless of actual resource utilization. Commitments may be negotiated within an enterprise agreement or purchased programmatically;
- The type of server needed, or "instance", in cloud lexicon, which differs in terms of number of CPU cores, memory, attached storage, I/O requirements and GPUs;
- The levels of service availability and performance target, that are other elements in trade-off with the overall price to pay and must be assessed according to what the company can accept to pay less. A possible lever regarding service availability are preemptible instances, for example, that can be purchased at a much lower price compared to the standard ones but depend on the provider's spare capacity and can be stopped by the provider within short notice in case of critical raises of the demand;
- The geographical location of the vendor's cloud data centers: usually, the higher the physical proximity, the better the performances and the lower the latency. The choice of the geographical region in which the server reside may depend for some organization on regulatory, compliance, disaster recovery or business continuity requirements;
- The number of locations in which copies of the stored data are replicated, as on the provider's side they imply the use of additional infrastructure for hosting them;
- The operating system and the associated licensing fees, depending on whether the licenses are provided by the cloud provider itself or the previously exiting license agreements are transferred into the cloud;
- The willingness on the customer's side to have a fully dedicated infrastructure, that may originate for instance by regulatory requirements for not sharing the infrastructure among multiple tenants;
- The level of support needed for running workloads in the cloud and the desired time of support response. [9] [31]

Finally, the pricing model in use depends on the service model through which the services are delivered to the customer. As already explored, with Infrastructure as a Service, the customer purchases resources as servers and storage space and deploys its own applications on the virtual machines, controlling and managing it. This means that the bills he receives are based on the amount or duration of the resources consumed for service delivery, going to replace the costs he would incur if he were to personally orchestrate the same elements. A similar discourse applies to PaaS,

although the operation of the service offered is different and consists of making available to the client a virtual infrastructure on which he is free to build and release his own applications, taking advantage of programming languages and tools made available by the platform. The customer is still billed according to the use of almost all of the same infrastructural elements, including servers, network and operating systems. In both cases, for the customer this means having to monitor a different set of metrics, with different unit prices, in order to keep consumption and spending under control. However, different is the case of SaaS, software application running on Cloud Infrastructure and previously created and replicated for different customers. This service model is generally offered as subscription-based, which implies that the customer has no visibility into the infrastructure underlying the application and does not have to worry about the billing of individual architectural components. Rather, SaaS generally implies using simpler cost metrics such as the number of subscriptions or users, in case the licenses are not uninominal. [16] [32]

Trying to compare service models in terms of cost, albeit at a high level, moving up the stack of cloud service models, i.e., going from IaaS, where the cloud provider manages computing resources as processing, storage and networks to SaaS, where the components whose management is entrusted to the cloud provider make up almost all of it, costs decrease. The SaaS cloud service model overall turns out to be the most affordable configuration, while IaaS is the most expensive. At the same time, the service model also impacts other variables to be taken into account, such as the level of IT expertise required of users, which follows the opposite path and is minimized with SaaS. [33]

2.4.3. Cloud cost allocation model

The choice of cost model is basically nothing new with the advent of the cloud compared to the traditional on-premises charging process. The allocation of Cloud costs can still be solely to IT or charged back to the individual teams responsible for consumption, or an intermediate showback mechanism can be put in place. This choice is even more important, however, given the increased level of spending delegation to business users and the need to hold them accountable to an on-demand consumption paradigm.

The benefits of implementing a chargeback mechanism on business units are many. First and foremost, visibility of resource utilization is provided to teams, allowing cost-saving opportunities to be identified and encouraging more informed overall utilization. Capacity planning and budgeting processes are also informed and facilitated. Finally, IT is strategically allowed to move away from its mere role as a cost center and conversely be recognized as a business enabler.

An effective chargeback model should respect some characteristics: it should be accurate, charging for actual resource usage, without disregarding any cost component or resource; auditable, meaning that IT should maintain records and repositories for accountability purposes and to be consulted in case of any disputes; flexible, in order to handle possible pricing variations, which as we have seen turn out to be quite common; finally, scalable in order to accept growing workloads. [34] [35]

A showback mechanism proves, even in practice, [36] to be a valuable and almost always necessary step toward grounding an actual chargeback. Just offering transparency on IT resource costs to teams, while not actually billing for them, works in encouraging virtuous and improving behaviors, as business unit leaders, responsible for their portion of the IT budget, have cost reduction as one of their key goals and spur their subordinates to greater accountability on consumption.

2.4.4. Governance model

Given the relevant issue of the ease of provisioning cloud resources by business users, the choice of an appropriate governance model to regulate cloud resource procurement becomes critical. Gartner [9] identifies two alternative main models to govern the Cloud procurement and enforce cloud policies:

- **"In the way" governance**: a central IT acts as an intermediary between cloud consumers and cloud environments, collecting requests and performing provisioning itself. Following this approach, consumers' visibility on native interfaces is limited, as is their spending autonomy. Policy enforcement is ensured through the rejection of non-compliant requests.
- **"On the side" governance**: cloud consumers are allowed direct access to the native cloud environments and their spending autonomy is maximized, while on the other hand the central IT only partially controls the expenditures by configurating the cloud interfaces with policies.

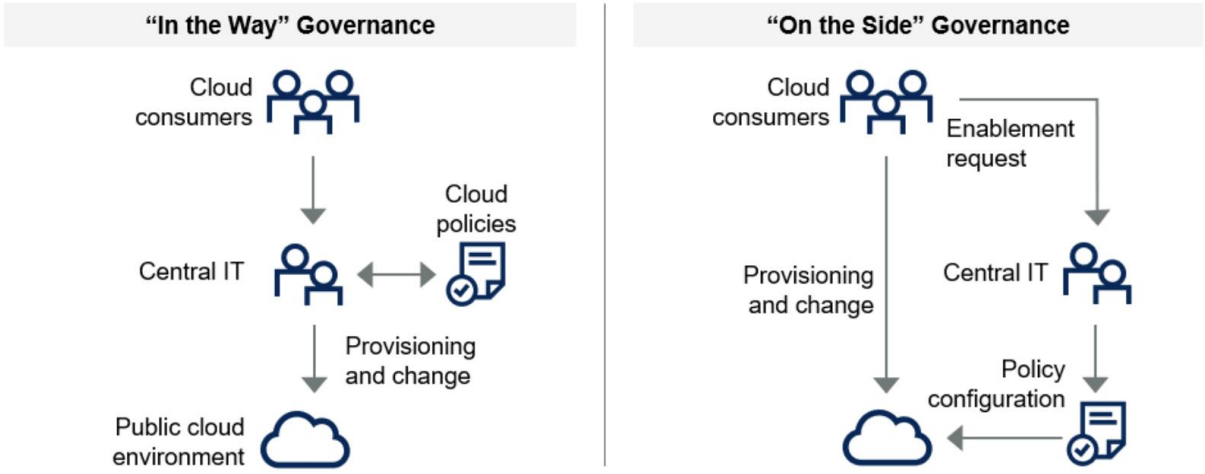


Figure 12. Alternative Cloud procurement governance models proposed by Gartner

2.4.5. Tool adoption

The support of an IT tool is undoubtedly indispensable in the implementation of cloud financial management processes. A tool built for this purpose must be in real time and able to read metrics from APIs in order to allow financial management processes to adapt at scale. [9]

Different types of tools may be adopted, including native management tools offered by Cloud service providers, third-party tools and in-house developed tools or extensions.

The starting point when choosing to adopt a tool for cloud financial management is undoubtedly to exploit the native functionalities provided by the cloud service provider itself, being the fastest and most straightforward way to equip the organization with a means to monitor costs. All major public cloud platforms offer a wide range of **native management tools**, including the ones for the management and control of the cloud spending, sometimes as an integral part of the tool's offer and thus without further payment, other times by charging customers for their use according to a consumption-based model.

Such tools offer the highest possible integration with the relative cloud platform, since no differently sourced tool could offer the same accuracy in collecting and analyzing metrics from the cloud service provider's platform. On the other hand, one of the main

disadvantages is that they cannot offer the same level of functionality outside the platform itself. This implies that, for a company adopting a multicloud sourcing strategy, a native cost management tool cannot be the optimal choice because it is not able to guarantee the same level of visibility on other platforms and thus a holistic integration of dashboards and a comparison of costs from each provider.

Another significant limitation to cloud providers' native tools is the substantial conflict of interest they experience in providing to the customers means to maximize their savings, which would potentially go to reduce the cloud provider's own revenue. [9]

So, although it is necessary to prioritize the adoption of these native cost management tools, once these capabilities are mastered, it is advisable according to Gartner to consider adding third-party or internally developed solutions, based on a functionality gap analysis and identify cost management requirements that remain unmet.

The reasons behind the sourcing of a **third-party cost management tool** therefore can be different, ranging from the will to address these functionality gaps or to disengage from the cloud provider to the need for a tool better suited to managing a multicloud environment. In this latter scenario, a thorough assessment of compatibility with the platforms of different active providers should be conducted to avoid duplication of functionality already available and ensure that there are no unsupported platforms or functionality.

For third-party cost management tools, moreover, it is easier to build a return on investment (ROI) [37] since they provide tangible financial benefits by substantially reducing the amount of the cloud invoice received [9].

The offerings in the market for third-party solutions are quite wide and varied, but it is possible to identify certain types of tools that include cost management features, such as:

- Tools explicitly aimed at end-to-end cost management, with capabilities ranging from the management of the budgeting process to the tracking and allocation of costs, to the creation of dashboards for visualization and optimization;
- Tools punctually focused on the optimization of the costs and the reducing of the amount that appears in the cloud invoice. Tracking and reporting functionalities are usually not encompassed in this kind of tools;
- Tools with a broader scope and addressed to cloud governance at a higher level, enabling the configuration and enforcing of cost and provisioning policies;

- Tools that deal with monitoring the availability and performance of the cloud services a company uses. In terms of cost, some of the tools pertaining to this category simply offer reporting capabilities, while others also go so far as to offer users spending optimization recommendations;
- Cloud Management Platforms (CMPs), providing a wide range of functionalities in the broad domain of cloud management, including governance, security and cost management aspects. Compared with other types of tools, the lesser focus on a specific aspect is likely to penalize in terms of the features offered in the sphere of cost management.

According to a research by the Cloud Transformation Observatory of Politecnico di Milano [38], the main functionalities of a CMP fall into four main areas:

- **Classification**, the categorization of applications and access by business users, including:
  - resource tagging capabilities, in order to organize resources hierarchically and facilitate invoice interpretation;
  - role based access control, allowing for the analysis of user categories and provide them with the right information and permissions depending on their role in the organization;

- **Monitoring** information on the different types of costs involved, encompassing:
  - reporting and cost visualization capabilities through dashboards and Business Intelligence;
  - forecasting cloud spending trends and monitoring any deviations from the estimated budget;
  - the ability to have cross-cloud visibility across multiple cloud providers and compare purchasing plans;

- **Alerts and notifications** functionalities, i.e., checking for anomalies and reporting corrective actions, within which fall in turn:
  - the detection of spending anomalies, diagnosis of causes, and alerts for users when certain thresholds are exceeded;
  - the provision of recommendations for rightsizing resources based on utilization pattern or shutting down idle resources;

- Actual **cost optimization** on top of the rationalization actions, which can be distinguished in:
  - manual optimization of resources based on recommendations received from the platform, or

- automatic resource optimization by shutting down unused or underutilized resources.

A final option that should be mentioned among the strategies for adopting a cloud financial management tool is to develop it internally within the organization, rather than sourcing it from the market. In fact, Gartner believes this market is still rather immature with respect to the needs expressed by organizations. However, it suggests not to develop in-house from scratch a whole cost management instrument, but rather extensions to the already available tools, in order to fill missing features or supplement existing ones, as needed. Recommendations provided in this regard are to leverage the building blocks approach typically employed by cloud providers and start with those in coding, to uniquely and downwardly define the scope boundaries of the functionality being developed, and to accompany the coding by thoroughly documenting it in order to make it understandable and usable to end users [9]. Developing a cloud financial management tool internally guarantees by its very nature a high level of customization and adherence to actual business needs, but on the other hand, it implies costs related to competences and maintenance, since it requires an IT team with specific skills and implies greater difficulties in keeping up with the market's technological evolution [38].

The following scheme aims at summarizing the advantages and disadvantages of the different types of tools that a company may choose to adopt. The trade-offs have to be assessed. Trade offs must also be evaluated in light of the sizing of the cloud services the organization uses and the strategic directions coming from top management.

	PROS	CONS
Provider's native functionalities 	• Most straightforward way to monitor cloud costs • Highest possible integration with the relative cloud platform • May come free-of-charge with respect to the Cloud platform	• Low interoperability with other platforms → not suitable for a multicloud environment • Cloud vendor's conflict of interest prevents from maximizing savings
Third party Cost Management Tool 	• Wide range of functionalities • Adequately supports a multicloud environment • ROI and business case easy to build, as it provides tangible benefits in terms of savings	• Can be expensive and requires a vendor scouting and selection process • The market is still immature with respect to business' needs
In-house developed tool 	• Possibility to punctually fill missing features or supplement existing ones, by leveraging building blocks • Hishest level of customization and adherence to the organization's needs	• It implies costs related to the technical competences and the maintenance of the software to keep up with the market

Figure 13. Synthesis of pros and cons of different tool types for Cloud Financial Management

2.4.6. The FinOps practice

A widely recognized practice for Cloud Financial Management is FinOps, hatched by the homonymous FinOps Foundation, non-profit organization with the mission of building a community where to empower members reciprocally through the sharing of standards and best practices within the Cloud financial management discipline.

As defined by the Technical Advisory Council of the foundation, *"FinOps is an evolving cloud financial management discipline and cultural practice that enables organizations to get maximum business value by helping engineering, finance, technology and business teams to collaborate on data-driven spending decisions."* [39]

FinOps is fundamentally a cultural practice: as stressed by the name itself - a krasis between the words Finance and DevOps - it is grounded in the communication, transparency and collaboration between business and technical teams. The desired optimization of cloud costs cannot occur without an awareness of and accountability

for the costs of cloud resource consumption by individual teams. A cross-functional team integration and the pooling of each department's core competences are fundamental starting points toward the objectives of gaining greater comprehension and control over the financials of Cloud and enabling more informed investment decisions.

Furthermore, according to the FinOps mindset, the opportunities of cost savings are not to be looked at, per se, with a narrow perspective, but rather in a wider frame of revenue generation or enablement of a greater release velocity of products and features.

Principles

Six fundamental principles guide the activities of a FinOps practitioner:

1) **Teams need to collaborate**, meaning that Finance, IT and technical teams have to be aligned in terms of speed, granularity (for instance considering the number of levels in the breakdown of costs), glossary, KPIs and work together almost in real time since the cloud operates on a per-resource, per-second basis. Moreover, common guidelines about governance and control of cloud usage have to be established;
2) **Everyone takes ownership for their cloud usage**, indicating that developer teams need to be encouraged to keep track of their cloud usage and assess it against their budget and they need to have team targets in order to be held accountable for their expenses. A showback policy, in order to allow visibility and awareness or a chargeback one, to actually allocate the costs to the teams, are effective enabling instruments with this purpose;
3) **A centralized team drives FinOps**, in charge of negotiating volume and custom discounts, expenditure commitments or reserved instances with the cloud provider and of properly allocating costs to teams and cost centers according to their actual resource consumption. While this central team is allegedly composed of executives figures, operations and engineers are suggested to stay focused on actual resource usage optimization;
4) **Reports should be accessible and timely**: the assurance of continuous reporting, processing cost data as soon as they are available, allows for the triggering of feedback loops that positively influence team behavior, offers insights into resource consumption allowing for proper sizing and increasing automation of the same;
5) **Decisions are driven by business value of cloud**: costs' trends and variance are constantly analyzed and assessed against internal team benchmarks in order to assimilate best practices and against external benchmarks to determine

how the company is performing as a whole and inform trade-off decisions among cost, quality and speed. Overall, the cloud has to be thought as a driver of innovation;

6) **Take advantage of the variable cost model of the cloud**, considering it as an opportunity rather than a risk. The scalability of the infrastructure is to be exploited to rightsize instances and services and pay for the optimal level of resources, while constantly keeping sight of similar services and resource offerings in order to spot lower pricings thus opportunity for savings. [40]

Lifecycle phases

Three phases can be individuated that iteratively compose the FinOps journey: Inform, Optimize and Operate. The object of placement on this model may be a business unit, a team, or an application, which is why instead it makes less sense to assign to one of the three phases phase an organization as a whole.

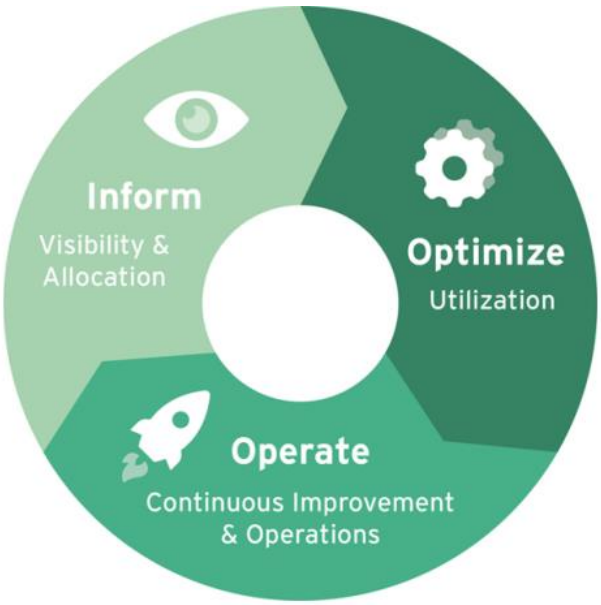


Figure 14. The three phases of the life cycle of a FinOps Journey

During the ***Inform*** phase, the organization starts understanding what it is paying for its cloud resource consumption and what are the drivers behind the expenditure. By giving each team in real-time visibility into its spend thus its impact on the overall bill from the cloud provider, shared accountability is created and more efficient consumption behaviors are driven. Teams understand what and why they are

spending and, for the first time, an individual can see the impact of their actions on costs.

The fundamental activities within the Inform phase are the following [40] (those considered most important for the purpose of the thesis are explored in depth):

- **Properly organizing the resources and defining a cost allocation strategy**, that allows to keep visibility into the cloud spending without the burden of conducting manual activities of attribution of line items of a cloud bill to the cost centers, which would obviously be inefficient due to the enormous amount of data that have to be processed. A typical cloud bill indeed includes, for every resource consumed during the period, be details about the cloud resource involved, where it was run, the quantity used, and the rate at which the resource was charged. It does not provide however any business logic, in other terms it does not answer questions such as who owns the resource, who should pay for it, or what business service the resource belongs to. The basic mechanisms that allow to map spending data to the business are:
    - The exploitation of native hierarchical classification usually offered by the cloud provider itself, under the name of accounts, project, folders, subscriptions, resource groups running the resources.
    - The implementation of a tagging strategy. Resource-level metadata as tags or labels may be applied within the cloud service provider, or on a third-party platform and allow to break down cost reports according to application, account or environment criteria, for instance.
- **Identifying untaggable resources and allocating shared costs**: there are cases where native hierarchical classification and tags or labels are not sufficient to allocate the expenditure on the relative cost centers, since some resources are not univocally attributable to a project or department but rather shared among many of them. A typical example of shared resource is the network connection. Possible strategies to minimize the untaggable resources are to implement tagging further up the stack or to duplicate the infrastructural elements underlying the resources and tag the smaller sets with the department using the resources. However, a costs-benefits analysis should be performed in order to individuate the shared resources for which the effort of allocation overcomes the actual benefits stemming from it, and develop strategies only for the most expensive ones. Otherwise, the tagging of shared resources is typically to perform manually. Where is not possible to individuate a proper driver or metric to assign them to different cost centers, one option may be to divide the costs equally among all responsible. [9]
- **Creating showback or chargebacks mechanisms**, depending on the will to actually allocate the incurred costs to the budget or Profit & Loss of the

individual team responsible for the expenditure or solely give these teams visibility into what they are spending, without actually charging them for the resources consumed.

- **Defining budgets and forecasts** of cloud usage. The prediction of future spending is usually conducted on the base of a combination of historical series and assessment of future plans. Expenditures predictions should be conducted on two levels: on a company-wide level and at a higher level of granularity, for each team, application, service, project or workload. Breaking down the information to this more detailed level is what truly enables a discussion about the actions to be taken in case the monitoring of ongoing expenditure shows significant deviations.
- **Analyzing trending and variance** of cost drivers, in order to monitor their progression over time and obtain valuable insights into the cloud spending.
- **Creating scorecards** with KPIs allowing the FinOps team to know constantly how projects are performing in terms od costs, speed and quality.

During the *Optimize* stage, improvements to the cloud are implemented and goals for the next stage are defined. It is necessary for processes to be able to set and track business decisions almost in real time. Cost-avoidance and cost-optimization are of paramount importance at this time.

Relevant activities pertaining to the *Optimize* phase are:

- **Identifying anomalies** of spend, which not only identifies spending thresholds, but also any peaks and drops in usage given the variable and scalable nature of the Cloud;
- **Identifying underutilized resources**, so to understand whether the company is paying for resources unnecessarily and identify potential room for optimization;
- **Evaluating the use of Reserved Instances and Committed Use Discount**: with a greater understanding of the Cloud and related spending, at this point it should be possible to more easily understand what resources are needed and consequently consider paying for them through instruments that provide advantageous discounts in exchange for taking on some additional risk.
- **Compare prices and workloads**: better workload management allows the organization to cut expenses. In addition, once the infrastructure requirements needed for the function are understood, different cloud providers can be compared in order to identify the best one.

The O*perate* phase, finally, is dedicated to executing the actions necessary to achieve the previously defined goals and the pursuit of continuous performance improvement. Once processes are automated, management can take a step back and try to understand whether spending is in line with company goals.

The key activities of the third phase of the life cycle are as follows:

- **Communicating spending data to stakeholders**: having daily or, at most, weekly data allows stakeholders to make better decisions. At this stage, the organization can also focus on how these information is communicated and try to automate the reporting process.
- **Implementing cultural change**: the diffusion of awareness of Cloud relevance and the key principles across all the people in the organization is fundamental to reach the business objectives.
- **Sizing instances and services** and **automating resource optimization**: it consists in the implementation of changes regarding the underutilized or idle resources previously identified.
- **Defining governance and policies for cloud utilization**, so to understand the existence of services that are using resources that could be better exploited. [40]

Maturity model

The discipline suggests a "Crawl, Walk, Run" approach to implementing FinOps, which is basically to start on a small scope of processes or capabilities and to scale up gradually when the value generated for the business warrants it. Taking rapid actions on a small scale and limited scope allows FinOps teams to iteratively evaluate the results of their actions and consequently plan further actions in a broader, faster or more granular manner.

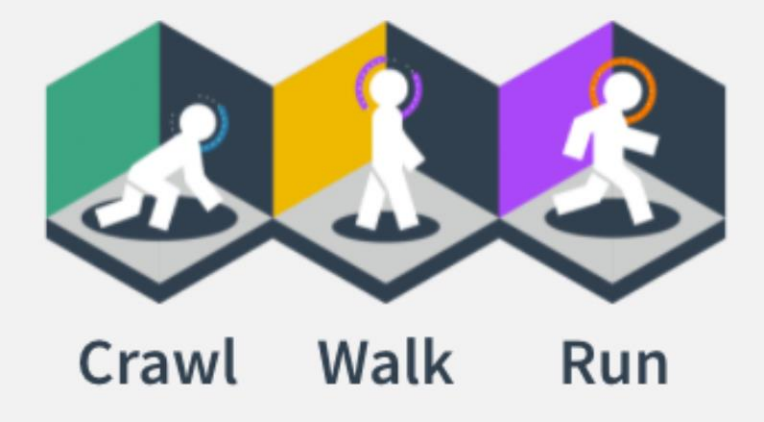


Figure 15. The three stages of the FinOps maturity model

The model can also be used for assessment at a given moment in time of one of the Capabilities (e.g. cost allocation, forecasting, managing commitment based discounts). In this sense, broadly speaking, the three stages can be summarized as follows:

- a **crawl** stage is characterized by poor use of tools and reporting, basic processes and policies built around capability, basic KPIs for measuring success, lack of alignment among major teams;
- a **walk** stage is recognizable by an alignment among teams on best practices regarding capability, KPIs of medium to high complexity, partial automation of processes, and identification but not addressing of the most difficult edge cases;
- a **run** stage is characterized by addressing the most difficult edge cases, KPIs with ambitious goals to achieve and automation as the favoured approach. [40] [41]

3 Methodology

This chapter aims to illustrate what was the methodological approach followed in gathering evidence that led to the subsequent development of the model for analysing the maturity of cloud financial management practices.

First, the general level of maturity on the Italian landscape is assessed, through the presentation and commentary of research data provided by the Cloud Transformation Observatory regarding the spread of Cloud cost control and optimization practices, as well as FinOps.

The use of this evidence has a twofold functionality of:

- illustrating the state of the art on the Italian landscape regarding cloud financial management and FinOps issues, so far treated only from a theoretical point of view within the literature review, and
- allowing to have first concrete feedback with respect to the levers in organizations' possession to cope with the challenges proposed by the different consumption paradigm and the consequent variability of cloud spending.

Next, four case studies obtained through interviews to practitioners are presented, in order to have a purposeful focus on how Cloud Financial Management is actually being grounded, through what levers, and with what priorities. The objective of these empirical observations is to carry further empirical evidence and legitimacy to the identified managerial levers that organizations can exploit to react to an increase in Cloud spending or behave proactively in order to contain it, and thus take full advantage of the potential offered by the cloud.

Particularly relevant is the first one, a FinOps implementation case study is presented, derived from an interview to a FinOps Foundation practitioner, enabling to shed light on how the FinOps practice concretely works and what benefits it can bring.

4 Survey

Through an extrapolation of research data provided by the Cloud Transformation Observatory of Politecnico di Milano, it was possible to have a glance on the current state of the art in Cloud cost containment and optimization, and adoption of FinOps practices, within the Italian landscape. Above all, the purpose was to have a concrete feedback with respect to the levers that are being concretely exploited within organizations to cope with the variability of cloud spending.

The sample to which questions were submitted and whose responses were analyzed amounted to 86 companies, pertaining to a variety of sectors with a slight prevalence of manufacturing and public administration and health care. As for size, in terms of number of employees, the companies surveyed ranged from very small (less than 10 employees) to very large (more than 5,000 employees), with an imbalance in the distribution toward the range of companies exceeding 1,000. Some of the questions, due to the very nature by which they were constructed, were answered by fewer companies than the entire sample.

A first question was directed at investigating how widespread the phenomenon of annual budget overruns for cloud spending was, a typical bellwether of a lack of control over the financial management.

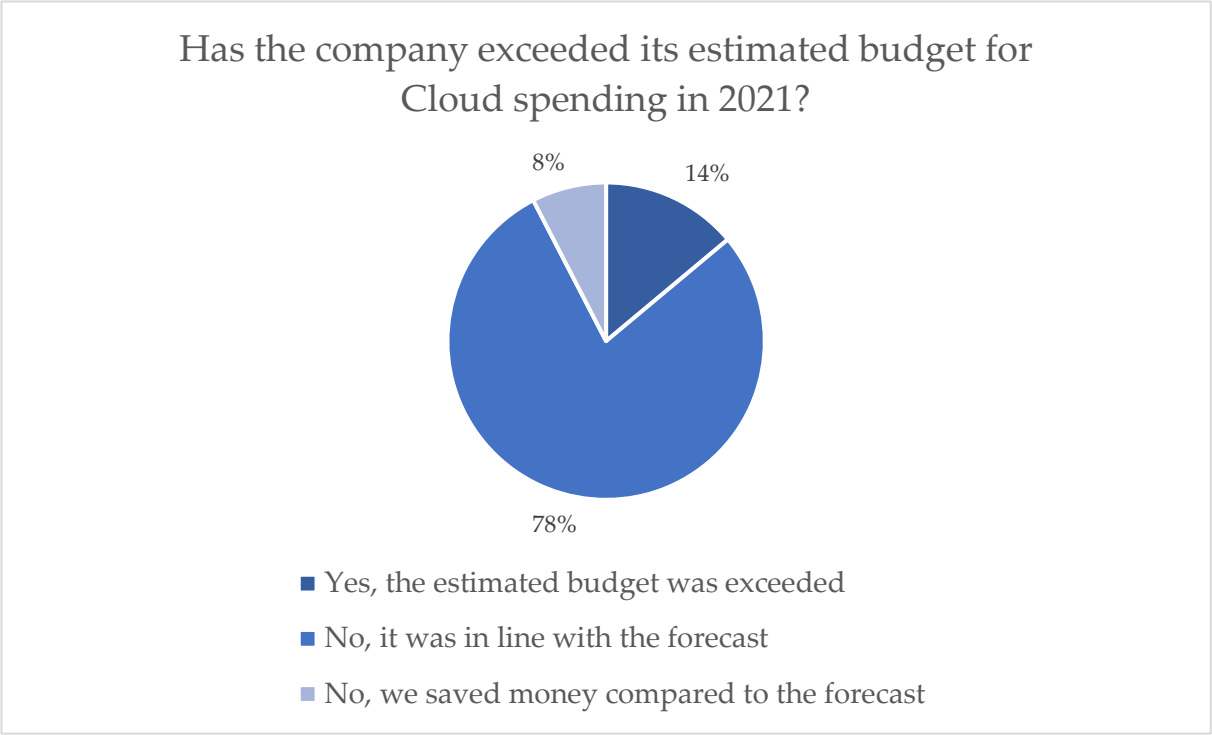


Exhibit 1. Cloud budget overrun

Among companies where the budget forecast was not met, the predominant reason identified behind the deviation was that demand for Cloud services was higher than expected (73%).

With this respect, the respondents were then asked what kind of actions are putting in place in order to respond to the new managerial and strategic challenges raised by the increasing cloud spending. The most popular answer was optimization of services based on actual resource consumption (43%). This was followed by continuous monitoring of resources in order to turn off those regularly not in use (39%), automatically turn off at certain times those for which consistent patterns of non-use are detected (28%) and set up automatic scale-up or scale-down mechanisms based on workloads (24%). It is worth noticing that all of these strategies are enabled by the use of a Cloud cost management tool, either specially purchased or developed in-house. Further on, a question designed to explore the use of different levers, including technology, will shed light on the topic. Another point of attention is that, overall, 37% of the sample still do not have systematic cloud cost containment strategies in place.

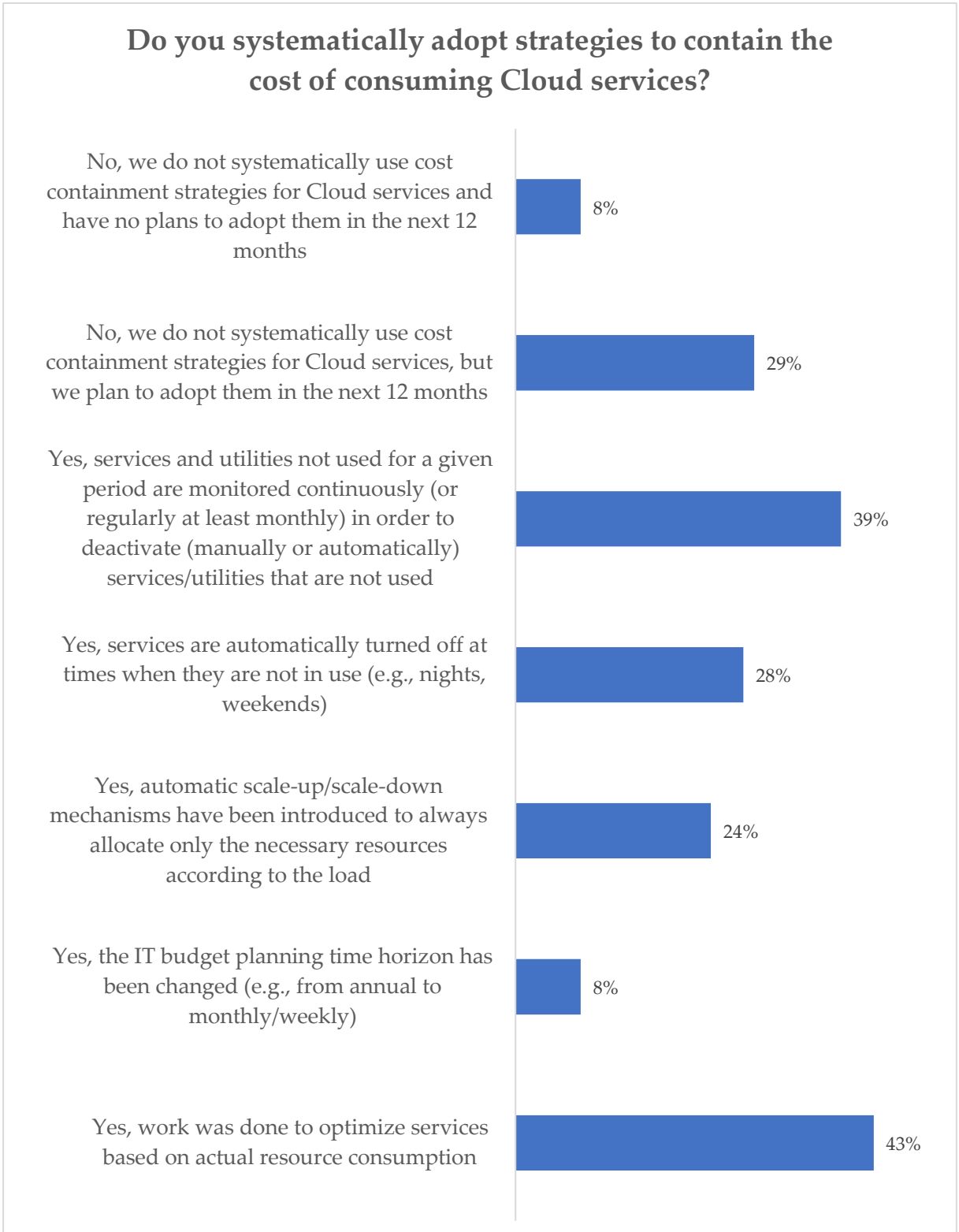


Exhibit 2. Adopted strategies for the containment of Cloud costs

In line with the key FinOps practice principles of collaboration among teams, breaking down silos between IT, Finance, Procurement, and technical teams, and spreading Cloud cost accountability, companies were asked about the extent of involvement of different types of individual stakeholders in the financial management of Cloud services. What was found is that the figures characterized by the most active and intense involvement (in terms of effort in hours spent in this area) are still those pertaining to IT (IT Manager and Chief Information Officer), while significantly more sporadic, if any, activity is reported for people in charge of Finance or Procurement. Those with the least involvement overall are the people in charge of business lines, while data regarding the CISO show little attention to security issues in cost management.

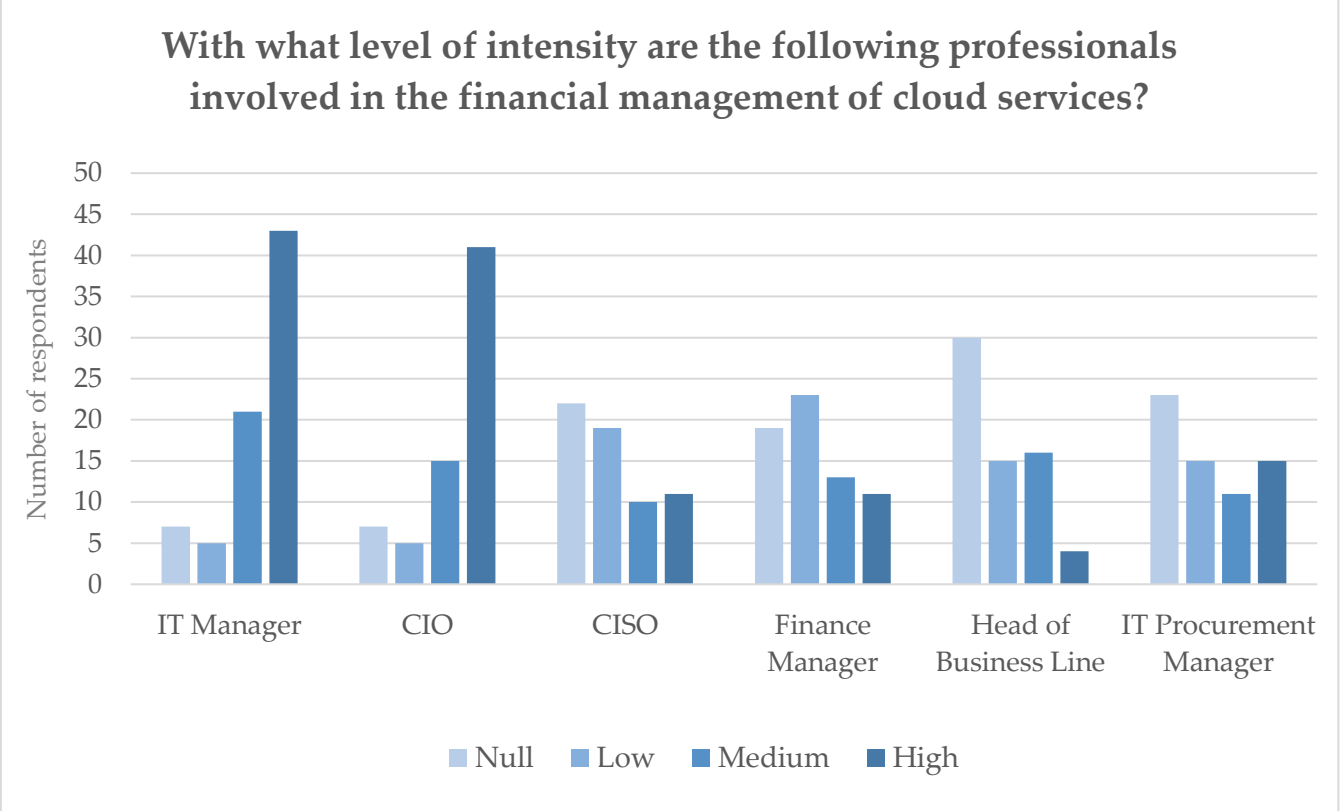


Exhibit 3. Levels of involvement of different stakeholders

Exhibit 4. Levers exploited for the Cloud Financial Management

This question was aimed at understanding what aspects are being leveraged to meet the challenges introduced by the paradigm shift introduced by cloud computing and the increased variability of spending. The sample of companies surveyed found that hard levers such as adopting an IT tool that facilitates cost monitoring and tracking (33%) or a structural review of cost management processes and policies (24%) are

preferred or prioritized over lighter solutions such as strengthening cost management and FinOps skills by training pre-existing resources or acquiring new ones from outside (11% and 7% respectively). Another very relevant finding is that a total of 56 percent of the companies surveyed noted that they had not implemented any kind of change management action in the area of financial management. This is quite significant of how on average the need for adaptation is little perceived and the mindset of organizations still too anchored to that of on-premises management.

		Cost allocation policy	
		Only to the IT	Chargeback on Business
Management of services	Centralized in IT	**55%**	**19%**
	Self-service in the units of business	**11%**	**15%**

Exhibit 5. Procurement Governance model and Cost Allocation model adopted

The still low sensitivity with respect to the need for a change in the procurement model and shared responsibility for cloud spending is confirmed by this evidence, aiming to draw a picture of the situation in terms of policies for governing costs, intersecting a theme of how services are provisioned (in the two alternatives, the "in the way" and "on the side" models proposed by Gartner can be recognized, respectively) and one of charging policies.

The most popular strategy (adopted by the 55% of respondents) is clearly still to centralize the governance of costs and simultaneously allocate all of them to IT. The risk of such a configuration is that IT is perceived as a mere cost centre and not as the enabler of a digital transformation strategy.

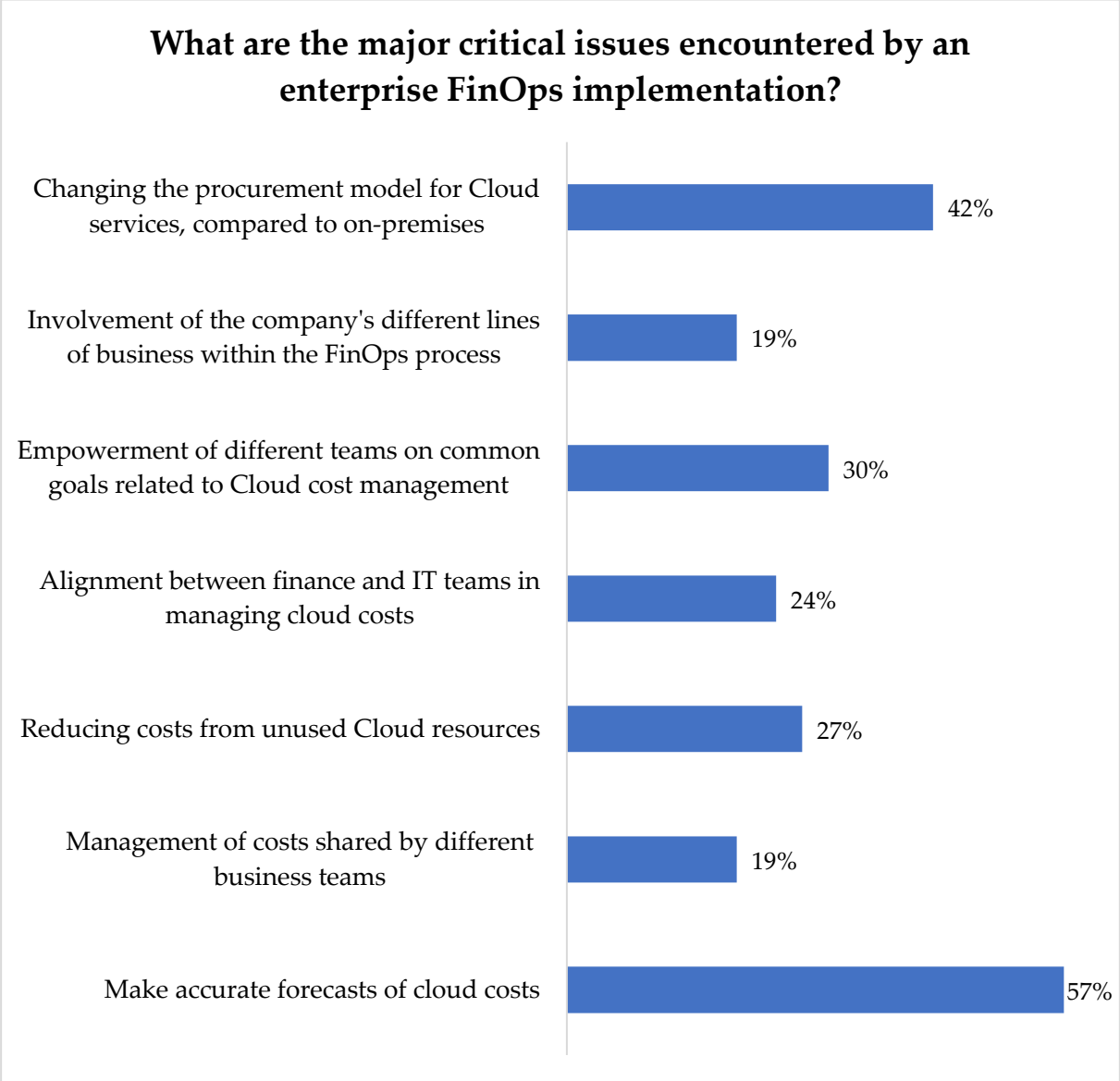


Exhibit 6. Major criticalities encountered in FinOps implementations

A final question was addressed only to companies that were already familiar with the implementation of FinOps, who were asked what were the main critical issues in this regard.

57% agreed that it is challenging to accurately estimate cloud spending, followed by 42% who confirmed the difficulties in changing the procurement model from on-premises.

5 Case studies

The four case studies collected are presented below. The companies have been anonymized with respect to privacy. The cases are generally divided into three sections: one describing the interviewee(s) and any peculiarities of the company, a context section where the focus is on delving into the level of complexity of the cloud transformation taking place and the cloud adoption strategy, and an in-depth section on the levers leveraged to respond to the critical issues of Cloud Financial Management.

5.1. FinOps implementation in an online retail leader

In order to gain a greater and more practical understanding on how FinOps works a FinOps Foundation practitioner was interviewed. This professional, who will remain anonymous so as not to violate sensitive information to him and his company, is currently employed as Head of Cloud Technology at an Italian retail company leader in the online sales of fashion, luxury and design goods.

Moreover, the interviewee has a significant experience in his recent past as a solution architect at Amazon Web Services (AWS), one of the most important Cloud Service Providers on the global market. His experience and expertise in both the supply and demand side of the Cloud Services market have been a precious contribution in identifying what are the enabling managerial levers to consider for cloud financial management and what is the proper way to prioritize them.

5.1.1. The context

The interviewee has reported that his entry in the company coincided with the formation of a "Cloud adoption & governance" team, on which his mandate has been focused, created with the idea of establishing a cloud strategy and aligning processes, programs and training to allow cloud transformation to be implemented correctly. This mandate naturally is declined on a variety of aspects, among which the financial one is certainly prominent. He was indeed responsible for the implementation of a Financial Operation plan, name for a series of initiatives that would have ground a real Cloud cost monitoring.

To frame the broader digital transformation context and the strategic dimension within which the cloud initiative was embedded, the respondent told that the Cloud journey had begun at least 3 years before he was recruited. The objective of the company in tech terms was to become “cloud only” so to completely decommission

the on-premises infrastructure. At the moment he entered, the company was beginning a specific technologic stack part (the front-end) implementation phase. The Cloud was seen as a platform enabling a software strategy, based on the scalability and flexibility principles to respond the enormous growth the e-commerce was having. The following development project was the data platform one. Together, these two projects started the public Cloud extensive usage the company makes nowadays. Now, as quoted by the professional, "the Cloud represents a tactical destination for all migrations".

When asked about the distribution of Cloud costs among different service models (SaaS, IaaS, PaaS), the interviewee stressed the difficulty of making a clear estimation, particularly given the fact that SaaS often goes beyond the visibility offered by technology, giving the example of Salesforce. "It is easier – he said – to obtain a cross-section of the expense within a single Cloud Service Provider". The context in which the company operates is indeed a multicloud one, with AWS being the largest provider and smaller providers for specific workloads and use cases. Overall, his estimation was a 60%-20%-20%, heavily unbalanced toward the IaaS component.

5.1.2. The FinOps Journey

Identification of the problem and start of the initiative

When asked about when the FinOps implementation in the retail company started, the respondent stated that the real watershed could be identified in the moment they noticed a misalignment between the invoice projections they had plotted for the just passed 12 months and the actual invoice received from the Cloud Service Providers (the aforementioned AWS) for the resources actually purchased throughout the year (through a classic pay-as-you-go logic). Particularly, as an expert in the FinOps practice, he underlined the real red flag that got his eye was not the data in absolute terms, but rather the growing trend of this gap between the forecasted expenditure and the final balance at the end of the financial year.

Answering, at this purpose, at the question who the most concerned stakeholders were, thus the ones who commissioned the initiative in the first place, the interviewee told that the uncontrollability of the costs was especially perceived by the Chief Information Officer (as the man in charge of a Tech department of approximately 1200 people) and of course by the Finance and Procurement functions, that as for company organization had always been quite integrated and communicating (for instance, when a monthly bill is received, a bilateral approval is needed on how and when to pay).

In the company being examined, the *Crawl* stage of the FinOps maturity model encompassed three main actions:

- the recruitment of a full-time person dedicated to the monitoring of Cloud expense;
- the change of the third-party software for obtaining cost information for the creation of expenditure dashboards;
- the launch of an initiative of cost reduction with the Chief Operating Officer and sponsored by the board.

The result, by the end of the first year, was a reduction of the cost baseline by 20%, that from that moment on has never raised back up.

Processes and policies

Since the tech department of the company, by the nature of the technology stack, is vast and articulated in terms of the software development teams that make it up, the ownership of the infrastructure cannot be centralized, meaning in other words that the single teams have the responsibility of putting tags on resources and deciding whether to switch a resource on or off, based on its consumption analysis. Otherwise, a bottleneck in the center would be created, which can only get worse with the scale-up and would never lead to the *run* stage of the maturity model. In other terms, picking up on the two alternative governance models proposed by Gartner, the company opted for the "on the side" model, with provisioning left to the end consumers of cloud resources and IT in charge only of providing guidelines and consumption policies.

Furthermore, no chargeback dynamics are currently in place, since on a Finance level, not having clearly defined cost centers, it would not be feasible to implement them. This does not mean, however, there is no accountability on the generated costs: teams have visibility and responsibility on their costs, they just do not receive dedicated invoices from Finance (in other terms, a showback policy is in place instead).

Tool

Three distinct phases regarding the tool support can be identified along the timeline of the cloud adoption in the company, according to the respondent.

At the very beginning of the Cloud journey, the company had carried out a trial period without any tool, using only the native functionalities of AWS. Not considering them sufficient, after a while a Cloud Management Platform was adopted, a kind of third-party tool with a broad range of functionalities, was adopted. This was the configuration at the time of the interviewee's entry and the launch of the cloud cost initiative.

This tool, however, was not focused enough, in the practitioner's opinion, on the financial aspect but rather attempting to cover a number of IT elements as Governance and Security as well, it was not perfectly functional under a finance perspective. "In embarking on a path of FinOps adoption" – he told – "a tool is not necessarily a number one priority per se, but rather asking oneself and answering the question *how can I make the costs visible and transparent?*". Not being appropriately equipped for this purpose, jointly with the evaluation of relevant drivers as the size of the organization and the distribution of teams, has led to the decision of sourcing a new third-party tool, expressly focused on cost tracking, allocation, reporting and optimization.

Other explicit requisites for the new cloud management platform were the ease of use on an experience level and the possibility to create and visualize custom dashboards related to their systems, on a functional level. A further requisite, given the cloud sourcing strategy of the company, was also the possibility to support a multicloud environment, in order to enable a complete and unified view of expenditures and compare the use of resources from different providers.

The solution has been identified through a software selection process and the choice fell on Apptio (back then the name was Cloudability).

The new tool has allowed to obtain every two weeks a simple line with the updates on the cloud cost initiative, to present in a meeting with the COO, in order to make speeches and take consistent decisions.

Stakeholders involved and organizational aspects

Another advantage brought by the new tool is to limit the effort of the full-time person recruited in monitoring costs. After helping with the selection and configuration of the platform, indeed, this resource has been free to spend her time on cost trend analysis and, most of all, on the dialogue with different development teams. This latter, according to the interviewee, has been a necessary job enlargement action, as the extent of delegation of spending to cloud consumers that the "on-the-side" governance model implies values the outreach phase and thus the role of a liaison figure to facilitate team alignment.

Talking about how the cloud cost initiative was conducted on several fronts, the directors of technologic areas have been the first stakeholders involved, according to a top-down approach, as the most influential figures in terms of sponsorship of the initiative and speed of awareness and application. Alongside, a bottom-up approach has been put in place by the respondent, through the creation of a "Cloud Champions"

program for the execution, useful for obtaining a more operational, day-by-day point of view from selected managers in charge of Cloud operations. This program has been "an executive collection" of optimizations that were needed in order to scale up as fast as possible, according to the respondent.

What has been said so far remains valid especially for the Tech department, for the rest of the firm instead the Finance was the main interlocutor, with whom hard work has been carried out to reestablish visibility on costs and offset them according to meaningful metrics for the business. Currently, costs are on brands (thus customers, with respect to a retail company) there is no longer a single budget line reporting the monthly spend and shared according to metrics defined by Procurement. This enables two relevant data extractions per month: a first draw in the closing forecast that they can provide to Finance and a second one for the distribution of the expenditure on the different brands.

Benefits experienced

As described by the FinOps Foundation, this practice is more than adopting a number of actions addressed to have a better monitoring and saving of costs. First of all, the Cloud cost initiative has allowed different stakeholders (software development teams, Finance, Procurement and the executive level) to communicate with greater awareness on how people operate outside one's own team and to establish a collaboration in which everyone is truly involved in the creation of value for the Business.

In this regard, the respondent was also asked about the potential usage of the TBM taxonomy for the standardization of communications between Business, IT, and Finance. The answer was punctual and precise: "TBM exhausts its value in the on-premises world, the FinOps model better fits the overall flexibility of a public cloud environment. The two models are complementary, TBM is designed to be much more encapsulated in traditional Procurement processes, in fact it fails to reconcile with the on-demand/pay-as-you-go model, risking as a consequence to leave hidden costs in an improperly defined IT Budget".

As mentioned above, the most visible impact of the initiative undertaken by the Cloud adoption & governance team has been a significant reduction of the annual cost baseline attributable to Cloud services. Furthermore, a more proper allocation and accounting of the expenditure has allowed the company to formulate reservation plans, exploiting a native feature of AWS, substantially being a commitment on spending that is worth discounts if respected, which is done annually and helps to keep the spending baseline constant.

5.2. Cloud cost management tool adoption in an electrical cable manufacturing company

The second company under analysis was an Italian company that manufactures power cables for the energy and telecommunications sectors and operates globally.

The interviewee, in particular, has the role of Global Infrastructure and Operations Manager. He is in charge of the IT infrastructure part, the stack underlying the application part, then data center, disaster recovery, networking, telecommunications and firewalls. He reports directly to the corporate CIO, while reporting to him are those responsible for network, user computing, app and sharepoint, and the systems part, which includes data center, cloud and LSA i.e., the first level help desk. The role is directed to the Headquarter, meaning that with his team he is in charge of creating corporate standards or worldwide programs for services/solutions (e.g., e-mail, sharepoint and other types of cross-cutting and common services) that may have common value-added in all the countries where the group operates through a subsidiary.

Compared with the previous case study, the technology-oriented sensibility rather than organizational issues meant that the focus was more on the implemented tool than on other levers such as those of organization, culture, skills, and processes, although some insights emerged on these fronts as well throughout the chat.

5.2.1. The context

The opening questions were again addressed to understand the technological and strategical context of the organization and the ongoing cloud transformation journey. The interviewee told that the cloud transformation path has begun in 2016 with the modernization of some applications and renegotiation of some contracts, followed by a substantial migration of the infrastructure stack, which to date is approximately 90 percent in the cloud. The distribution of the Cloud expenditure is around 60% on SaaS and 40% on IaaS. The sourcing approach is inevitably a multi-cloud one, as under the infrastructural point of view, providers are engaged such as Azure, AWS and IBM, with a spinoff named Kyndryl for a private cloud tied to the management of the ERP system. On the application level, the respondent has less insight, but said that systems such as ServiceNow, SalesForce, and Microsot365 are definitely in the Cloud. In terms

of strategy, the idea is “cloud first”, but the company moves by opportunity. So, they rarely start Lift & Shift type projects because they are complex, risky and not very cost-effective. For new projects they usually try to prefer cloud projects.

5.2.2. The introduction of a Cloud cost management tool

The company is organized with procurement located in the headquarters and finance that is instead located by country. This implies that while contracts with suppliers are negotiated centrally, cost management and billing take place locally.

In starting to provide cloud services to the different countries, they realized that they were losing visibility of individual local accounts, since the native tools offered by the different hyperscalers (i.e., cloud providers) did not offer the ability to set up a hierarchy of accounts and thus bill according to country. "The route account does not see the ones below, you would have to impersonate individual accounts to see the costs but you never get an overall view," the interviewee recounted. In addition, tagging was not taking place for the entirety of the resources deployed, and the fact that the tagging was not capillary, lacking some pieces, led to receiving invoices that were difficult to interpret.

The main stakeholder from which the need to change approach to cloud cost management came was the interviewee himself, since as the owner of the infrastructure portion of costs he had noticed that the application portion did not consider infrastructure costs at all and there was no means to make them aware of it.

What they were able to do instead through the use of the new tool was to create a template of a virtual data center to which security and authentication management policies were applied, such that, as far as AWS is concerned, an account is associated with each virtual center. In this way there is a route account and a series of underlying accounts through which countries can access and use the different services, with local billing by country. Notably, there is no real chargeback of costs, rather it is AWS that bills the local subsidiaries. For example, AWS Germany bills the German subsidiary directly.

Although therefore no internal chargeback of costs on business units occurs, the result is still that the business user bears the costs arising from its own consumption of cloud resources. The cloud procurement governance model, on the other hand, maintains a hybrid configuration between the two possibilities that as been explored so far. The provisioning of cloud resources, in fact, is always done by a central IT for programs and projects in charge of the headquarter (so those cross-country), for local specificities instead local ITs have the right to create and manage services according to the policies built and shared.

After looking at the market, the selected tool was Cloud Health by VMWare, since the company already had an agreement with VMWare, so it was a simple option, beside allowing them to have the cost split per account and per provider that they needed and granting the possibility to manage a multi-cloud environment. When asked whether this tool is now being used in conjunction with the native capabilities offered by cloud providers, the respondent said that currently the native tools are only used to get quick and specific views, while precisely leveraging the cost management tool to get an overview of the services offered by different providers.

The tool, as anticipated, thus responds to the functionality of widespread tagging and an alert system when certain spending thresholds are exceeded. By internalizing all local accounts, it allows to collect information and see what is being spent and what is and is not being used, so as to set up resource resizing. In addition, the platform also offers the possibility of comparing the same machine or server offered by different hyperscalers and then suggesting purchase plans, including considering longer time horizons and the possibility of commitment discounts.

On the issue of monitoring, the tool has enabled the construction of reports that are sent monthly to the various account managers (then BUs or countries), detailing costs but with the possibility of giving an overview at the head quarter level. "Automating the shutdown of resources is always complex"- the interviewee continued -"because having the services cover worldwide there is never a time when there is no one working on a machine. Rather, reporting is useful to point out any inefficiencies from a resource sizing perspective. So rather than shutdown we talk about reshaping resource capacity." So the company refuses to use automations because they are always very risky for scaling. As told by the respondent, they work well if you have a battery of front-end application servers, in which case you can turn them on and off depending on the load. They have a fairly flat machine load, unlike, for example, an ecommerce company that has seasonality. Nevertheless, the infrastructure and operations manager confirmed how, once you set up the tool with the report that gives the cost views you want to have, the human effort in managing the tool is almost zero.

Finally, responding to the question of how monitoring is done according to different cloud service models, the manager said that the tool in question mainly handles the IaaS part, while for licensing analysis (SaaS) working on a per-application basis with application contract models, they use asset management software such as ServiceNow.

5.2.3. Hints of cultural and organizational aspects

As for activating softer levers for managing cloud costs, a dedicated person was brought in to try to facilitate a different corporate culture. In the context of the manufacturing sector, the respondent pointed out, an investment that generates a recurring cost rather than a one-time outlay is always seen as "troublesome," generating ill-feelings. The transition from an on-premise model to a cloud model, with many costs shifting from CapEx to OpEx, needed to be accompanied by the creation of a culture of "you spend what you consume." Unlike the old contracts, every cloud project has to take into account not only the application activities but also the costs generated at the underlying infrastructure level. Thanks to the outreach efforts conducted, the culture is now quite pervasive and even the project manager in the application side is asking what the infrastructure costs are, which was not the case before.

The respondent was asked how the prioritization of levers on which to act to adopt a cloud cost management paradigm had taken place. His response was that the technology lever was absolutely prioritized over others and was indeed enabling with respect to organizational adaptations. By making clear the costs generated by the consumption of cloud resources and managerial inefficiencies, the tool made it possible to target adjustments to the organizational part. Indeed, the interviewee was keen to point out how applying the organizational and communication model typical of on premise to the cloud had been one of the mistakes that had most diverted the company from optimal management of cloud spending.

As for the major critical issues encountered in this adjustment path, the interviewee insisted on the complex relationships with the vendors they interface with. The difficulties lay mainly in asking for vendor support to structure the accounting part, since they have no interest in doing so, and in negotiating contracts with hyperscalers in order to have the ability to bill locally, given the need to have local accountability and one at the head quarter level.

The benefits found were mainly in terms of cost savings (at least a 20% of spending before the tool was used), mainly due to recommendations regarding purchasing plans, and in terms of reducing the percentage of unmanaged (assets in the cloud not associated with a particular project or account).

5.3. The case of an industrial group in the energy sector

The third case study to support the arguments of the thesis is that of an Italian industrial group operating in the engineering, technology and energy sectors, with

specific expertise in hydrocarbon plants and a leader in the development of technologies for the energy transition. The people with whom the dialogue took place belonged to the ICT Budget & Reporting team and the IT technical and infrastructure team.

At the time of the interview, the company was in high turmoil on the cloud, as they were in the process of evaluating whether to change their contract with Microsoft - the host, with Azure, of much of the company's IT infrastructure residing in the cloud - following the proposal of a consumption commitment-based agreement. In other terms, Microsoft was proposing to the company under consideration a contractual renewal with different billing methods, since, compared to the previous scenario, the contract would have included a timebound commitment to consume, with monthly billing based on consumption but without any kind of upfront payment. This type of contract is in principle potentially much cheaper, provided, however, that the company is able to make a fairly accurate cloud spending forecast and then commit to a conscious and sustainable amount. Otherwise, the company would in fact have risked finding itself in a more economically costly situation than before.

For this reason, the company was in the process of reviewing its cloud financial management policies, its organization, and its technology equipment in order to equip itself with the right arrangements firstly to understand whether the new contract proposal was worthwhile, and secondly, regardless of the potential change in the agreements with the cloud provider, to better manage its cloud spending.

5.3.1. Context

The group's total cloud spending is around 1.4 million euros annually. The IT infrastructure in place has considerable complexity and, as in the case of many businesses with a long corporate history, is necessarily "hybrid." At a high level it presents itself as composed of:

- two owned datacenters with connectivity and redundancy (they are mirrored, so that in case of failure of one, the other can act as a back-up) capable of guaranteeing Business Continuity to all services that do not possess characteristics consistent with the specificities of the Cloud;
- multiple remote locations geographically distributed in different continents, which benefit from the services provided centrally and hosted in the corporate datacenters and on the Cloud;
- Azure, as the main Cloud environment, delivering services in IaaS, Paas and SaaS mode. The IaaS component is also used as a natural extension of the Datacenters and, as such, is interconnected directly to the primary datacenter;

- other cloud environments that deliver "vertical" services related to specific areas of expertise (such as SAP for Hana and Oracle for Exadata).

As recounted by the person leading the infrastructure stack, almost everything that was moveable to the cloud has been migrated; 90% of what they have on-premise is not cost-effective to migrate as a result of cost-benefit analyses and assessments regarding lifecycle. "The cloud gives dynamism but puts in front the fact that after two years some products need renewal that traditionally they wouldn't have," said the respondent, specifically.

Overall, the infrastructure/IT efforts are moving in the direction of creating a communication environment that allows for the increasingly easy amalgamation of services distributed and delivered by different and heterogeneous platforms, so as to abstract the complexities associated with the physical infrastructure and with the idea of getting to improve efficiency during the implementation of new services through the presence of logical "semi-finished products" that can be reused at each new opportunity. The strategic approach the company is taking is definable as "Cloud-first," but not "Cloud-only."

5.3.2. Actions of Cloud Financial Management

The biggest problem that the possibility of contractual change highlighted was the difficulty in accurately forecasting cloud spending and analyzing deviations between budget and actual.

For monitoring Azure consumption spend, the company is partnering with SoftwareOne, a leading global provider of end-to-end software and cloud technology solutions, which provides PyraCloud as a cloud cost management tool. However, the referrers stated that they were aware that they had never used this tool efficiently and to its full potential, and indeed that they were even unaware of some of its features.

Regarding resource tagging, in particular, they realized how this is handled partially on the provider tool and partially through Azure's native capabilities. This turned out to be an inefficient approach for two reasons: on the one hand, the dashboards of the two tools do not always "talk" to each other and manage to integrate, and on the other hand, this does not allow the tool to have a comprehensive analysis of resource consumption and thus make proper spending recommendations.

While up to three years ago IT costs were labelled as “general administration” costs, the ICT Budget & Reporting department has developed an IT cost management system

where they have created job orders with a series of phases and sub-phases. Each subphase refers to an application or pool of applications that is pertaining to the same area (e.g., procurement, construction, commercial). This system allows them to carry out chargeback to functions: they perform chargeback on all IT costs, including the infrastructural ones, to the cost centers or company to which they belong, by using the number of users created on the applications as a driver, through allocative cycles on SAP. They try to put in all the operational costs of licensing and application maintenance and try to allocate the infrastructure costs as well. It is a fairly automated model, according to the referents' words, with the flaw, however, that management control at the corporate level is not aligned with it. Moreover, the inaccuracies and misalignments highlighted in the way resources are tagged suggest that the allocation of costs is not so precise and correct.

Regarding the cloud resource provisioning model, shifting activation to the business functions is something they are categorically ruling out at this time, at the instruction of the CIO who considers it too risky and unpredictable, leaving it in the traditional way in the hands of IT.

In general, to handle Cloud Financial Management issues characterizing the company's complex scenario, a working group with heterogeneous skills (composed precisely of people from the ICT Budget & Reporting department and those from the IT Infrastructure department) has recently been put together, with the aim of pursuing the following directions:

- Conducting cultural awareness initiatives to disengage from the still pervasive mindset of on-premise infrastructure management, empowering stakeholders (identifiable in application contact persons rather than various systems) and transfixing the awareness that what is brought to Azure, even if off, has a cost;
- Developing a process that allows, at the time of kickoff of new capitalizable initiatives, to intercept potential cloud costs;
- Making better and more comprehensive use of the tool, by:
    - Complete the tagging of resources on PyraCloud, such that, with respect to the cloud providers' native capabilities, it is possible to have complementary views, which focus precisely on individual providers on the one hand and allow them to be compared and have purchases recommendations on the other;
    - Setting up dashboards and reporting so as to obtain statistics on when certain environments are not in use and give evidence of the costs that are saved by either turning off resources or not buying them at all;
    - Limiting potentially unused resources, also taking advantage of the automatisms proposed by the tool.

5.4. The case of a large-scale retail group

The fourth and last case study was about a French supermarket and hypermarket franchise. It is a group operating in 30 countries globally, the fourth largest retail group in the world in terms of revenue and sales, and the second largest in Europe.

The contact person interviewed is the head of Cloud of the Italian division of the group, heading a team of 4 people between internal and external people (resources drawn from Partners). He reports to the head of Architectures, Integrations, Cloud and Data, who in turn reports to the CIO. Their structure represents what is referred to in the literature as a Cloud Center of Excellence: IT is not structured into a series of teams that manage an IT aspect as much for the Cloud as outside of it, rather this structure manages every aspect regarding the Cloud 360 degrees. They work with the data team plus they manage the foundation part, network infrastructure but not only shared. Within their sphere of expertise also falls a discourse of cost management, analysis, optimization and budget reallocation among different business functions.

5.4.1. Context

There are two main active Cloud Service Providers: Google Cloud Platform for the vast majority, by virtue of a partnership between Google and the group at the corporate level, and Microsoft Azure. They cannot use Amazon Web Services for a group policy argument, Amazon being a competitor in the retail world. They use all three major service levels, but in terms of spending, IaaS is the predominant part as an expense. The contract with GCP is managed by the Head Quarter in France, including at the level of any discounts, with billing accounts by country. Subscription at the Italian level then remains on terms contracted at the HQ level in France.

In the overall infrastructure, Cloud and Saas occupy about 50 percent of the application fleet, the rest is still on their data centers. The Cloud and Saas part is either managed by them on their Cloud Service Providers, or in SaaS, on other cloud providers managed by other providers.

In terms of the strategic direction of development for new applications, we can talk about Cloud First. A Cloud Only approach, for a discourse of how the business works, would not always be possible, because there are sever or applications that need to run on the outlets, and for which it is unthinkable to use the cloud. Having dependence on

the network 100%, thinking that it is available 24/7, is unthinkable and risky, at least for the time being.

5.4.2. Actions of Cloud Financial Management

The IT budget is managed by someone inside the IT world, not Finance. The invoice is paid by IT, the shared infrastructure that is pooled is expensed by them, through a mechanism that could be called a "reverse chargeback," meaning that a budget is assumed (within which functions try their best to stay), which is sent in the form of budget lines from the various business functions to the business platforms, i.e., the IT-side references of the various business functions of business such as HR, E-commerce and Supply, for example. Individual initiatives that come into existence with the cloud as a target, must include a budget at the OpEx level that is transferred to the cloud team's budget and is used to pay the bills.

Resource provisioning therefore is centralized, must be authorized by the cloud team and is enabled by budget transfer from the business functions.

The key moment that made the respondent realize the need for more careful cloud cost management was within 2021, when there was a strong push for cloud adoption, either through migrations of existing applications or through the emergence of new applications directly in the cloud, which caused consumption overall to soar. The need for an awareness on cloud financial management therefore came from the cloud team and was due in particular to the fact that the budget, due to the previously described nature with which it was constructed, was inelastic within the financial year and the consumption trend was significantly in the positive towards the middle of the year, with a projection towards the end of the year painting a major budget overrun.

It was therefore deemed appropriate to provide each business platform with a dashboard (albeit at a not too granular level) to show the costs of their respective functions' cloud initiatives. Through this dashboards, liaisons figures can see cost trends and get a year-end projection and are incentivized to be their own to identify problems or anomalies within the applications and costs generated and to "go knock on the Cloud team's door" to see if there is room for improvement or optimization.

It was then decided to implement a cost-reduction plan, which first involved mainly non-production environments through automatic machine shutdowns, which brought about a 50-60% cost reduction by leaving machines on during working days and hours only. Identification of potential shutdowns was done in the form of interviews and

then shared. In one case, there was a shared infrastructure with a microservice layer. There a time slot was decided in agreement with the various teams that were non developing. In other cases, when there were teams with specific infrastructure, the Cloud team talked with the application owner and the people developing to figure out what was the best time, considering that it was always possible for them to turn the environments back on in case of a problem in production that requires troubleshooting in the test/UAT environment.

Shutdown, as opposed to tagging, is done automatically and is managed by a tool, an open-source product with customizations that they developed in-house. Resource tagging was not done on that tool but was a pre-condition granted through the native capabilities of CSPs. It was a matter of configuring this tool, at the permissioning level, so that it could work with the predictably tagged resources that the Cloud team was going to census as they went along. The tool only helps with the GCP part, it would not natively support Azure features, customization would have to be done, but that was not cost-effective from a cost-benefit assessment, since they really have very little on Azure.

The tool is currently used only by their team of four people, who are able to work with it having customized it themselves.

Regarding the activation of other levers of Cloud Financial Management, the interviewee's responses indicated little or no intervention.

FinOps methodology is applied in a very limited way, some aspects are inherited from CSP platforms, such as the ability to offer real-time reporting through billing visibility on a daily basis and cost projections. Teams are not yet accustomed to working collaboratively; rather, they maintain some independence, except for sporadic contacts. As for cost optimization, what little is done is mainly performed manually.

The respondent's structure was created by the need to have a vertical team on cloud technology, and it expanded in terms of resources when the critical cost issues were found, but the new people added were not sought with specific skills in financial management or vendor & contract management.

6 Findings

Embarking on a cloud transformation journey, whether it is a migration of existing infrastructure stack and application fleet or making it possible to deliver a range of IT services from scratch, involves a number of innovations to typical ICT Financial Management processes that are not always known within the company how to address. This also happens because the critical issues in question cross-cuttingly impact a number of departments previously accustomed to working rather independently of each other. So it happens, for example, that the choice of cloud resource provisioning model and purchasing policies, as defined by Procurement, have impacts on the IT and Finance side, in terms of visibility into variable and multifaceted spending, or that the complexity of Cloud Service Providers' offerings, in terms of the breadth of services offered, pricing models and underlying architectures, requires the attention of different departments to understand all the managerial implications and make decisions in an informed way.

Despite recognizing how the levers for properly addressing the challenges presented by Cloud Financial Management are interdependent and intertwined by their very nature, this chapter is aimed at synthesizing the knowledge gathered through academic and empirical research and breaking down the basic elements that an organization must consider in order to contain and optimize cloud spending.

6.1. Actionable leverages for Cloud Financial Management

From the findings of the literature review, research data from Cloud Transformation Observatories, and the case studies gathered and analysed, the main levers held by an organization that can be invested in from a Cloud Financial Management perspective can be summarized as:

- Resources and skills;
- Culture and organization;
- Processes and policies;
- Tools.

6.1.1. Resources and skills

The human resources that are useful for holistic and comprehensive management of the financial aspects of the cloud pertain to various fields of expertise.

Appropriate **vendor and contract management** skills must be leveraged first to negotiate with providers knowledgeably, given the multiple types of pricing offered and the constantly updating landscape of services, and second for monitoring and verifying adherence of actual cloud provider performance to contracted Service Level Agreements. In fact, as shown by both the theory summarized and the experience of the practitioners interviewed, cloud service providers cannot be relied upon to optimize costs from resource consumption, since although on the surface some of the platforms' native capabilities go in this direction, they have an obvious conflict of interest in this regard.

Another category of core competencies that a business consuming cloud services must develop is **technology**. Adequate technical resources are needed first and foremost for the selection and sizing of services and architectures underlying the application layer, given the breadth of alternative model offerings and the constant updating of service offerings, and since these kinds of choices can significantly impact spending. Second, as evidenced by the case studies, such skills are required in the set-up and configuration of third-party tools, although once the run-in phase is over the effort required is substantially reduced.

A third type of skills, more "soft" but equally relevant given what is prescribed by the FinOps framework, are **communication and interpersonal skills** to promote the spread of a culture that breaks free from the traditional culture of managing the costs of an on-premises infrastructure. In practice, it has been noted how a super partes figure, acting as a glue between different departments, introducing a common glossary and fostering collaborative practices and constant alignment, can be a great facilitator of progressive improvements in Cloud cost management.

These skills can be developed internally, through the organization of dedicated training courses or alternatively sourced from outside the company’s perimeter, through tailored scouting and recruitment processes.

With reference to the latter strategy, it is particularly indicated, especially with regard to vendor & contract management skills and the technological skills of using cloud cost management tools, to look for people with supply-side experience and who know as many providers as possible. In particular, knowledge of the services offered, pricing models and licensing policies of the major market players can facilitate managing a

multicloud environment, comparing different offerings and reducing the risk of lock-in.

6.1.2. Culture and organization

As emphasized by the key principles of the FinOps discipline and repeatedly remarked upon by the managers who were interviewed, the shift from managing an on-premise infrastructure to managing the cloud, with all its implications in terms of financial management, is also and above all an issue of cultural paradigm shift.

The key concept of financial accountability, of "everyone should be responsible for their own use of resources and pay according to their own consumption", is not always easy to propagate in the enterprise, especially in teams where, even for generic IT cost, before the advent of the cloud, by corporate policy no cost reversal took place.

Several of the major critical issues introduced by the Cloud in ICT Financial Management cross-cuttingly impact departments traditionally accustomed to releasing with relative independence, whether these are due to the new consumption paradigm itself (such as the greater freedom of business users to spend, who do not need purchasing approvals from Procurement), or introduced by supply-side inefficiencies (such as the constant updating of service offerings and pricing policies or the lack of standardization between different cloud vendor platforms).

This requires **breaking down the silos of the IT, Finance and Procurement departments** and **bringing the different teams into real-time collaboration** that allows them to understand how to realize cost savings, set up proper processes as much for the day-to-day management of workloads and spending as for the evaluation of new project opportunities in the cloud, for example, and ultimately create value for the business.

The cultural leverage can be harnessed by companies in different ways. One possible action in this sense can be team **awareness propaganda through training courses on the pervasiveness of the cloud in the company**, illustrating to teams how their actions in turn impact departments outside their own. A further step regarding this lever is the **creation of a multidisciplinary team** that moves out of the mere IT perimeter and embraces the Finance and Procurement components. The achievement of the highest level of maturity is achieved through the inclusion within the crucial decision-making hubs also of the key line of business or product referents and the enterprise architecture components, for a solution design that is conversant with the business.

Finally, the **addition of central figures with interpersonal skills with the role of facilitators of collaboration and communication** between different departments may be useful.

6.1.3. Processes and policies

In terms of processes and procedures, the first that need to be **revised** consistently with a new consumption paradigm are the three classic processes of IT Financial Management: **Accounting, Budgeting and Charging**. Given the innovations brought by the Cloud, new workflows are needed, taking into account a range of inputs that they traditionally did not contemplate.

The greater responsibility delegated to end users of IT services complicates the budgeting process. Expense planning requires renewed attention by individual teams to resource demand, then to workload observation and continuous, real-time monitoring of consumption. Above all, it becomes an essential feature of a budget to have elasticity, the ability to change lines throughout the financial year with relative ease and speed, as needed. In addition, spending forecasts become even more critical with provider agreements for discounts on spending commitments over multi-year time horizons, a typical pricing model of large hyperscalers. Forecast accuracy, with these kinds of contracts, becomes the discriminator between potential savings and the risk of spending even more than necessary if the target to which the organization has contractually committed is not met.

The accounting process, which is responsible for tracking actual costs against budget and tracing expense items back to cost centers, so as to in turn enable charging, becomes even more essential in wanting to ensure widespread cost accountability. It suffers from the extreme granularity of invoices from cloud providers, which is why an update of the existing cost model and classification criteria is required. Traditional cost breakdown models such as the TBM taxonomy fail to understand the flexibility of the typical on-demand/pay-as-you-go model, instead remaining more anchored in the on-premises paradigm and risking leaving hidden costs, the attribution of which becomes complicated. In addition, the Cloud emphasizes the already existing problem of allocating costs attributable to shared resources among multiple cost centers. What can come to the aid of the accounting process is extensive resource tagging, which can be implemented through the native capabilities of Cloud platforms or even better, particularly in multi-cloud contexts, through third-party tools explicitly dedicated to containment and optimization of Cloud costs. Tagging resources allows them to be classified hierarchically with respect to relevant dimensions of analysis for the organization, such as projects, countries, customers, so as to give order to the cost items and allow them to be more straightforwardly attributed.

The charging process, as previously mentioned, is closely linked to the accounting process and the identification of the correct items attributable to cost centers. The main choice regarding this process concerns the **allocation of Cloud costs**, which can be solely to IT or charged back to the individual teams responsible for consumption. In other words, as ITIL puts it, it is a matter of deciding whether IT should be considered a cost center or a profit center. The concept therefore is not new compared to traditional ICT Financial Management, but its importance is renewed, given the greater delegation of spending to business users compared to procurement and the fact that without proper "self-control" spending is likely to get out of hand easily. The ability to chargeback is therefore a powerful mechanism that can hold a team accountable through the direct impact on its Profit&Loss. A middle ground, on the other hand, is showback, which consists of giving teams visibility of Cloud spending in relation to their consumption, without actually billing them. The reasons behind a showback policy could be either the will to create awareness on the expenses through the disclosure and affect user behavior in order to contain the costs or to use it as an intermediate step, preparing for a future scenario in which actual chargeback will be put in place.

On a parallel track to the cost allocation policy travels that on the **governance model of cloud procurement**, whereby the choice can fall on two alternative options, namely centralized in IT or self-service in business units. The former, otherwise called "in-the-way" governance, involves a central IT taking care of provisioning at the request of business users, acting as an interface between them and the cloud environments and personally enforcing defined policies. The second, also called "on-the-side" governance, sees IT configuring policies on Cloud interfaces and then letting business users free to access the environments and request the services needed.

The optimal configuration, which fully embodies the best practices of Cloud Financial Management and the key principles of the FinOps discipline and marks the ultimate enfranchisement from the on-premises cost management model, is provided by the consistent combination of a cost allocation model with chargeback and self-service governance of business units.

6.1.4. Tools

The fourth fundamental lever for a comprehensive and appropriate management of Cloud costs and financial processes is the technological one. As stressed by both academical research an technical guides, cloud cost monitoring, because of a number

of elements that make it substantially different from the traditional on-premise IT financial management, requires for purpose-built software.

When discussing tools for Cloud Financial management, there are three alternatives available to a company: leveraging native features of cloud platforms offered directly by vendors, purchasing a third-party tool, or developing tools or extensions in-house.

Each alternative has its own advantages and disadvantages in terms of time required for actual implementation and deployment, cost, functionality offered, and coverage of business needs. it is up to the CIO generally to assess the trade-offs between these dimensions and understand which the most correct choice is to make visible and reduce costs due to cloud resource consumption. There is no one alternative that is uniquely better than the others; assessments of technology leverage should be made based on the size of the business, the number of users, the breadth of the infrastructure stack and application fleet, and the IT department's evolutionary strategy.

What emerges from both the survey and the case studies, however, is that a third-party tool is often the most popular solution as part of a journey to rationalize cloud costs and implement FinOps-type practices.

The reasons for such a choice are to be found first and foremost in the structural advantage they offer by supporting a multi-cloud environment. The ability to keep track in a single place of all the services a company purchases and to compare the unit costs or performance of different providers through integrated dashboards becomes a competitive advantage factor in an era when for a very large number of companies, especially large ones, turning to a multiplicity of providers is now the norm.

Second, the reason why more and more companies are scouting and purchasing third-party cloud cost management solutions is the breadth of functionality they offer, through which they directly address issues typical of Cloud Financial Management and the paradigm shift from on-premise.

Through tagging capabilities, which allow resources to be classified hierarchically with respect to projects, accounts, and countries in which the company operates, third-party tools relieve the Finance department of the typical issue of reading invoices that are difficult to interpret, reducing the granularity of information and reorganizing it. This consequently facilitates the accounting process and enables chargebacks (where company policies provide for them), i.e., the distribution of costs due to resource consumption, to the cost centers responsible for the expense.

Through settable and customizable dashboards and reporting, these tools enable the monitoring of cost trends, any deviations from previous spending forecasts, and inform and formulate the budget for the following year.

Other important features include the ability to set up mechanisms for detecting anomalies in spending and for alarms when certain thresholds are exceeded; the provision of spending recommendations, including by comparing the cost of the same resource across different providers and considering commitment discount plans over multi-year horizons; suggestions for efficiency through shutting down long unused resources and shutting down at certain times of the day those for which consumption patterns with peaks and troughs are evident; and the ability to automate the implementation of such optimizations. The latter feature, in particular, as learned from the case studies, is very useful for companies with extensive use of front-end applications with a fairly flat machine load, as an e-commerce company may be, while it can be risky to scale up for larger companies that operate on a global scale and make extensive use of virtual machines for the back-office.

The following picture synthesizes the four endogenous variables a company should leverage to switch from an on-premises financial management to a conscious and properly informed Cloud-based financial management. The levers, again, are never to be considered standalone, but rather to be acted upon coherently and jointly.

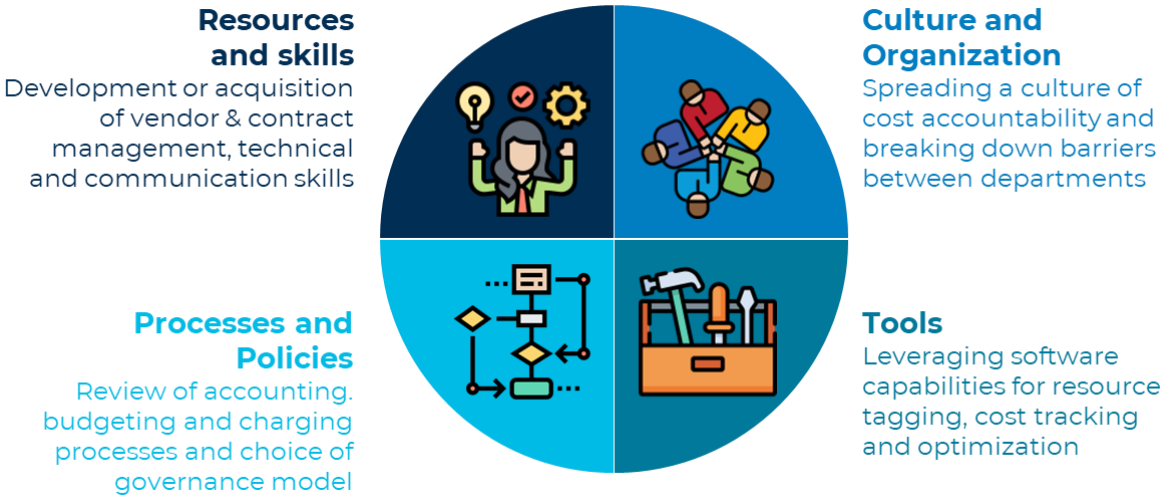


Figure 16. Synthesis of the main levers for a proper Cloud Financial Management

6.2. Strategic considerations and prioritization of actions

Although the four identified levers are applicable to any business context, another key finding of the paper is that **there is no "one fits all" strategy**. As the case study in the online fashion retail company shows and as explained by the FinOps practitioner, evaluations regarding the levers to be used depend on a number of intrinsic factors of the organization.

Taking the first case study as an example, as it can be identified as a benchmark, the choice of the "on-the-side" provisioning model, and of deferring both spending decisions and tracking and monitoring of spending to the different development teams, was due to the size of the tech department and the division into teams according to the peculiarities of the technology stack, which made it impossible to centralize ownership over the infrastructure on the IT. Gartner itself recognizes such a governance model as optimal with a view to large-scale cloud adoption, explaining how it allows for minimizing shadow-IT and taking full advantage of flexibility and speed, typically presented as the major benefits of the cloud [9]. However, this may not prove to be as appropriate for smaller organizations that are not as advanced in other respects: in absence of a structured program of awareness and training toward the business and a clear definition and enforcement of procurement policies by central IT, in all likelihood might temporally be more correct to prefer an "in the way" governance model with IT acting as the intermediary.

The other important lesson learned from the FinOps implementation case study is the need for **consequentiality and consistency of action on the different levers**. Every choice has important implications that if not managed may bring no return on the investment made or even worse lead to spending being even more out of control. To return to the choice of the "on the side" governance model, the natural consequence was the need for a central figure, skilled on FinOps themes, to align and coordinate the different teams, in the absence of visibility into purchasing decisions from IT. That figure was identified in the person previously hired for cost monitoring, part of whose time, in turn, was freed up by a decision made about another managerial lever, namely the change of third-party cost management tool, which after an initial setup period allowed precisely a greater level of automation.

7 Cloud Financial Management Maturity Model

7.1. Model construction

In this chapter, a qualitative model is proposed to assess a company's maturity in cloud financial management against the complexity of the cloud transformation path undertaken. The purpose of the model is moreover to evaluate the consistency among the levers acted upon or to highlight possible misalignments, in order to address them through an action plan that restores a balance toward a conscious management of the cost implications of cloud transformation.

The model developed is a matrix that arises precisely from the intersection of a vertical axis, representing the level of complexity of cloud adoption, derived from data regarding the state of technological advancement, and a horizontal axis, representing the level of maturity of cost management and based on the extent of actions implemented on the four identified managerial levers.

It is necessary to underline again that the model constructed is qualitative, since both the axis can be considered as continuums and not as discrete sets with two clearly separable levels. The drivers that determine the positioning on the two axes are multiple and not always necessarily concordant. The fact that the majority of drivers on one axis go in favor of a low or high level may result in a more pronounced shift within the matrix, but overall, the possibility of intermediate placements should be considered as well.

The need to have an axis that expresses the complexity of cloud adoption should be emphasized because, unlike other previous technologies adopted at the enterprise level, cloud adoption cannot be represented as a binary choice but rather must be evaluated on several dimensions such as pricing and deployment methods adopted [30]. Specifically, the drivers that determine the positioning of a company on the vertical axis of the matrix are:

- the **relevance of cloud spending to total IT spending**. This driver is quantitative and given by the ratio between the budgeted expenditure for a financial year on Cloud services, and the overall IT budget. The percentage could also be calculated net of the budget for personnel costs, since the dimension of interest is rather the comparison between the sizing of cloud services and that of traditional on-premises assets. The higher the relevance of

cloud spending, the higher the complexity of the cloud adoption and of the consequent monitoring of the costs that spur from it;

- the type of cloud purchases made, i.e., the **distribution of spending among different service models**. This driver has proven to be relevant because, while SaaS-type purchases allow the underlying infrastructure to be ignored and underlie rather simple cost metrics, such as the number of subscriptions or users, IaaS and PaaS require the timely monitoring of several elements underlying service delivery, such as the number of servers, storage and network, each of which has its own metrics and costs per unit of expense. Hence, a majority of IaaS and PaaS use with respect to SaaS shifts the positioning toward the top of the matrix.
- the **sourcing strategy**, or, in other words, the number of active providers for the use of Cloud resources, regardless of the service model in question. A multicloud approach to sourcing, which on the one hand has a number of advantages including the possibility of adopting a "best-of-breed" approach that takes advantage of each provider's core competencies and the reduction of lock-in risk, has proven on the other hand to entail a number of difficulties from a cost management perspective, such as the complexity, when considering cost monitoring, of integrating different dashboards of KPIs or that of having to maintain several contractual relationships. Therefore, the choice to operate in a multicloud environment brings the company under scrutiny to the top of the matrix.

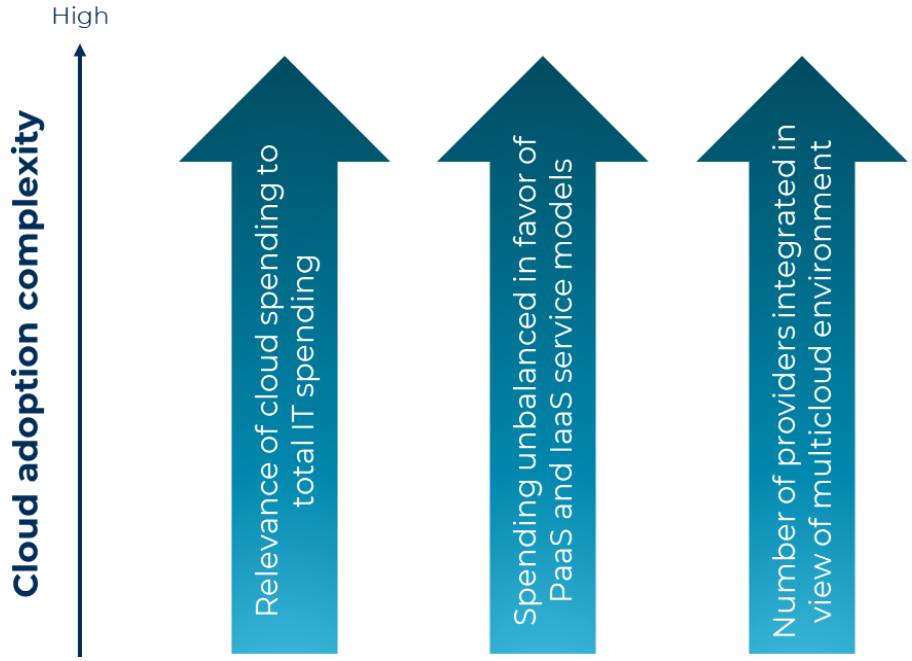


Figure 17. Drivers of the Cloud adoption complexity axis

The drivers, on the other hand, that allow determining the positioning on the horizontal axis, representative of cloud financial management maturity, are the investments on the four levers that have proven to be significant in setting a development path to overcome the difficulties introduced by the cloud paradigm within ICT Financial Management:

- In terms of **resources and skills**, leverage can be considered unused when a plan to develop specific skills in vendor & contract management, use of cloud cost management technologies, and relational and communication soft skills is not formulated and put into practice. It is representative of a higher level of maturity, on the other hand, to use this leverage through the activation of a structured program to bring these skills inside the company perimeter, for example through the organization of training courses, particularly on the topics of cloud cost management and FinOps, or alternatively through sourcing from outside through enhanced recruitment.

- The **culture and organization** driver can move toward a high level of maturity of Cloud Financial Management in the presence of a structured plan of initiatives aimed at spreading the culture of the cloud paradigm and the principle of cost accountability and increasing collaboration among different departments with a view to improving decision making. Specifically, actions that an organization can take in this regard include organizing training costs, creating multidisciplinary teams with formalized collaboration mechanisms, and adding figures to act as facilitators of alignment between teams.

- As for the **processes and policies**, the necessary step toward a proper management of cloud implications is the revision of accounting, budgeting, and charging processes, with workflows that accentuate the involvement of all departments essential to keeping spending under control. Of particular concern are choices regarding the cost allocation model and the procurement governance model. Regarding these dimensions, it is indicative of a high maturity of Cloud Financial Management practices to consistently choose to perform chargeback on the business units responsible for consumption (an intermediate level is reached with the implementation of a showback mechanism) and implement "self-service" governance, with provisioning delegations attributed to business users.

- The adoption of a cloud cost management **tool**, which is of utmost relevance in enabling the reengineering of accounting, budgeting and charging processes, is generally a gradual path, with strong dependencies on intrinsic characteristics of the organization. Generalizing, however, it is possible to say that the use of

native features offered by provider cloud platforms is representative of low-to-medium maturity, while complementing them with in-house customizations or third-party tools, is indicative of high maturity. Within a third-party tool, it moves even further to the right within the matrix to take full advantage of all the features offered, including those for tagging resources, monitoring, setting alert mechanisms, spending recommendations, and inducing automated rightsizing optimizations.

The following picture summarizes the drivers that determine the positioning of a company on the horizontal axis of the matrix.

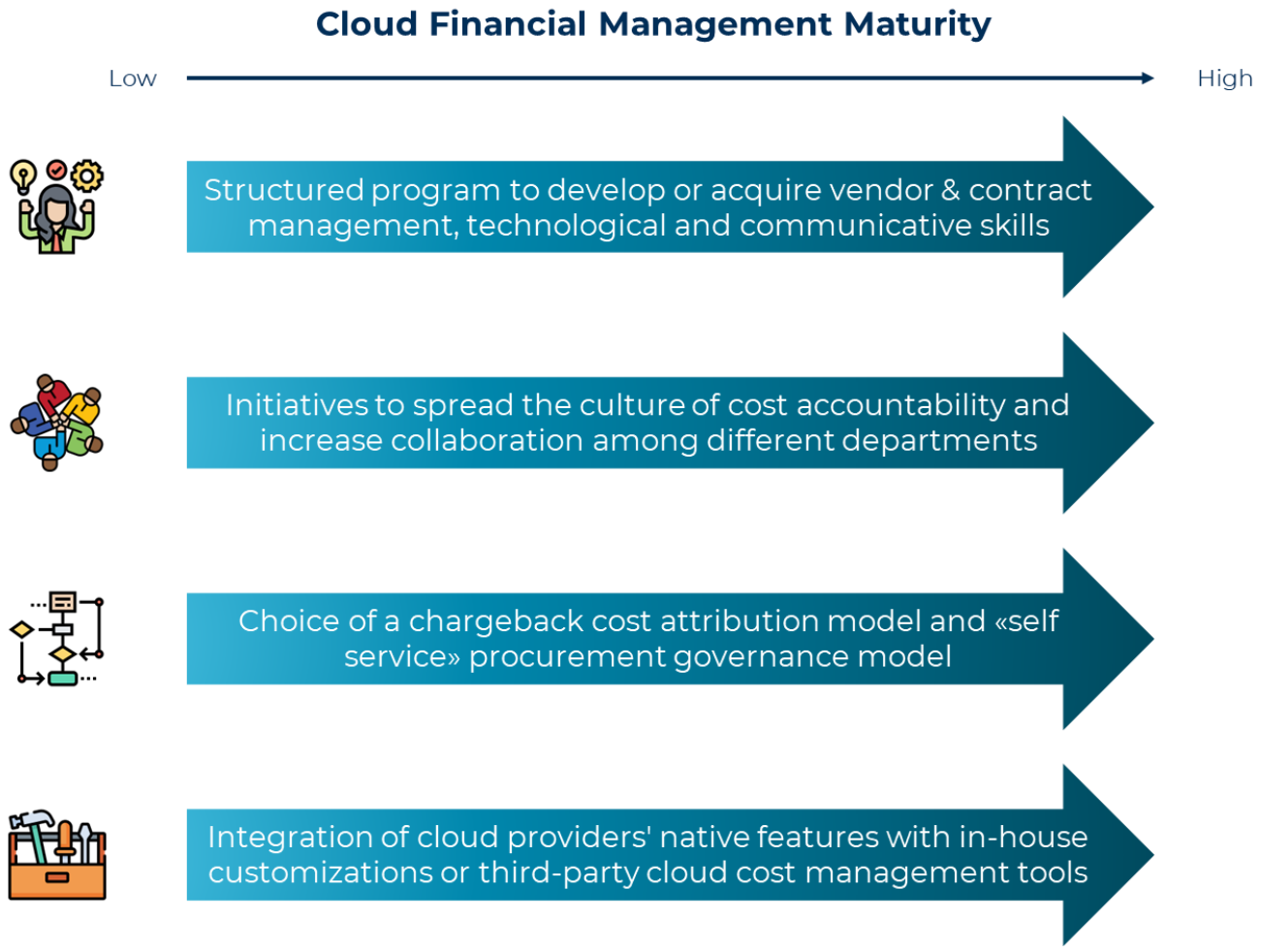


Figure 18. Drivers of the Cloud Financial Management Maturity axis

The intersection of the vertical axis, representing Cloud adoption complexity, and the horizontal axis, representing Cloud Financial Management Maturity, gives rise to a

matrix model, within which four quadrants can be identified, corresponding to as many profiles, to which an organization can be traced.

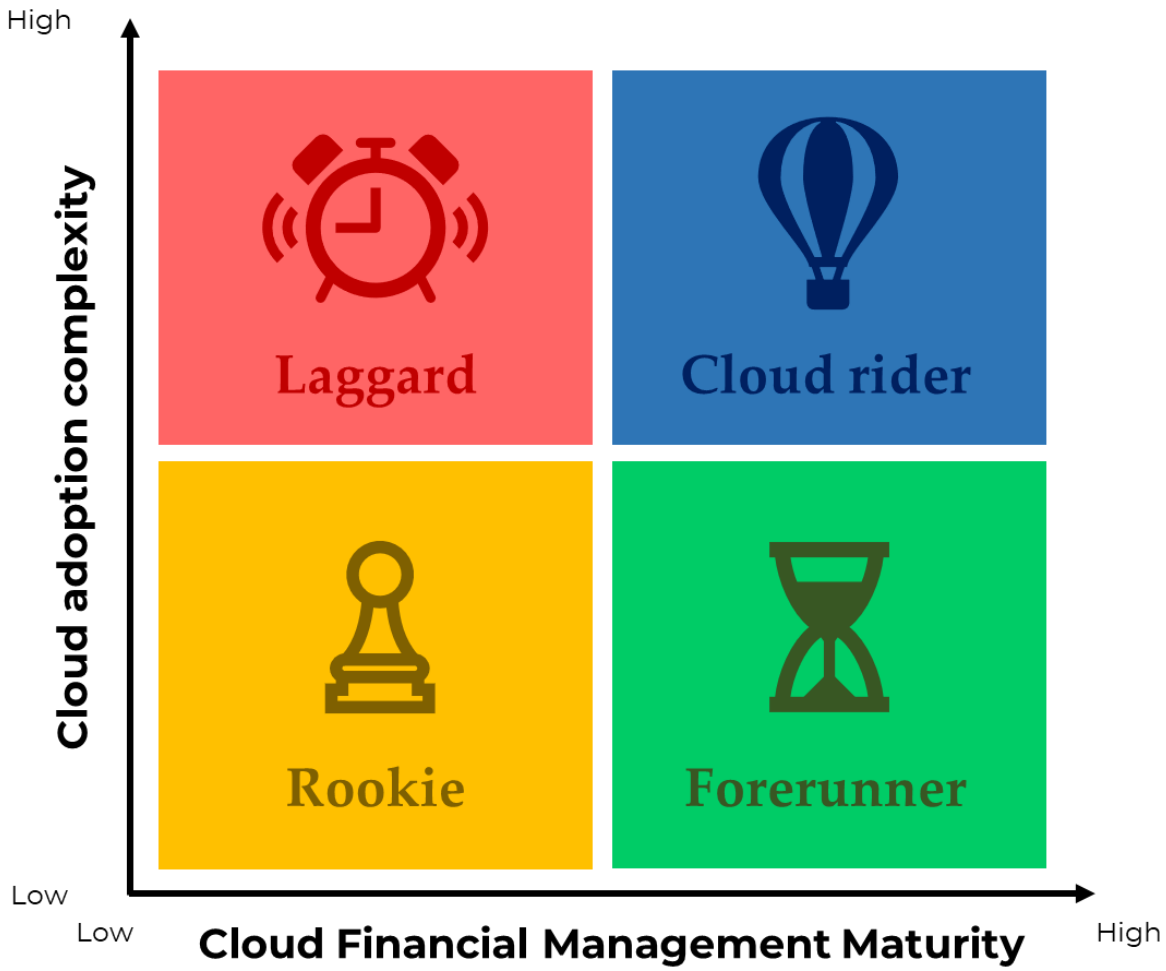


Figure 19. Qualitative model for Cloud Financial Management Maturity assessment

Net of the one at the top right, which undoubtedly delineates an awareness that has already taken place with respect to the need to proactively manage the costs arising from cloud adoption, all positioning within the matrix can either arise from a well-defined strategy or be the result of happenstance, of a series of choices made more or less consciously. Positioning should therefore be evaluated from the perspective of the company's broader technological and organizational direction strategy.

With this regard, it is important to emphasize that the model should not only have the functionality of representing a snapshot of a company at a given instant in time, but

also that of allowing to identify in which directions it is possible to evolve, leveraging the elements that characterize the maturity of financial management practices. Therefore, the model is not only proposed with a static perspective, but also dynamically, as a starting point for a roadmap of initiatives aimed at a more comprehensive and financially aware management of the Cloud's financial implications, consistent with the organization's technology objectives.

- ***Rookie***: In the bottom left quadrant, we find an organization that has yet to embark on or has recently embarked on a cloud transformation journey and therefore has not yet equipped itself with the means to manage the associated costs, which are currently zero or of minimal significance relative to total IT spending. Although not optimal as a positioning, it is consistent. If the intentions are to keep completely on-premises or not to expand toward the Cloud the application/infrastructure fleet in the years to come, investing in the purchase of a dedicated tool to manage and optimize costs or in acquiring or developing the necessary skills to do so could prove to be a counterproductive choice that can unbalance the cost/benefit ratio in favor of the former and thus move from a situation of stability. If, on the other hand, the company's goal is to embark on or enhance a cloud transformation journey, executives (CIO and CFO mainly) will need to consider which levers to operate and whether to make the increasing complexity of adoption and maturity of financial management practices travel hand in hand. The actions implemented could be in order to move directly in the direction of becoming a *cloud rider* or rather to test their financial capabilities in advance by initiating pivot initiatives, for example in terms of enhancing underlying processes and procedures or collaboration between the Finance and IT teams.

- ***Laggard***: In the top left corner, an organization can be identified whose interventions in terms of change management and exploitation of the levers to properly manage and optimize the spend have been very limited compared to the complexity of the Cloud adoption path it has undertaken. Among the four, it is the worst quadrant in which a company can place itself, as it denotes a situation of strong inconsistency and characterized by strong unpredictability from an economic point of view, directly proportional to the significance of the cloud spending, especially in terms of IaaS and PaaS. The risk lies in the possibility of losing visibility into the tracking of spending against the cost centers or teams that feed it and consequently receiving a bill from the cloud provider of inexplicable proportions. A *laggard* position is obviously occupied by mistake and not in an intentional and strategic manner. This happens when,

while running the infrastructure in the cloud, the importance of adapting financial practices to a consumption paradigm profoundly different from the on-premises one is underestimated. The answer to realizing this mismatch may lie in launching FinOps initiatives as soon as possible in order to fill the gap or in a divestment from the cloud and a gradual return to on-premises management.

- ***Forerunner***: In the bottom right quadrant, it is possible to recognize an organization that, in adapting to cloud cost proper management practices, has been ahead of its time, even going beyond the level needed given the limited complexity of cloud transformation. Such positioning may be the result of a distinct organizational sensibility of the company, which has made it a priority to adapt as soon as possible to an albeit minimal level of technology infrastructure moved to the cloud, through cross-departmental involvement of potentially affected divisions. This could occur as much at the direction of executive levels that understood the benefits of increased collaboration between Finance, IT and Procurement, as it could due to contextual factors that are not strictly attributable to a true cloud expansion strategy. Another possibility is that the company is in this quadrant because it is deliberately adopting a showback policy to make the business units responsible for consumption aware of the costs they generate, in preparation for a near future in which concrete cost chargeback will occur. What these potential example scenarios have in common is that the firm may be potentially ready to scale up with the migration of a greater portion of the infrastructure stack or application fleet, thus approaching the *Cloud rider* status.

- ***Cloud rider***: In the upper right quadrant is the profile of an organization that is implementing a complex cloud transformation path and masters cloud cost governance in all its aspects. The company makes extensive use of cloud services, especially in the IaaS and PaaS components, purchasing them from different vendors so as to diversify and reduce the risk of lock-in to a specific CSP. Although the expense is high in absolute terms, costs are kept adequately under control through widespread resource tagging, put fine-tuned as much through native CSP features as through the use of an appropriately selected third-party tool based on business needs. This facilitates the job of the Finance department, informing the accounting process and allowing for an accurate chargeback on business units. The third-party tool is also leveraged for functionalities to monitor the consumption of infrastructure resources underlying service delivery, detect anomalies, and shut down unused

machines. The *cloud rider* has also adapted the skills of its employees through training and awareness courses on FinOps discipline and the need for cost accountability. A cloud center of excellence may have been created, bringing together Finance, IT, Procurement departments and line-of-business managers in periodic meetings, who collaborate and make shared decisions through the use of real-time reporting. Collectively, not only the Cloud Financial Management Maturity is consistent with the level of Cloud adoption, but also the different levers were exploited coherently and sequentially with each other.

Overall, the key principle underlying the model is that certain levels of complexity of cloud adoption must be matched by significant investments in terms of resources and skills, cultural change and organizational adaptations, financial management processes reengineering and tool adoption. Otherwise, there is the risk of being in a situation where failure to govern costs causes them to rise, to the point where they exceed the benefits the company hoped to gain from cloud adoption in the first place and force it potentially to even return to on-premise.

7.2. Application of the model to case studies

The purpose of this section is to offer an example of the application of the model, taking advantage in this regard of the information gathered from the companies interviewed to create the case studies.

To recap, there were four companies under examination:

1) The online retail leader in the fashion industry
2) A power cable manufacturing group for the energy and telco sectors
3) An industrial group in the energy sector
4) A large-scale retail group

Hereinafter, for the sake of convenience and synthesis, the companies will be referred by the number associated with them in the list above.

Proceeding in order, company number 1 can clearly be categorized as a *Cloud rider*. The level of adoption complexity is high as the cloud transformation journey has been underway for several and years and has an ambitious and clear goal of complete decommissioning of the on-premises infrastructure through a "cloud-only" strategy. The sourcing environment is a multicloud one, although AWS is the provider of choice for much of the infrastructure stack, and the distribution of spending among the

different service models is heavily skewed toward IaaS. To this level of complexity, the company has adequately responded through the implementation of key FinOps principles. At the organizational level, a dedicated team was created to govern the cloud in all its facets. The culture of cost accountability has been spread through widespread stakeholder involvement, ensured by not only top-down but also bottom-up initiatives such as the "Cloud champions" program, the use of a "self-service" governance model on business units, and a showback mechanism, which makes costs visible by holding users accountable for spending. This, in turn, is made possible through the use of a purposely purchased third-party tool that enables the monitoring of resource consumption by tagging and offering real-time dashboards, and the implementation of automatic optimizations such as detecting and shutting down unused machines. To top it off, the hiring of a person dedicated to cost monitoring and dialogue with the various development teams helped first in the setup and running-in of the tool and then in facilitating collaboration among the teams.

The positioning on the matrix of company number 2 is more complex and overall dubious, mainly because the interviewee was a distinctly technical figure, which is why the conversation in terms of managerial levers revolved mostly around the tool aspect. The complexity of cloud transformation can be summarized as medium-high, as the journey, which began in 2016, has resulted in about 90 percent of the infrastructure stack being in the cloud. The sourcing environment is also multicloud here, but compared to the previous case, SaaS occupies a larger portion of spending than IaaS, and the overall strategic direction is cloud-first but not cloud-only. The maturity of cloud financial management practices is certainly consistent as far as the technology aspect is concerned, as the providers' native capabilities have been supplemented with the purchase of a third-party tool in order to fill the gaps in terms of tagging resources and managing an environment with multiple providers. The tool is also leveraged for setting alerts beyond certain spending thresholds and creating complementary views of spending, at the country level and group level as a whole. Regarding other levers, the information gathered is scarce, but on the whole suggests an overall medium to high maturity. chargeback to country accounts is in fact carried out, albeit not internally but managed directly at the contractual level with AWS country subsidiaries; procurement governance has a hybrid configuration, due to the high size of the group, centralized in Head Quarter IT for cross-country services and self-service type instead for services peculiar to individual countries. Cultural change enjoys a fair amount of pervasiveness, according to the interviewee, due to the introduction of a facilitator figure. Overall, it is possible to say, albeit not with absolute certainty given the reasons above, that company number 2 also mirrors the profile of the C*loud rider*, albeit with a more “inward” placement than number 1.

As for company number 3, it is evident how the profile of a *Laggard* can be found in it. Indeed, in this case, it was the possibility of a contract renewal with the leading provider of cloud infrastructure resources and the potential change in billing arrangements that had highlighted a backlog in cloud financial management practices. In particular, the proposed commitment discount had necessitated more accurate forecasting of spending, against which the company, at the time of the interview, had then begun to move reactively. The group's cloud environment is characterized by very high complexity. Annual spending is in the millions and the infrastructure complex and hybrid, characterized, moreover, by the use of cloud services globally, an IaaS interconnected with the primary datacenter, and a multiplicity of providers for the delivery of vertical services. On the horizontal axis of the matrix, the company's cloud financial management maturity is medium to low. In fact, the contact persons interviewed first acknowledged that for a long time they had made partial and inefficient use of cloud cost management software that they had under a partnership. Asset tagging was done partially on that tool and partially on Azure's native tools but in a manner that was patchy and limited the possibilities of integration of the respective dashboards. This in turn leads to the inability to receive appropriate spending recommendations from the third-party tool and definitely invalidates the correctness of the allocation of spending to cost centers, which was nevertheless in place. Instead, the governance model is immovably centralized in IT. More generally, the enterprise is still excessively anchored in the traditional on-premises infrastructure cost management model. For all these reasons, the company was categorized, as anticipated, as Laggard. However, the plan of actions that has been assumed to remedy the current situation is corrected for a rightward shift within the matrix. In fact, a multidisciplinary working group, composed of people from IT and Finance, was recently created in the company to take initiatives on the lines of raising awareness of the FinOps culture, aligning ICT Financial management processes, and fully exploiting the functionality of the available third-party tool.

Last, company number 4 can be identified in the lower left quadrant of the matrix, thus as *Rookie*. In fact, the complexity of cloud adoption can be considered low for the following reasons. There are two active cloud providers, with GCP however largely predominant, so the sourcing approach is akin to a monocloud. Although half of the application fleet resides in the cloud and IaaS is the largest service model in terms of spending distribution, the real migration push to the cloud has come recently and overall spending takes up a relatively small portion of the overall IT budget. The department dedicated to cloud governance is also quite small in terms of people working on it. The maturity of cloud financial management practices, on the other

hand, is also low. First, effective cost reversal does not in fact take place; rather, a "reverse chargeback" mechanism is in place, whereby business functions shift part of their budgets to IT in advance so that IT then pays the cloud providers' bills. This mechanism proves inefficient because it does not provide the budget flexibility throughout the year that the on-demand nature of cloud services requires instead. The governance of cloud resource purchases is also centralized in IT, which encumbers the provisioning process and complicates IT's work. The process of identifying spending improvements is also cumbersome and is not done through a tool. Instead, open-source software, customized in-house, is used to automate the shutdown of idle resources, combined with native GCP features for resource tagging. To conclude, on the other hand, the levers of resources and skills and culture and organization do not appear to have been acted upon, as, respectively, the newly inducted resources are not framed in a strategic plan of cloud financial management skill enhancement and the teams are not yet accustomed to continuous collaboration.

The following picture sums up the four companies' positioning on the matrix.

Figure 20. Positioning of the case studies' companies on the model

8 Conclusion and future developments

A cloud transformation journey is generally undertaken in search of the benefits of business scalability and flexibility given by not having to incur the capital cost of purchasing and owning hardware and software. However, the exploitation of the pay-as-you-go paradigm, which substitutes a variable cost model to the traditional CapEx costs of on-premises, harbours pitfalls, mainly due to the increased spending delegations that are typically given to business users, the end consumers of cloud resources. Congenital difficulties in the cloud paradigm, such as precisely the ease of resource provisioning from end users, billing methods based on continuous consumption, and the increase in Operation Expenditure, are compounded by critical issues related in one way or another to the offerings of cloud services and platforms by major providers. Factors such as the constant updating of offerings and associated pricing models, the overload of alternative architectural configurations in service delivery, the extreme granularity of billing, and the lack of standardization across different provider platforms, in fact, complicate life for companies in understanding and containing Cloud costs. Moreover, these critical issues cross-cuttingly impact departments as diverse as IT, Finance, Procurement, and lines of business, which have traditionally been accustomed to working independently and non-collaboratively.

This thesis work was aimed at analysing the impacts of the Cloud on traditional ICT Financial Management processes and identifying, through both academic research and empirical evidence gathering, what levers and tools are in the hands of organizations for accurate management of cloud spending. There are four areas in which actions to adapt to the cloud paradigm fall: resources and skills, culture and organization, processes and policies, and tools. Although there is no one-size-fits-all strategy, as the path and prioritization of the levers varies depending on the peculiarities of the business, and the strategic objectives of the cloud transformation path undertaken, a joint and consistent use of these four levers can ensure that cloud spending is kept under control and optimized. Finally, a qualitative model was developed and tested to assess the maturity of cloud financial management practices in place, evaluating it against the level of complexity of cloud adoption in the enterprise. The model can be used both statically, providing a snapshot of the state of the company at a given moment in time, and dynamically, allowing potential gaps in the cloud cost management strategy to be identified and possible improvement actions to be directed.

The thesis work is meant to contribute to both the academic research and the industry practitioners.

The academic research will in fact benefit from a gathering of knowledge of a primarily technical-managerial nature on the topic of cloud computing, with a vertical focus on the discipline of financial management.

As for the industrial implications, two types of practitioners are meant to be addressed and, hopefully, positively affected by the reading of this paper: those on the demand side of the Cloud services market, then employed in companies which are currently or soon will be on the path of a Cloud Transformation and need to implement logics for the control and optimization of costs related to it, will be able to get advice on what actions to prioritize and levers to exploit in order to grant a successful and efficient Cloud Transformation; those on the offer side of the market, employed in companies providing Cloud Services, will gain a greater understanding of the challenges that customers face when dealing with the Cloud Financial Management and valuable insights on how to adjust and improve their value proposition to meet these needs.

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