TCO for Cloud Services

A Framework

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ECAR

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Introduction

Cloud computing is driving transformational change in how IT services are delivered. The speed and flexibility of cloud resources can shorten time to deployment in development, prototype, preproduction, and production environments. Researchers are finding cloud-computing resources to be an important part of their toolkit for computationally intensive research and analysis of large data sets. Students and staff are embracing easily accessible and low-cost cloud-based services such as file storage and synchronization.

One of the common justifications for moving to cloud services is cost savings, but the data are often insufficient to support such claims due to the inherent challenges in effectively identifying and comparing the total cost of ownership (TCO) for both cloud-based and on-premises fulfillment of IT services. Pertinent costs for on-premises services are often hidden, are partially visible, or unaccounted for because they are not part of the requesting department's budget (e.g., electricity, space, staffing, etc.). The ability to effectively compare TCO is essential to understanding the complete impact on our institutions and the attendant shifts in costs as we migrate to the cloud. Clarity about TCO also underscores the strategic shifts in IT service delivery that higher education is experiencing.

To address the challenge of fully understanding costs and to facilitate data-based decisions, the ECAR-TCO Working Group has created a TCO framework. Appropriate application of the TCO framework will help institutions effectively understand and analyze all costs associated with running a system or service on premises versus moving it to the cloud. The framework enables more accurate identification of the cost to a specific department, as well as the cost to the institution as a whole. However, the framework is not a silver bullet; often case, the decision to select one option or another may include other factors that make up the full business case, such as capital investment required, staff skillsets, security, privacy, etc.

In this TCO framework, our goal is to incorporate all the significant factors impacting the total long-term investment into a solution. Additionally, we want to determine and identify the key stakeholders who are responsible for funding the expense.

A TCO analysis is not the entire business case. Rather, the TCO comparison will help support a business case by providing key information about the options and scenarios being considered. Business cases are

important for defining who the customers are, what their requirements are to support the business proposal, what outcomes you expect, and what value you hope to achieve for the institution.[1]

What Do We Mean By TCO?

For the purposes of this paper, we take a holistic perspective of TCO, incorporating both the quantitative and qualitative factors uniquely pertinent to comparing the benefits and risks of an on-premises IT solution (which may already be in place) to those of a cloud-based solution.

Quantitative

Quantitative factors are those that can easily be associated with a monetary cost. Whether this spending is in new outlays or sunk costs, in the IT budget or that of some other department, someone in the organization is directly or indirectly funding these costs. On-premises and cloud-based solutions typically have different expense cycles and significant differences in capital versus operational expenses. On-premises solutions may have more upfront (capital) expenses and lower ongoing expenses while cloud-based solutions may have a more consistent level of annualized expenses. In order to effectively compare the quantifiable costs of each, it is important to compare costs over an extended period of time, typically three to five years.

Tangible vs. Intangible Value

The economics department at a major university maintained a small data center in its building. The departmental IT director liked maintaining this data center and resisted moving to the central data center because of chargeback costs from central IT, saying, "It would cost me more and I don't have that in my budget." However, the department chair realized that there was an alternative use of the space in the building, one with significant "value" to the department, although no direct budgetary impact. The cost of using space in the central IT data center was thus offset by the value of having the space available for other uses. Only a full TCO analysis would have shown this relationship between visible costs (in the budget) and invisible "opportunity" costs (not in the budget), as well as the true cost of various hosting alternatives.

Qualitative

TCO is often thought of solely in terms of quantifiable, hard-dollar costs. However, there are associated qualitative factors, such as agility and lost productivity due to system downtime, that do not directly or easily translate to a dollar amount but are of equal importance in the decision-making process because they address strategic value issues or impact intangible or overall institutional costs. These qualitative factors must be included to conduct a comprehensive comparison and analysis of on-premises and cloud-based options. Reviewing these factors with all teams involved in the project will provide an opportunity to discuss facts or events that could pose potential risks and identify opportunities. Even if these events never occur and the costs are never incurred, the review provides awareness of issues that might not be addressed if the focus were only on the hard costs. With both on-premises and cloud-based solutions, TCO factors may be visible (e.g., physical servers), partially visible (e.g., in some other budget, such as electricity or air handling), or invisible (not obviously in anyone's budget, such as skill development among the IT staff or a cost shift to a different department).

What Do We Mean by Cloud Computing?

While a number of definitions for cloud computing exist,[2] for the purposes of this report we are using the definition developed by the National Institute of Standards and Technology (NIST):[3]

> 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 [on-demand self-service, broad network access, resource pooling, rapid elasticity, and measured service], three service models [software as a service (SaaS), platform as a service (PaaS), and infrastructure as a service (IaaS)], and four deployment models [private cloud, community cloud, public cloud, and hybrid cloud].

Cloud solutions can also have an on-premises component. There can be instances, for example, when a web-accessible product requires dependent third-party systems that are installed on campus-based physical networks, hardware, or appliances.

Calculating TCO in the Higher Education Context

An increasingly rich set of cloud-based alternatives is available to campus-based IT services. Some of the most compelling reasons to move to the cloud are the promise of faster time to deployment, lower cost for like or better service levels, immediate scalability, and lower security risk. In addition, moving to the cloud may free up IT staff to focus less on commodity services and more on issues with direct mission impact and to offer new capabilities only available in the cloud. Despite our desire to take advantage of the vast promise of cloud technology, we lack a methodology to accurately and fully benchmark the costs of today's on-premises services against cloud alternatives. Without such a methodology, institutions risk making potentially costly decisions that are difficult to undo, and so they either continue with the status quo or take a leap of faith into the cloud, hoping the decision was the right one.

Although TCO tools exist in the corporate world, these do not fully take into consideration issues and challenges unique and significant to higher education institutions. The goal of the ECAR-TCO Working Group was to develop a flexible methodology that can be applied by a variety of higher education institutions and customized to fit local environments. In developing the TCO framework, we highlighted the following issues and challenges that may require special attention when comparing cloud-based with on-premises services:

Teaching, Learning, and Research

- Higher education activities increasingly rely on highly collaborative environments that can engage a variety of constituencies across multiple entities in higher education, business, and government. Cloud technologies are a good fit for delivering such environments but often bring new compliance and legal risks that must be addressed.
- Researchers may have a hard time simply shifting from their departmental labs to a central data center, let alone to the cloud. The reticence is generally based on issues with network capacities and speed, compliance and other legal restrictions (e.g., export control, human-subject regulations, etc.), loss of control, data sensitivity, or chargeback costs.
- Funding models for sponsored research add complexity in comparing costs between purchasing computing equipment and using cloud options for sponsored research. Computing hardware purchased as part of a grant is generally classified as a direct cost and is not subject to indirect overhead rates. Cloud computing services are not capital assets because they are not owned by the university and thus are generally subject to indirect costs. This means that buying computing equipment is not "taxed" by the university but using cloud services is, which must be considered when evaluating TCO for sponsored research–related uses.

Overall Organization

- Both on-premises and cloud-based services require that we engage people from multiple functional groups across the campus, including departmental and central IT, facilities, purchasing, legal, and accounting. This engagement is a critical component of correctly calculating TCO with a campus-wide perspective.
- The IT community itself faces the challenge of ensuring that staff are appropriately trained for the move to the cloud and, if appropriate, transitioned into different jobs that blend new sets of skills needed to procure, design, and manage IT services based in the cloud.
- Financial managers and service managers are realizing that they have never really had to calculate the full TCO for IT systems or didn't have the tools to do so and now face the challenge of modifying existing financial processes and procedures to accommodate cloud costing impacts. For example, "hidden cost subsidies" now must be accounted for, including (but not limited to) the use of computers funded elsewhere, the impact of overhead costing rules, and facilities and staffing costs normally absorbed by other organizational units.

Calculating and reviewing TCO has the potential to cause a culture shift in the decision-making process in higher education, one in which technical engineers, financial managers, administrators, and executive leadership begin to take a holistic approach, discussing hidden cost subsidies, technical direction shifts, and revised funding models to support cloud technologies. This need for a cultural shift is highlighted in *Cloud Strategy for Higher Education: Building a Common Solution*:[4]

> Cost savings are not one of the primary motivations for this move [to the cloud] and we would endorse a Cloud First strategy for higher education even if it were only cost-neutral, when compared to on-premises computing.… Moving to the cloud will require both an initial and ongoing investment in order to train staff and fund initial exploration.… In order to fully leverage cloud technology, senior IT leadership will need to elevate the financial discussion to the university level and remove cross-subsidies that distort the financial incentives of campus technology decision makers. Effective IT governance processes are another possible avenue for minimizing the impact of campus financial distortions.… The intangible benefits of the cloud (e.g., geographic diversity of services, fault tolerance, enhanced security and compliance, and automation) can make it more attractive.

It is precisely those intangible benefits and costs, and the hidden and cross subsidies, that this TCO framework is designed to expose and include in the comparative analysis and that must be raised to and addressed at an institutional level.

Hidden Costs and Subsidies

As noted above, cost comparisons between on-premises and cloud-based services are difficult because some costs of providing on-premises systems are generally not part of the IT budget and other costs (and benefits) may be difficult to quantify.[5]

For example, the TCO of a campus-based learning management system (LMS) would include costs for hardware, software, and system operators, as well as for space, cooling, and electricity (for both hardware and people); some of these costs are in the IT budget and others not. Some (such as the cost of the LMS software itself) are obvious, while others have to be approximated or allocated (e.g., the cost of a database management system), if they are to be counted at all. If a cloud vendor provided the LMS service, all of these costs would be rolled into a single bill from the service provider, including that service provider's profit. The costs of people to manage the system, implement upgrades, and provide support to

the community are also part of the TCO, and some of these might not be tracked or could be spread across several departments. For a complete TCO analysis, all costs have to be brought together—hence the concept of "total cost." This is particularly significant, since many operational costs tend to be very different when a cloud provider operates the LMS.

Another concern in determining TCO are hidden subsidies, i.e., costs that are not incurred by the people who benefit, thus providing a subsidy to those people. Research computing resources provide an example of this situation. While researchers typically buy their own computing equipment, they often do not directly bear the costs of space to house it, electricity to run it, or equipment (and more electricity) to cool it. Most often, those costs are borne by the institution's facilities department and rolled into institutional overhead. Even when such costs are charged back by the facilities department, they rarely make their way down to a particular research grant due to various government accounting rules. Given the significant costs to power and cool today's research computers (as much as $50,000 per year for a single rack),[6] compared to the costs of providing lighting and cooling for more typical office or research space, researchers with large banks of computers are getting a cost subsidy over their less compute-intensive colleagues—as well as over researchers who are moving their work to the cloud where no such subsidy exists. Current rules governing charges for federal indirect costs further affect the comparison between local and cloud computing costs because equipment is exempt from indirect cost burden (routinely over 50% for most large research universities), whereas cloud services are not.[7]

Another subsidy that is common with research computing has to do with related uses of computers purchased for a particular project. In general, the research project that purchases a computer bears the full equipment cost, whether it is fully used or not. When a particular researcher is unable to fully utilize a local computing resource, that spare capacity may be made available to other researchers at little or no charge. This may be a perfectly reasonable thing to do (unused computing cycles are lost forever—just like unsold airline seats and empty hotel rooms), but using these resources represents another hidden subsidy, albeit to different researchers from the ones purchasing the equipment. One of the selling points of public cloud computing is that you only pay for what you use, but this also means an end to these types of subsidies, something that should be considered when comparing local versus cloud computing costs.

In the framework, we have identified several hidden subsidies and indirect costs that affect TCO, including energy and electricity costs, facilities costs, some types of departmental labor (e.g., the graduate student who helps out with computer support), centrally borne costs such as business continuity services, and many types of infrastructure costs. It becomes particularly important to highlight costs that are not directly identified by the institutional or IT department's accounting system (to "unhide" them) to complete the analysis. While it is true that subsidies from one group to another "don't affect my budget," they are all costs to the institution, and if the real TCO of a service can be reduced, the institution has more resources with which to fulfill its educational and research mission and achieve greater transparency in the distribution of resources.

The TCO Framework

The TCO framework provides a methodology to conduct a comparison of the costs associated with running an IT service or function on campus versus running a comparable service in the cloud. It is intended to assist campus business and IT leaders who are evaluating "build versus buy versus lease"

business cases for technology decisions with a reasonable expenditure of time or effort for the most common use cases. The framework:

- Includes factors that highlight the major distinctions between traditional on-premises solutions and cloud-based solutions, some of which are unique to the higher education environment
- Accounts for research, teaching, and learning, as well as administrative use cases
- Addresses the multiple service models of cloud computing (Iaas, PaaS, SaaS)
- Is flexible enough to work across the diversity of institutions found in higher education
- Is adaptable to address situations or factors that it does not already include

In the interest of keeping the framework easier to use, we have limited the number of factors to those we consider to be the most significant and have excluded some that might contribute to the cost of any particular technology system in a relatively insignificant way. Use of the framework should ultimately:

- Guide data collection and analysis to enable the user to move to effective, holistic decision making about alternatives in a timely manner
- Provide an effective and concise comparison of quantifiable factors that can be reasonably estimated in dollars, which can provide the basis for IT project budget for the solutions being evaluated
- List and describe qualitative elements that can be equally important in understanding total costs and their role in decision making
- Be able to be completed in a relatively timely fashion (this framework is intended to take a day to complete, not a week or a month—not counting the groundwork)

The following is a list of basic questions that will help you get started comparing your current model with the proposed alternate(s) in the TCO framework:

- What type of data will be stored or processed by the planned solution? Think about whether or not these are files (of varying file types); transactional, computational, or research data; or data used for reporting and/or business intelligence.
- How sensitive are the data to be stored or processed by the planned solution? Various legal requirements, as well as institutional and organizational policies, may apply for sensitive data (e.g., HIPAA, PCI, PII, FERPA, financial, proprietary, research, etc.).
- What is the business criticality? TCO will vary depending on whether or not you need to ensure integrity and availability 24/7/365.
- What is your institution's size and type? The solution that works best for a large research institution may differ from the solution that meets a small community college's requirements (e.g., as regards to capacity, scalability, agility, etc.).
- Do you have an existing option to compare, and how broad will the use of the solution be? Consider whether the solution will be used by a single department, the entire campus, the entire university system, or a consortium of organizations (multiple universities and/or research partners).
- What are the expected needs over time? TCO may need to be adjusted for growth—for instance, in terms of storage capacity, compute power, or bandwidth usage—or for contraction.

How to Use the TCO Framework

The framework is a single spreadsheet that consists of:

- A brief instruction sheet for guidance in completing the worksheets (see appendix A)
- Three separate but connected worksheets that address a range of pertinent factors: foundational, quantitative, and qualitative
- A summary worksheet that automatically combines the results into a single condensed comparison

The framework is available as a Google Spreadsheet, which can be copied to complete any specific evaluation or downloaded as an Excel spreadsheet. Once copied or downloaded, the framework can also be modified to include other cost factors not listed to deal with specific issues at your institution. For each cost factor under consideration, the worksheet also has a place for you to include notes or specific issues that are relevant to understanding the answers you provide.

An on-premises solution often entails a higher level of cost upfront and lower costs afterwards. A cloud-based solution often entails lower start-up costs and different ongoing costs. To ensure an effective "apples-to-apples" IT TCO comparison, the comparison should be measured over an extended time. To facilitate this, the framework captures data over a four-year time frame (which could be modified for a longer period, if desired). The four main worksheets in the framework (foundational risks, quantitative factors, qualitative factors, and summary view) are described in more detail below.

Foundational Risks

The two factors included on the Foundational Risks worksheet—data sensitivity and business criticality—are important not only in and of themselves but also because they must be addressed to determine the importance of many other factors in the framework.

In considering data sensitivity, first identify the type of data that will be stored and/or processed. Second, rank the sensitivity of those data relative to legal, regulatory, or policy requirements. Finally, assess the degree to which each option under consideration will enable you to comply with those requirements via appropriate security controls to maintain confidentiality of the data being processed and/or stored. The framework calculates the associated risks in two ways:

- **By asking whether the factor itself is a major concern in the comparison ("importance"):** A value of high, medium, or low (H, M, L) is used for this ranking. For example, protected health information regulated by HIPAA would likely receive a rating of high, whereas publicly available data would be low.
- **Via a simple relative assessment between the solutions under consideration:** To compare one solution to the others, a value of +1, 0, or -1 is applied (where +1 is more effective at mitigating the risk and -1 is less effective). For example, if you are comparing storing protected health information in two different cloud solutions, you might give one provider a value of 0 and another a value of +1 based on their security environment and contract terms. It provides a way to quantify and score various options based on the qualitative data.

Data security and protection is of the utmost concern, whether the data are hosted on premises or in the cloud. The cost of securing and protecting data must be realistically assessed to ensure the approach measures on-premises versus cloud-based services. When campuses evaluate security and privacy, predisposed beliefs and preferences are common regarding the security and privacy of on-premises and cloud alternatives. When evaluating alternatives, an objective assessment should consider the security

and data-protection measures of the service and also the mission of the organization. An academic institution's primary mission is scholarly, whereas a cloud provider's business depends on the security and protection of customers' data. Colleges and universities must often devote additional planning, work, and funding for security and data protection, whereas a cloud provider's business depends on its ability to protect the confidentiality, integrity, and availability of its customers' data.

For business criticality, first analyze the functionality under consideration to understand its goals, outputs, and dependencies. Second, rank how critical this function is to pertinent business processes. Finally, assess the degree to which the option under consideration will enable sufficient availability and integrity to meet your needs using the same methodology as described above.

Foundational Risks	
Data Sensitivity	Identify the type of data that will be stored or processed. Next, rank the sensitivity (H, M, L) of that data relative to legal, regulatory, or policy requirements. Then, assess the degree to which each option under consideration will enable you to comply with those requirements via appropriate security controls to maintain the confidentiality of the data being processed and/or stored.
Business Criticality	Analyze the functionality under consideration to understand its goals, outputs, and dependencies. Next, rank how critical (H, M, L) this function is to pertinent business processes. Then, assess the degree to which the option under consideration will enable sufficient availability and integrity to meet your needs.

Quantitative Factors

The Quantitative Factors worksheet addresses a set of cost factors where the annual costs can readily be identified. These factors are grouped into three categories:

1. **Hidden Subsidies and Indirect Costs (one time and ongoing):** Cost factors that are often unrecognized, including energy and electricity, facilities, indirect costs (for grants), student labor, disaster recovery, and business continuity. For example, an on-premises system may have tape backups performed to protect against data loss, but the actual cost to restore the service to an operational level during or following a major disaster, such as a fire in the server room, may never be calculated (in the assumption that we'll just deal with that if it ever happens). A cloud solution, in contrast, might provide geographic redundancy and automatic failover in the event of any service or utility outage or disruption as a standard feature of the solution. More detail about each of these factors is described in the worksheet, in two places: Basic information is included in the Description column, with a second column containing additional information for some of the more complex factors in the table.
2. **One-Time Costs:** Cost factors that arise during the implementation phase of the service or solution, including customization and business process reconfiguration, system rearchitecture (cloud solutions often need an entirely different architectural approach to take full advantage of the different operating parameters), integration with other systems, migration (from an existing solution to the new one), hardware, and software.
3. **Ongoing Costs:** Cost factors that continue during the operation of the service, including hardware-related costs, licensing and subscriptions, data ingress/egress (found in some cloud services), and a variety of labor-related costs split into various types, including one that is new for cloud-based services: contract and SLA management.

For each cost factor in the Quantitative Factors worksheet, identify its relative importance in your environment (using the ranking of high, medium, or low, as described in the Foundational Factors section). The importance element does not impact the final cost calculations and is provided simply to help in the overall assessment of the cost factor; you are making an intentional choice to devalue some factors over the others. Once the importance of each factor is ranked, you should identify the yearly costs of each factor (for up to four years) and enter those figures into the appropriate cell for each solution under consideration.

Finally, this sheet includes a column that allows you to identify "Whose Budget?"—that is, where the cost is actually carried, e.g., in the facilities division, the central IT division, another administrative business unit, or an academic department. This optional column can be used where you consider it relevant.

Quantitative Factors		
Hidden Subsidies and Indirect Costs (one time and ongoing)		
Factor	**Description**	**Additional Information**
Energy/Electric Costs	The cost of the electricity required to run the infrastructure providing the service.	
Facilities Costs	The cost of the space required to house the infrastructure providing the service, e.g., data-center costs.	
Indirect Costs (grants)	The facilities and administrative (F&A) costs that are assessed by a university for any grant expenses.	
Student Labor	The cost of student labor to provide technical support that is not generally counted in the cost of ownership.	
Disaster Recovery System (Readiness)	The operational cost to ensure the service can continue to be available and/or can be restored to operation in the event of a disaster (at an appropriate level). These costs are distinct from the actual disaster response identified just below.	On-premises services require a much larger build-out to achieve a similar level of protection to what their cloud competitors offer. These costs are considered the ongoing operational costs of providing those backup services or facilities in readiness. For on-premises solutions, this typically involves backup of data and possibly maintaining an off-site co-location facility. Cost factors to consider include tape backups, redundant storage facilities, and fail-over computing facilities. For cloud solutions, similar costs are part of the SaaS and PaaS hosting fees or a low cost add-on option (replication of storage within a data center, and/or geographic redundancy across multiple data centers). The vendor may provide services to facilitate fail-over to alternate facilities in IaaS for a fee.

Quantitative Factors (continued)		
Factor	**Description**	**Additional Information**
Business Continuity (Response)	The costs associated with the response to a disaster incident (e.g., fire or earthquake) and restoring the service to operation (temporary and/or normal operation), i.e., "incident response." These costs are distinct from the ongoing disaster recovery system readiness costs (e.g., implementing and maintaining backups and off-site servers) identified just above.	Ongoing cost estimates are considerate of two things: the cost of responding to a disaster, and the expected frequency of disasters (e.g., once every 4 years or once every 10 years). Secondly, determining how to amortize these costs (e.g., evenly across N years, or capture them fully in one of the years).
One-Time Costs		
Factor	**Description**	**Additional Information**
Customization/ Business Process Reconfiguration	The cost to either customize the tool to meet your existing business processes or change existing business processes to be compatible with the tool.	
System Re-Architecture	The cost to redesign the service and systems to take optimal advantage of the option under consideration.	
Integration	The cost to integrate the new service with other systems and services.	
Migration Costs	The cost to move from the current solution to the new solution, such as staff retraining costs.	
Hardware Costs	The cost at any point to acquire and deploy servers, networking infrastructure, etc., to be used for an on-premises solution or to support a cloud-based solution.	Hardware for on-premises solutions is typically purchased to support peak load, even though the hardware may run idle for the vast majority of year. A cloud solution may also require some new on-premises hardware for integration purposes.
Software Costs	The cost to acquire software and associated support that may be required to run an on-premises solution or to support a cloud-based solution.	Software to support a cloud solution may include special on-premises "integration" systems or additional software licensing beyond what is included in the basic cloud "subscription/licensing" These costs would be identified under "Ongoing Costs."
Ongoing Costs		
Factor	**Description**	**Additional Information**
Hardware	The operational cost of running the hardware. (ongoing data-center and on-premises networking should be captured in the Hidden Subsidies and Indirect Costs section above.)	

Quantitative Factors (continued)		
Factor	**Description**	**Additional Information**
Subscription/Licensing	Cloud subscription fees or software licensing fees.	
Data Ingress/Egress Fees	The costs to upload data to or download data from the service.	
Service Management Staff	The cost of managing the end-to-end operational and strategic direction of the application or service. This cost may include a "service owner" (and/or service manager) and "process owner."	Examples range from continuous service improvement efforts to the strategic operation of the service, such as using "reserved instances" or buying servers on Amazon's "Spot Market" (bidding on excess compute capacity at low rates).
Application/Database Administrator Staff	The cost to have application or DBA IT staff to run the service, including Tier 3 support.	
System Administration Staff	The cost to have system administration IT staff to run the service. Typically includes traditional sys admin activities for on-premises services. For cloud services, consider cloud system administration costs of managing instances, cloud infrastructure scale, and market pricing variations.	Systems administration work may differ in the cloud, including monitoring instances, spinning up and spinning down servers for demand, etc.
Data-Center and Operations Staff	The cost to have staff to manage the hardware and the data center (on-premises).	
Network Staff	The cost to have network IT staff run the service.	
Security Staff and Related Infrastructure	The cost to have technical or "physical security" staff to provide appropriate levels of security for the service.	
Technical Support Staff	The (apportioned) cost of Tier 1, 2, and 3 technical support staff (help desk) related to the service.	
Functional Staff	The cost of the nontechnical staff who perform the business functions of the service.	
Vendor/Contract Management Staff (SLA, compliance)	The cost to have staff manage the relationship with the service provider and ensure the service provider is complying with the terms of the service contract (i.e., performance and regulatory compliance as appropriate) on an ongoing basis after the contract has been finalized.	

Qualitative Factors

Qualitative factors are those that cannot easily be translated into financial terms but represent significant advantages or disadvantages of a cloud-based or on-premises solution that should be considered when comparing alternatives. These include agility, contract review and negotiation, elasticity and scalability, regulatory and policy requirements, security, and service levels. When completing this worksheet, organizations may find additional qualitative factors to add to their analysis.

Given that qualitative factors do not have inherent monetary figures to use in a comparison, a relative cost calculation approach can be used. For each cost factor, identify the relative importance (high, medium, low), followed by the "cost" for each solution relative to the others (-1, 0, +1).

Qualitative Factors		
Factor	**Description**	**Additional Information**
Agility	Does the option under consideration allow for easy and quick deployment of and changes to the processing and storage functionality provided?	
Contract Review and Negotiation	Can the solution be implemented with minimal contract review and negotiation to achieve the desired outcome?	
Elasticity and Scalability	Does the option under consideration facilitate easy and quick expansion of available processing and/or storage capacity during times of peak need and reduction of that same capacity during times of lower need?	
Regulatory and Policy Requirements	Does the option adequately enable compliance with external regulations (e.g., HIPAA, FERPA, PCI, etc.) and/or internal policies? This relates to data sensitivity and privacy, as well as other compliance requirements such as data retention.	
Security	Does the option under consideration provide effective mechanisms by which to prevent constantly expanding security threats and to monitor for security events or breaches?	For cloud services, one way to determine whether their infrastructure and security are sufficient is to identify what third-party controls or certifications they have (e.g., Cloud Controls Matrix,* ISO 27001/2,† SOC 2,‡ PCI DSS,** etc.) and review the resulting reports.
Service Levels	Does the option under consideration provide satisfactory service levels *and* guarantee appropriate associated remedies regarding important parameters of the functionality (e.g., availability, performance, and support)?	Be sure to reflect on the cloud provider's and your own internal service levels in a truly objective way.

* Cloud Security Alliance, *Cloud Controls Matrix*.

† Learn more about the these two standards (*ISO/IEC 27001–Information security management* and *ISO/IEC 27002:2013–Information technology—Security techniques—Code of practice for information security controls*).

‡ The Service Organization Control (SOC) 2 Report is an accounting standard based on Trust Services Principles (a new version of which was released in January 2014 by the AICPA Assurance Services Executive Committee).

** Read about the PCI Data Security Standard (PCI DSS) and related documents.

Summary View

The Summary View worksheet is automatically completed using the data you enter in the other three worksheets. The four-year total cost of each solution is brought forward for each quantitative factor. For the foundational and qualitative factors, the importance ranking is treated as a weighting factor and applied to the Relative Effectiveness data for each solution: high = 3, medium = 2, and low = 1. In other words, each foundational factor will show up in the summary as a value between -3 and 3 if the importance is high and between -1 and 1 if the importance is low. This provides a simple way to combine both of the foundational factors into a single numeric score for each solution under consideration and similarly to combine all six of the qualitative factors into a single score for each solution.

The summary worksheet also includes a column where you can add your own conclusions about each individual cost factor, as a way to help synthesize a comparison of the solutions as you make your assessment.

Conclusion

Cloud computing services have already shown increasing promise in higher education as they provide highly flexible and potentially lower-cost computing solutions. However, an effective comparison of alternative computing solutions requires a thorough analysis of all the costs of ownership, including those that are readily quantifiable and those that are of a qualitative nature. Using this framework will help ensure that that all the components of value, opportunity, and risk of cloud computing are understood and that informed campus decisions to support business needs can be achieved.

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Notes

1. A comprehensive perspective on developing a full business case for cloud-based solutions can be found in Asbed Bedrossian et al., *Cloud Strategy for Higher Education: Building a Common Solution* (Louisville, CO: ECAR, November 5, 2014).
2. See, for example, Thomas Dopirak, *ACTI Data Management Glossary* (Louisville, CO: EDUCAUSE, February 2013), which uses the *Wikipedia* definition, "Cloud computing is the use of computing resources (hardware and software) that are delivered as a service over a network (typically the Internet)."
3. Peter Mell and Timothy Grance, The NIST Definition of Cloud Computing (NIST Special Publication 800-145), September 2011.
4. Bedrossin et al., *Cloud Strategy for Higher Education*, 8–9.
5. This section of the paper originally appeared in Jerrold Grochow and Kelli Trosvig, "Hidden Costs and Subsidies Complicate TCO," *The Inside Line* (blog), *EDUCAUSE Review Online*, September 16, 2014.
6. The computation is based on a 25kW rack in a reasonably efficient data center (PUE of 1.5) in New England, where electricity cost is in the range of 15 cents/kWh.
7. To learn more, see Jerrold M. Grochow, "Federal Indirect Costs Affect Total Cost of Ownership," *EDUCAUSE Review Online*, April 13, 2015.