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Toward Sustainable Funding for Information Technology Infrastructure

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Overview

Information technology (IT) services have been, in the main, very effectively deployed in universities and postsecondary institutions. The enabling capabilities of IT are used throughout all aspects of each institution's teaching and learning, research, administration, and communication activities. So successful have been the uses of IT services that they have become inseparable parts of the fabric of institutional life, as well as critical components that not only ensure the ongoing effective and efficient operation of our institutions but also their vitality and viability.

The continuing growth in the need for IT services requires both a method to identify them and a framework for ongoing funding. The practice of funding IT solely from current operating revenues is insufficient for planning, implementing, and operating an IT infrastructure consistent with the requirements of a 21st-century knowledge economy (Goldstein, 2004).[1] In addition, most methodologies for assessing and projecting IT costs are insufficient in both scope and rigor to provide IT professionals with the toolset necessary to ascertain, cost, and develop sustainable resource projections. The concomitant demand to improve and expand IT services provides an additional complexity that further challenges the current approach.

The purpose of this research bulletin is to present a framework for the effective, ongoing, sustainable funding of IT infrastructure in universities and colleges. The bulletin provides a perspective on the role of IT infrastructure in supporting core educational, research, and administrative functions. The framework also articulates the composition of IT infrastructure and derives a cost model for the provision of infrastructure services. The model is intended to be straightforward, enabling ready adoption while also providing flexibility so that it can be updated on a periodic basis to reflect changing technological demand and supply conditions.

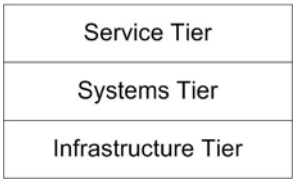
Highlights of a Sustaining Funding Model for IT

The framework developed here consists of a three-stage model.

- *Stage 1—Identification and definition of IT infrastructure:* Stage 1 provides the conceptual framework for defining what IT infrastructure is and how it relates to the activities of higher education institutions.
- *Stage 2—Assessment of IT cost:* Once the IT activities have been identified, determining their costs is both necessary and achievable. Stage 2 uses a total cost of ownership methodology to facilitate full economic costing of IT components.
- *Stage 3—Determination of cost drivers:* Stage 3 develops a method for predicting future expenditures so that a sustainable funding structure can be established.

Stage 1: Identification and Definition of IT Infrastructure

The framework used here uses a three-tiered structure to describe the provision of IT services to users.[2]



In the Service Tier, an IT service is defined as the capability the user requires to facilitate a business process or function. In higher education, IT services address four areas: research, teaching and learning, administration, and communications and networks.

In the Systems Tier, an IT system is defined as the collection of resources, assets, knowledge, policies, procedures, application systems, and organizational structures that are necessary to provide and operate an IT service. The Systems Tier includes the physical and nonphysical aspects of the service provision, and it represents a holistic approach to operating a service.

In the Infrastructure Tier, IT infrastructure is defined as all physical systems, resources, and processes required to support enterprise IT systems and services. This includes:

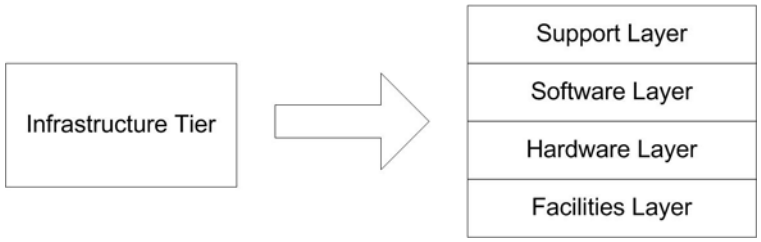
- Facilities to house equipment
- Computing hardware to facilitate IT systems hosting
- Computing software to facilitate IT systems hosting
- Network hardware and software
- Security hardware and software
- Identity management and network access
- Phone switching hardware and software
- Video and Web conferencing hardware and software
- Human resources required to service and maintain configuration
- External services required to service and maintain configuration

This model focuses on providing a framework to determine the infrastructure requirement as it responds to the identified organization needs at the Service Tier. This does skip over the Systems Tier, where the use of IT is determined and made effective and can be considered the most important aspect of the operational management of IT. Business process engineering, change management, project management, and the majority of human resource management reside at the System Tier level. It is for that

reason that this tier has received the overwhelming volume of attention of IT management and resources.

To develop a funding model, we must reduce the complexity of the interconnected, interdependent IT components so that we can obtain a functional understanding of the funding requirements of any given infrastructural structure. By adopting the tiered approach we can abstract the fundamentals of infrastructure provision from the system elements of service provision and create discrete infrastructure identities that can be quantified and costed. As a result, this model concentrates on the Service Tier and the Infrastructure Tier. The Service Tier identifies the requirements to fulfill the organization's service needs while the Infrastructure Tier identifies the requirements to fulfill the needs of the systems that support the service needs.

To further define a system's infrastructure, the Infrastructure Tier can be subdivided into four layers:



From the bottom up, facilities include the physical environment and services necessary to provide a sustainable location for the physical hardware:

- Electrical power
- Network bandwidth
- Heat, ventilation, and air-conditioning (HVAC)
- Fire suppression
- Room space
- Lighting

Hardware includes the equipment required to provide a physical platform for hosting the systems required to provide the IT services:

- Computers
- Servers
- Storage devices
- Archive devices

- Firewalls
- Phone and network switches
- Hubs and routers
- Cables and wiring
- Wireless transmitters

Software includes the programs required to provide a fully functioning IT system:

- Application software
- Security management software
- Database software
- Operating system software
- Computer utilities software
- ID and security management software

Support includes the human and knowledge resources required to ensure effective operation of the IT infrastructure. Support does not include the operating superstructure of the system to provide a business service because this resides in the Systems Tier.

Relating Service to Infrastructure

As noted above, providing an IT service requires the operation of a system that consists of both tangible and intangible resources. For the purposes of determining a funding framework, we must reduce the system to the tangible infrastructure. Then, the infrastructure required to provide a service must be mapped to that service. In this way we can relate the service to the underlying infrastructure. The service and infrastructure layers can be combined in the following matrix:

Service Layer	Research	Teaching and Learning	Administration	Networking and Communications
Support				
Software				
Hardware				
Facilities				

To demonstrate the use of the matrix, we can apply it to a specific example of an administrative system. The following is an example of the framework applied to a student information service:

Service Layer	Student Information Service
Support	System administrators System help desk
Software	Student information application Oracle database Identity and security management
Hardware	Application servers Database servers Storage and archive devices Firewalls
Facilities	Server room Network bandwidth

Through this mapping, the relationship of tangible infrastructure elements can be identified with the service provided, allowing for these elements to be quantified and costed.

Stage 2: Assessment of IT Costs

We asked ourselves if costing of the infrastructure components should be direct, all-inclusive, or incremental. Since we must provide these services on an ongoing, sustainable basis, we determined that the cost model should be based on an all-inclusive approach[3] that suggests all expenditures related to supporting the system should be included. This total cost of ownership (TCO)[4] approach includes both direct and indirect costs incurred throughout the life cycle of a resource:

- Acquisition
  - Hardware (purchase and lease costs) and software (purchased or developed)
  - Commissioning and deploying applications and systems
  - Hiring and contracting of experts to assist acquisition
- Operations
  - Maintenance
  - Training
  - Support
  - Downtime
  - Auditing
  - Virus protection and recovery

    - Power and energy consumption
    - Safety costs
- Retirement and disposal
    - System transition
    - Hardware disposal

Regardless of whether costs are classified as capital or operating expenses, the TCO approach suggests that the costs identified below should be included in the determination of the full cost of infrastructure provision. Categorization of costs (direct, indirect, and capital) is important to ensure that all costs are captured, but the items in each category may vary by institution. The list below identifies the major categories that are common within higher education.

Direct Costs

Direct costs include those that are directly attributable to the provision of infrastructure service, such as:

- Network access fees
- Power costs
- HVAC costs
- Space occupation costs
- Human resource support labor costs
- Training costs
- Licensing fees
- Maintenance fees
- Upgrade and conversion costs

Indirect Costs

Indirect costs include expenses required to deliver the activities necessary to provide service, such as:

- Overhead costs
- Administration costs
- Downtime costs
- Safety costs
- Risk costs

Capital Costs

Capital costs are incurred on a periodic basis to sustain the ongoing provision of services, such as:

- Hardware acquisition and commissioning
- Software acquisition and commissioning
- Facilities acquisition, provisioning, and commissioning

To effectively use this methodology, a matrix of cost factors relating the IT infrastructure components to the cost categories should be developed. The use of a hierarchical or tree structure to derive aggregated cost constituents makes this process relatively straightforward.[5]

The use of the TCO methodology will require agreement on what constitutes total cost. Nonetheless, the methodology is similar to costing schemas being used in many economic processes and is unlikely to be significantly different for the purposes required here.

Stage 3: Determination of Cost Drivers

Effective funding models must offer a formula that allows for estimating future resource requirements. Stages 1 and 2 enable the identification and quantification of the cost of IT infrastructural components, and Stage 3 determines and measures the impact of things that drive IT costs and thus enable effective estimating of future costs.

In order to achieve a forecasting framework, two further factors are required: identifying the cost drivers and determining their coefficients. By identifying the drivers and their coefficients, a funding formula can be constructed that allows the forecasting of funding levels for differing scenarios.

The cost drivers related to an IT infrastructure are:

- The number of system users
- The system requirements of the users
- The rate of technology/price index per system component

Number of System Users

The model provides the ability to identify the number of users in each service area at each infrastructure layer. For example, the number of students and faculty in the teaching and learning service area can be translated into the four-layer infrastructure requirements (support, software, hardware, and facilities). The coefficient of this driver is relatively straightforward to determine because group totals can be acquired from institutional records.

System Requirements of Users

Breaking down end-user services into their required subcomponents enables the determination of the user's or user group's system requirements—initially within each of the tiers and subsequently within each of the infrastructure layers.

Of course, system users are not a homogenous group, as there are ranges of users with very different needs. However, these users can be aligned with the four service areas because the requirements are similar within these groups:

- Research
- Teaching and learning
- Administrative
- Communication

If these categories are too broad, they can be subdivided into smaller groups and then aggregated for the funding analysis. The matrix provides an ability to aggregate the totals of each group to determine the requirement on both a vertical (user group) and horizontal (infrastructure layer) basis.

The coefficients of the identified services in the tiers can be obtained through an internal analysis of the IT service department's activities. For example, the help desk cost attributable to the student information system (SIS) can be determined by apportioning total help desk costs in the same ratio as the SIS call volume to the total call volume. Likewise, one can analyze the percentage of system administrators' time spent to service and maintain the SIS by assigning a percentage of total system administration costs.

For assessing resources that may be needed for the future, a tool such as the EDUCAUSE Core Data Service[6] can highlight areas of potential need and the resources required to meet them. In this way, the model can provide both the ability to project existing needs into the future and anticipate new resource requirements for the foreseeable future.

Technology/Price Index

The technology/price index is analogous to the Consumer Price Index in that it reflects the average price change for a given technological capability. There is a degree of ambiguity built into the index as a function of the rapid development of new capabilities and the equally rapid deflation of IT costs. Using the index therefore requires frequent reviews of technology pricing to create useable index projections.

The technology/price index comprises several key indicators within each infrastructure layer:

- Software
  - Operating system cost per user license

        - Database license per processor, per seat license
        - Application license costs per seat
    - Hardware
        - Cost per million instructions per second (MIPS) of CPU processing speed
        - Cost per gigabyte of RAM
        - Cost per terabyte of storage
    - Support
        - Wage and labor cost
    - Networking and communications
        - Bandwidth costs per megabit per second
        - Support
        - Software
        - Hardware
        - Network and communications

Although developing a technology/price index can take time and effort, once done it can be easily modified and recalculated when prices change. This index is a key element for assessing and updating TCO.

Conclusion

Thus the model provides the ability to determine and predict key cost drivers to technological usage for each of the institution's service areas. It also allows the flexibility to incorporate changes in the provision of services and the requirements of institutional stakeholders. The model further provides a dynamic methodology to incorporate the changes in the cost and ongoing development of technology.

What It Means to Higher Education

The growing requirement within higher education institutions to provide adequate resources to enable the sustainable provisioning of an IT infrastructure requires rational decision making based on evidence, rational predictions, and sound judgment. IT owners must provide a reasoned and understandable set of criteria to facilitate the required level of understanding among higher education leaders so that they can make informed decisions.

To be effective, IT managers need strategic, holistic, and long-term perspectives when considering IT design and funding. *Strategic* refers to the role IT plays in the institution's activities. There are very few administrative functions that do not have an IT component,

and increasingly, there are few research and learning functions that are not IT-dependent as well. *Holistic* refers to viewing IT from a systems perspective to see the interdependencies inherent in the provision of integrated systems. IT systems are a silicon cast of organizational policies, practices, and processes, and they are effective only to the degree that they are intelligently developed, efficiently deployed, and fully reliable and sustainable. *Long term* refers to adopting a life-cycle approach to funding IT as opposed to "event costing," which focuses on acquisition costs. The TCO approach provides both a life-cycle perspective and a comprehensive accounting for IT costs, which furnishes the basic cost elements for aggregating into the funding model.

Key Questions to Ask

- How can the projected cost of IT within an institution be estimated?
- Is IT funding aligned with the institution's strategic goals?
- How can the interdependent nature of IT systems be clarified and understood by nontechnical leaders?
- How can systems costing be related to systems funding?
- How can IT systems decisions be provided to decision makers in a framework that is both correct and does not require systems expertise?
- How can a growing strategic capability be adequately funded to ensure sustainability?
- What is the appropriate level of expenditure on IT infrastructure?
- Why is TCO methodology more than an accounting tool? How does it provide the basis for strategic decision making?
- Where can we benchmark our IT infrastructure costs against similar organizations?

Where to Learn More

- Broadbent, M., & Weill, P. (1997, Spring). Management by maxim: How business and IT managers can create IT infrastructures. *Sloan Management Review*, *38*(3), 77–92.
- Landon, B., Henderson, T., & Poulin, R. (2006, July 19). Massachusetts Institute of Technology peer comparison of course/learning management systems, course materials life cycle, and related costs: Final report. Retrieved April 26, 2007, from http://www.wcet.info/services/publications/MIT07-19-06.pdf

- McKeen, J. D., & Smith, H. A. (2003). *Making IT happen: Critical issues in IT management*. Chicester: John Wiley & Sons, Inc. Available from http://ca.wiley.com/WileyCDA/WileyTitle/productCd-0470850876,descCd-authorInfo.html
- Schmidtlein, F. A., & Taylor, A. L. (2000, December). Identifying costs of instructional technology in higher education. *Tertiary Education and Management, 6*(4), 289–304. Available from http://www.springerlink.com/content/u028646651g42841/?p=51a5625df13e452082ef0ad32b5ecc50&pi=4
- West, R., & Daigle, S. L. (2004, January 6). *Total cost of ownership: A strategic tool for ERP planning and implementation* (Research Bulletin, Issue 1). Boulder, CO: EDUCAUSE Center for Applied Research. Available from http://www.educause.edu/ecar/

References

- Boeke, M. (Ed.). (2004). *TCM casebook, version 2.0*. Boulder, CO: WCET. Available from http://www.wcet.info/services/tcm/about.asp
- Goldstein, P. (2004). *Information technology funding in higher education* (Research Study, Vol. 7). Boulder, CO: EDUCAUSE Center for Applied Research. Available from http://www.educause.edu/ecar
- Hawkins, B. L., & Rudy, J. A. (2006, November). *EDUCAUSE Core Data Service fiscal year 2005 summary report*. Boulder, CO: EDUCAUSE. Available from http://www.educause.edu/apps/coredata/reports/2005/
- Jones, D. (2004). *TCM handbook, version 2.0*. Boulder, CO: WCET. Available from http://www.wcet.info/services/tcm/about.asp
- Milonas, A., Smyser, R. W., & Grochow, J. M. (2006, August 1). *So, what does IT cost?* (Research Bulletin, Issue 16). Boulder, CO: EDUCAUSE Center for Applied Research. Available from http://www.educause.edu/ecar
- Pink Elephant. (2004). *Defining, modeling and costing IT services: Integrating service level, configuration & financial management processes*. Available from https://www.pinkelephant.com/en-US/ResourceCenter/PinkPapers/

Endnotes

1. The current state of funding is described well by Philip Goldstein (2004) in the study on IT funding in higher education. The lack of a strategic perspective is evident as is the precarious nature of most institutions' IT activities.
2. The basic framework used here is based on Pink Elephant (2004).

3. This approach differs from the 2006 model described in Milonas, Smyser, & Grochow (2006) in that it focuses on activities that drive costs. Another difference is in the inclusion of indirect costs, which, while subject to some subjectivity, yield a complete accounting of the total cost of ownership.
4. The TCO concept was originally developed by B. Kirwin of the Gartner Group in 1987. It was aimed at determining the cost of owning and deploying personal computers. Since its original publication, the concept has gained wide acceptance as an evaluation method for IT-related costs.
5. The approach differs from the *TCM Handbook*, a model for deriving the costs of course delivery developed by the Western Cooperative for Educational Telecommunications (WCET) (Boeke, 2004; Jones, 2004). The WCET model focuses on direct, manageable costs and does not provide a method for the determination or allocation of support costs.
6. The annual EDUCAUSE Core Data Service survey of higher education institutions on a range of subjects provides excellent insights into the current and the emerging state of technology in the sector (Hawkins & Rudy, 2006).

About the Author

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