

# IT Procurement - Total Cost of Ownership

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## INTRODUCTION

Is it an appropriate use of resources to embark on a new IT project? What are the costs of purchasing the system, versus the benefits of making the investment?

Potential benefits are often well-understood at the time of proposing a new IT system, but costs are less well-understood. The purchase price of a system or service often reflects only a small component of the true lifetime cost of an IT system.

One of the key tools to help evaluate IT decisions is the Total Cost of Ownership (TCO). The TCO is used to better understand actual cost of ownership over the expected lifetime of an item. The TCO attempts to consider all costs including not only maintenance and service costs, but also insurance, infrastructure related expenses, cost of downtime, licensing, and proper disposal at their end of life.

Formulating and understanding TCO estimates will enable your government to make better informed financial decisions when comparing potential IT products and services.

## KEY POINTS IN THIS DOCUMENT

- The Total Cost of Ownership (TCO) is used to better understand actual cost of ownership over the expected lifetime of an item.
- TCO can be thought of as the sum of the following potential cost factors: initial cost, cost of operations, cost of maintenance/services, cost of downtime, and cost of decommissioning.
- Individuals who understand your government’s financial model should be included in the TCO analysis.
- Vendor-lock in costs should be considered in the TCO calculation for both hardware and software choices. Vendor lock-in occurs when the selection of specific hardware or software choices makes an organization directly dependent on a specific vendor for a product or service.
- Before making the decision to purchase or build an IT solution, it is critical to understand exactly what the software requirements are for a system. Not knowing your requirements at the outset may lead to the purchase of solutions that include redundant or unnecessary features or a solution that underperforms or does not scale properly, leading to significantly higher costs.
- The document outlines TCO considerations for two categories of hardware solutions:
  - **In-house hardware:** housing and operating hardware onsite.
  - **Data centre solutions:** Hardware and services are located off-site at a third-party hosting location. The document outlines TCO considerations for four types of data centre solutions:
    - **Co-location:** when an organization purchases, installs, and manages their own hardware within the data centre (space leasing arrangement).
    - **Hardware leasing:** leasing physical hardware and space from a data centre.
    - **Virtual Private Servers (VPS):** separated, private, virtual environments that emulate distinct physical hardware.

- **Cloud-based and service-oriented models:** environments where hardware and functionality are provided on-demand and managed by the service provider.

The document outlines TCO considerations for three categories of software solutions:

- Purchasing commercial off the shelf (COTS) software.
- Developing software in-house.
- Using an existing open-source software solution.

## COST FACTORS IN TOTAL COST OF OWNERSHIP

TCO can be thought of as the sum of the potential cost factors outlined in Table 1 below. No two potential solutions will have the same cost factors and some potential costs do not fit neatly into a category.

**TABLE 1: COST FACTORS TO CONSIDER IN TOTAL COST OF OWNERSHIP.**

Factor	Examples of Costs	Additional Details
<p><b>Initial Cost:</b> All costs to evaluate, acquire, and implement the new IT system. This includes the purchasing price.</p>	<ul style="list-style-type: none"> <li>• Installation and setup costs (additional hardware/software requirements)</li> <li>• Power and cooling</li> <li>• Networking</li> <li>• Start-up training costs</li> </ul>	
<p><b>Cost of Operations:</b> All costs to operate the IT system following implementation of the new IT system, and before its decommissioning.</p>	<ul style="list-style-type: none"> <li>• Annual service agreements and licensing models</li> <li>• Ongoing training costs</li> <li>• Hardware depreciation and upgrade costs</li> <li>• Power conditioning and backup systems</li> <li>• Utility costs</li> <li>• Insurance</li> </ul>	
<p><b>Cost of Maintenance/Services:</b> Continuous costs to maintain and repair the IT system throughout its lifetime for the out-of-warranty period.</p>	<ul style="list-style-type: none"> <li>• Urgent repair costs</li> </ul>	<p>Many vendors will offer up-time kits that include components such as memory, hard drives, and power supplies that can be used for urgent repairs. The purchase and maintenance of an up-time kit will add to the TCO, it can</p>

		impact the time to repair, especially if the device is physically located in a remote location.
	<ul style="list-style-type: none"> <li>• Servicing costs</li> </ul>	Vendor availability of parts, plus the lead time for repair components, may require weeks in addition to considering the costs for service technicians to visit the site. An annual cost may be included to accommodate for such items.
	<ul style="list-style-type: none"> <li>• Replacement costs for estimated component lifetime</li> </ul>	As hardware ages the chances of a failure increase. This means that over time, the expected cost of maintaining a system will increase. This needs to be included in the costs. In some cases, components of systems have an estimated lifetime (such as a hard drive or a power supply) and replacement costs need to be included.
<p><b>Cost of Downtime:</b></p> <p>The cost to the organization for downtime of the IT system or loss of data. This includes the cost of having the system down, as well as the cost of bringing the system back online.</p>	<ul style="list-style-type: none"> <li>• Direct loss of functionality.</li> <li>• Lost staff productivity.</li> <li>• Cascading failures of other processes and systems dependent on the downed system.</li> <li>• Incorrect or inaccurate data collection.</li> </ul>	<p>When hosting systems in house, the organization must be prepared for a device failure.</p> <p>When purchasing cloud services, evaluate any contracts, service level agreements (SLAs), and other commitments for their impact on cost of downtime.</p>
<p><b>Cost of Decommissioning:</b></p> <p>All costs incurred in retiring an asset or system.</p>	<ul style="list-style-type: none"> <li>• Vendor lock-in</li> </ul>	<p><b>Vendor lock-in</b> occurs when the selection of specific hardware or software choices makes the solution and organization directly dependent on a specific vendor for a product or service. It also can make the cost of switching to</p>

		<p>another vendor so high that the organization is forced to continue in the relationship (which limits choices and can impose ongoing costs). This must be considered in estimating TCO for both hardware and software choices.</p>
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## KEY CONSIDERATIONS FOR CALCULATING TCO

This section outlines key considerations for calculating TCO.

### Financing

Individuals who understand your government’s financial model should be included in the TCO analysis. Business operations and financing will impact TCO calculations. Organizations treat capital purchases and depreciation differently, impacting the costs of leasing vs buying systems.

### Vendor lock-in

Vendor-lock in costs should be considered in the TCO calculation for both hardware and software choices. **Vendor lock-in** occurs when the selection of specific hardware or software choices makes an organization directly dependent on a specific vendor for a product or service. It can make the cost of switching to another vendor so high that the organization is forced to continue in the relationship (which limits choices and can impose ongoing costs).

In software selection, vendor lock-in appears where a product utilizes a proprietary interface or data format which limits compatibility with other systems.

In hardware systems, vendor lock-in is likely with single source items (where an item can only be purchased from one vendor due to proprietary hardware interfaces or patent restrictions). Closed systems can use proprietary data formats which can introduce additional challenges with archiving and

backups. This can force an organization to migrate data and re-engineer a solution, often with a high cost.

Vendor lock-in can significantly increase the TCO for a system by reducing the number of choices for future solutions as well as forcing unwanted developed decisions on the organization at an unscheduled future point. When assessing the TCO for options, careful consideration must be given to minimize the risks posed by vendor lock-in and understand the potential future cost and impact on the organization.

### Knowledge gaps

The cost of knowledge gaps is commonly overlooked in both software and hardware decisions. Access to expertise is required and needs to be reviewed on an ongoing basis in setting up and maintaining systems. Both with the physical and virtual servers, correct security hardening is required to ensure a robust and resilient system.

**‘As-service’** refers to a provider that provides the system/solution itself as a service. The provider installs, manages, scales, backups, and otherwise provisions the system. With the ‘as-service’ model of service, organizations can focus on the required services as the service provider is responsible for maintaining the correct operating system, network, and configuration management. This can result in a far more secure and robust system.

Before making the decision to purchase or build an IT solution, it is critical to understand exactly what your requirements are for a system. Not knowing your requirements at the outset may lead to the purchase

of over-specified solutions (i.e., solutions that include redundant or unnecessary features) or a solution that underperforms or does not scale properly, leading to significantly higher costs. Your government will need to gain an understanding of what is really needed for the task at hand (see the document “IT Procurement – Identifying IT System Requirements” for details).

## ASSESSING IT HARDWARE TOTAL COST OF OWNERSHIP

This section outlines TCO factors and considerations when purchasing different types of hardware.

Hardware options are split into two broad categories:

- **In-House Hardware:** Housing and operating hardware onsite.
- **Data Centre Solutions:** Hardware and services are located off-site at a third-party hosting location. This includes any cloud-based or third-party services. Data Centre Solutions discussed include co-location, leasing, Virtual Private Servers (VPS), and cloud-based services.

Select costs will apply for all hardware types, including:

- The costs for sufficient staff training.
- The ongoing costs from consumables and labour to maintain the hardware. In some cases, the new hardware system could reduce labour costs overall. For example, a new data input system may speed up data entry done by staff, which reduces the overall labour costs for the organization.
- Data backup strategies. These are not included in purchased hardware systems.
- Physical infrastructure changes or improvements that may need to be put in place for hardware.

In this section, we highlight key factors that are, for the most part, unique for each hardware type. Note that these lists of factors and potential costs are not

exhaustive and are a starting point for investigating the TCO of potential hardware solutions.

### In-house solutions

In-house hosting entails purchasing your hardware, and housing and operating it onsite. In-house hosting is complex and may require a significant investment up front.

Cost considerations for in-house hosting by TCO factor include:

#### Initial Cost:

- Trained individuals onsite to support the general operations and backups of the systems
- Power and cooling requirements
- Mounting and networking hardware
- Internet connectivity

#### Cost of Operations:

- **Security:** Consider how the data on the system will be protected, and the associated costs specific to hosting hardware onsite.
- **Redundant power systems:** Redundant power systems can include both battery backups and fuel based systems such as diesel, propane, or LNG fuelled generators. The cost of these items can be more than the cost of the computing hardware. They will have their own TCO calculations that will need to be considered with strict maintenance and testing schedules.
- **Network connectivity**

### Building vs buying hardware systems

**Building an in-house system** would entail assembling your hardware system from individual components. While the upfront purchase cost of an in-house build may appear lower, once the TCO is calculated, the total cost may end up being larger. Hidden costs and considerations for a custom built hardware solution include:

- Additional labour cost from time to assemble and test systems.
- Packages that require additional training for updates or for turnover of staff.
- Increased risk from hardware incompatibility.
- Lack of vendor support and repairability in the event of a failure.
- If the individual who built the system leaves without properly documenting their work, there is a risk of losing the knowledge of the system configuration and increasing the complexity of supporting the hardware.
- Components that are chosen for an in-house build are not necessarily enterprise grade hardware and have a shorter lifespan and narrower operation window in terms of environmental conditions.

While the upfront costs of **buying a complete hardware system** from an outside vendor may be higher, the TCO may be lower. With complete hardware systems, there are options for ongoing support contracts, consistent knowledge, and better overall hardware compatibility. A vendor’s technical sales representative can help the purchaser to understand the TCO for hardware solutions they are offering. Their goal is to assist the organization in the buying process so that they have a large knowledge base to draw upon when making a decision.

Governments can also use a “build vs. buy decision matrix” (see the document “IT Procurement – Tools to help select an IT system”) in addition to comparing TCOs to help decide what solution is right for them.

### Data centre solutions

With data centre based hosting, the hardware and services are located off-site at a third-party hosting location. Many applications and third-party services your government may already be using are considered data centre solutions. The data centre assumes costs for operations (power, cooling) as well as the physical

protection of the systems. Benefits of data centre hosting options include:

- Data centres are available in many locations in Canada thus allowing for adherence to Canadian and your government’s data privacy requirements.
- Your governments would not have to worry about power and cooling infrastructure or network connectivity.
- Data centres utilize industry standard access control, logging, environmental controls, redundant power connectivity, and fire suppression.

Types of data centre solutions include **co-location, leasing, VPS**, and **cloud-based services** each with its own unique advantages and impacts to TCO.

#### Co-location

**Co-location** is when an organization purchases, installs, and manages their own hardware within the data centre (space leasing arrangement). Some co-location sites will offer hardware support options on an hourly or contract basis, which can be utilized to reduce down times in the event of failures (as sites are operationalized around the clock) as well as being able to leverage an existing technical knowledge base. Co-location can:

- Reduce infrastructure and operational costs compared to in-house hosting
- Shift the upfront build costs from an initial large outlay to a monthly expense, as well as reducing overall costs by allowing organizations to benefit from economies of scale.

#### Hardware leasing

**Hardware leasing** entails leasing physical hardware and space from a data centre. Costs considerations for hardware leasing include:

- That there are no update build costs.

- Data centres carry all the hardware and operation costs apart from data usage.
- Service and maintenance may or may not be included in a lease.
- Data centres are responsible for managing hardware failures and repairs, but leasers still have to be aware of system monitoring.
- The leasing arrangement specifies set hardware. This can make it difficult to expand resources such as processing or data storage without modification to the hardware.
- It reduces the initial upfront cost, maintenance, and operational costs with higher monthly expenses.

### **Virtual Privacy Servers (VPS)**

**Virtual Private Servers (VPS)** are separated, private, virtual environments that emulate distinct physical hardware. TCO considerations include that VPS:

- Is scalable in terms of processing capacity, storage, and data bandwidth.
- Providers offer a variety of pre-built virtual machines that are available pre-provisioned for such services as databases and web hosting and may offer virtual services such as data storage pools and backup solutions.
- Reduces TCO as operations and maintenance/services costs are carried by VPS providers.
- Direct monthly costs are linked to storage space, processing, and bandwidth used.

- Requires technical experience to understand the ongoing operations of the system.

### **Cloud-based and service oriented models**

**Cloud-based and service-oriented models** are environments where hardware and functionality are provided on-demand and managed by the service provider. TCO considerations for cloud-based models include:

- There are generally no upfront hardware costs (no upfront financing is required), and reduced operation, maintenance, and infrastructure costs.
- Costs for services are commonly provided in a pay-for-use fashion (pay for the resources being used on a monthly basis). Service providers may also offer storage, computing power, archiving, backups, and networking services.
- Resources can often be scaled up on-demand (i.e. additional services can be brought online and integrated into the system as needed).
- Services are delivered through an API (Application Programming Interface, like an app) or service portal, so there is less need for in-house technical expertise.
- There is no longer a need to maintain detailed operating system and network expertise as this is handled by the service provider.
- The organization does not have to plan for hardware maintenance or future upgrades as all hardware and software is managed by the provider

## Summary

The impact on different TCO factors for each data centre type is presented in Table 2 below.

**TABLE 2. TCO FACTORS BY TYPE OF DATA CENTRE SOLUTION.**

TCO Factor	Co-Location	Leasing	VPS	Cloud-Based Services
<b>Initial Costs</b>	<ul style="list-style-type: none"> <li>Trained individuals to support the general operations and backups of the systems</li> <li>Initial hardware cost</li> <li>Installation costs</li> </ul>	<ul style="list-style-type: none"> <li>Trained individuals to support the general operations and backups of the systems</li> </ul>	<ul style="list-style-type: none"> <li>Trained individuals to support the general operations and backups of the systems</li> </ul>	<ul style="list-style-type: none"> <li>Trained individuals to support the general operations</li> </ul>
<b>Cost of Operations</b>	<ul style="list-style-type: none"> <li>Month co-location fee</li> <li>Data charges</li> <li>Service contracts</li> </ul>	<ul style="list-style-type: none"> <li>Month co-location fee</li> <li>Data charges</li> </ul>	<ul style="list-style-type: none"> <li>Month operation fee</li> <li>Data charges</li> </ul>	<ul style="list-style-type: none"> <li>Month operation fee (fixed or usage based)</li> <li>Data charges</li> </ul>
<b>Cost of Maintenance/ Service</b>	<ul style="list-style-type: none"> <li>Maintenance and service costs</li> </ul>	<ul style="list-style-type: none"> <li>Maintenance and service costs (may be included in lease costs)</li> </ul>	N/A	N/A

## ASSESSING IT SOFTWARE TOTAL COST OF OWNERSHIP

This section discusses three categories of software:

- Purchasing commercial off the shelf (COTS) software
- Developing software in-house
- Using an existing open-source software solution.

With software systems, there are areas with variable and uncertain costs. There are two additional software-specific cost factors to be considered in the procurement process shown in table 3 below: cost of search and cost of

integration. These factors overlap multiple cost categories and require in-depth analysis to understand the impact on TCO.

**TABLE 3. SOFTWARE-SPECIFIC COST FACTORS.**

Factor	Examples of Costs	Additional Details
<p><b>Cost of Search:</b> The cost of search covers evaluation studies to determine what, if any, software solutions exist in the marketplace to meet governments needs and to understand their functionality and usability in addressing those needs.</p>	<ul style="list-style-type: none"> <li>• Upfront evaluation studies, evaluating functionality, usability.</li> <li>• Test deployments</li> <li>• Proof-of-concept development</li> <li>• Assessment of references</li> </ul>	<p>This factor is common between different software categories but will have significantly different cost contributions to the TCO factor.</p>
<p><b>Cost of Integration:</b> The costs associated with planning and executing how existing data will be treated and what new processes and practices are needed to implement new software into workflows.</p>	<ul style="list-style-type: none"> <li>• Data migration, both in terms of how easy it is to migrate data in and out to avoid vendor lock-in</li> <li>• Additional work may be required for data cleaning and reformatting.</li> <li>• Interoperability: systems may be required to share data with existing systems and/or handle existing data formats</li> <li>• User migration</li> <li>• Training</li> <li>• Updating processes, documentation, and practices</li> </ul>	<p>Vendors may use proprietary data formats which can increase both cost and complexity of data and user migration.</p> <p>Careful consideration should be taken to understand if and how costly extracting data may be for backups, archiving, or future decommissioning.</p>

In addition to the TCO of the software, governments must also consider:

- **Data backup strategies:** backup strategies are not included in purchased software systems.
- **Costs of development or customization:** available software solutions will often not directly meet government needs and require customization. Software solutions may underperform or not scale correctly to increased demands leading to an increased TCO. Customization and new software require time and resources for testing and deployment.
- **Software licensing:** costs can be complicated and require detailed analysis

## Commercial off the shelf software (COTS)

Commercial software solutions refers to proprietary packages where it is generally not possible to evaluate the inner working of the solution. Commercial solutions may have costly and restrictive licensing schemes which introduce ongoing and recurring costs that must be accounted for in the TCO. In addition to the initial cost of the software, installation, and data migration, customization and licensing are significant factors that contribute to COTS TCOs. Considerations for TCO estimates are:

- Licensing costs (per user or per connection license costs, one time upfront cost)
- Number of licenses needed (also applies to cloud based software applications but is usually considered on a month-by-month basis, which is more flexible if the number of users fluctuates)
- Cost of installation, configuration, and testing the software.
- Customization costs
- Data migration, including risks of vendor lock-in

The benefits of COTS include:

- Support from software provider
- Economy of scale in testing and security
- Quick deployment times

## In-house development

In-house development means that your government would develop a solution internally. It is critical to have a clear understanding of what is required to help control planning and spending in development. Without a clear vision of what the application is required to do, costs can start to increase as development unfolds. Considerations for TCO estimates are:

- Risk in cost and time estimates
- Risk with lack of clear specifications
- Risks with security and proper testing and proper techniques for handling private data
- Long and uncertain delivery timelines
- Missing features
- Onboarding costs to train and acquire the skilled developers
- Testing and auditing
- Damage control and data loss in the event of a system failure

The benefits of in-house development include:

- Ability to build proof-of-concept system
- Ability for modification and long term support
- Planned data interoperability

## Open source software

With open source software, the code and inner working can be reviewed, and a number of rights are guaranteed to users. Among these rights, there are typically no ongoing license fees. Open source software platforms often have a very large user base and are trusted to deliver significant portions of the architecture of the world's data management platforms.

While open source software typically has no licensing costs, open source solutions are not a panacea towards reducing TCO. Like proprietary solutions, open source solutions typically require support and expertise for deployment and customization. Some considerations for TCO estimates are:

- Cost of installation, configuration, and testing the software.
- Customization costs

The benefits of open source software include:

- Heavily reviewed and robust code base

- Support for larger community user base
- Low cost of acquisition
- Flexibility for customization (with appropriate expertise)

There is a significant movement towards utilizing open source components by many organizations. While beliefs exist that open source software is more prone to security faults due to the free nature of the

software, this is not the case. A large number of components that drive today’s internet rely on open source components. As they are open, they work to build trustworthiness in the community.

A detailed consideration for calculating TCOs for open source software is available from the London School of Economics:

- [London School of Economics: Total cost of ownership of open source software](#)

## Summary

It is not uncommon for teams to want to build a solution. After a detailed assessment of the requirements, it may be discovered that solutions are possible by combining commercially available and open source solutions that are widely available.

The impact on different TCO factors for the three different software solutions is presented in table 4 below. A high degree of variability exists with some solutions and will need to be considered on a case by case basis. This list is not exhaustive but represents a general approximation of TCO factors.

**TABLE 4. TCO FACTORS BY TYPE OF SOFTWARE SOLUTION.**

TCO Factor	Build	COTS	Open Source
<b>Cost of Search</b>	<ul style="list-style-type: none"> <li>• Upfront evaluation studies</li> <li>• Test deployments</li> <li>• Proof-of-concept development</li> <li>• Assessment of references</li> </ul>	<ul style="list-style-type: none"> <li>• Upfront evaluation studies</li> <li>• Assessment of references</li> </ul>	<ul style="list-style-type: none"> <li>• Low cost of assessment as solution can be deployed and evaluated freely</li> </ul>
<b>Initial Costs</b>	<ul style="list-style-type: none"> <li>• Trained individuals to support the general operations and backups of the systems</li> <li>• Development risk and costs</li> </ul>	<ul style="list-style-type: none"> <li>• Trained individuals to support the general operations and backups of the systems</li> <li>• Initial software costs</li> </ul>	<ul style="list-style-type: none"> <li>• Trained individuals to support the general operations and backups of the systems</li> <li>• Software modification costs</li> </ul>

	<ul style="list-style-type: none"> <li>Onboarding costs to train and acquire the skilled developers</li> </ul>	<ul style="list-style-type: none"> <li>Cost of software customization (if possible)</li> </ul>	<ul style="list-style-type: none"> <li>Access to skilled developers for customization</li> </ul>
<b>Cost of Integration</b>	<ul style="list-style-type: none"> <li>Low cost as solution is custom and designed to be compatible with existing solutions</li> </ul>	<ul style="list-style-type: none"> <li>Cost of data migration and interfacing</li> </ul>	<ul style="list-style-type: none"> <li>Low cost as solution can be modified to be compatible with existing solutions</li> </ul>
<b>Cost of Operations</b>	<ul style="list-style-type: none"> <li>Internal support costs</li> <li>System security audits</li> </ul>	<ul style="list-style-type: none"> <li>Licensing</li> <li>System security audits</li> </ul>	<ul style="list-style-type: none"> <li>Internal support costs</li> <li>System security audits</li> </ul>
<b>Cost of Maintenance/Service</b>	<ul style="list-style-type: none"> <li>Maintenance and Service costs</li> <li>Security patching</li> <li>Feature updates (development costs)</li> </ul>	<ul style="list-style-type: none"> <li>Maintenance and Service costs</li> </ul>	<ul style="list-style-type: none"> <li>Maintenance and Service costs</li> </ul>