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The Patterns and Structures of Information Technology Departments in Higher Education

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THE PATTERNS AND STRUCTURES OF INFORMATION TECHNOLOGY DEPARTMENTS IN HIGHER EDUCATION

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Abstract

This study investigates the patterns and structures of the Information Technology (IT) department in US colleges and universities. It seeks to understand to whom the Chief Information Officer (CIO) reports, how the top level of the IT department is organized, and what functions the IT department offers. It then examines the university factors that are associated with variations. This quantitative case study uses primary data from the EDUCAUSE Core Data Survey (CDS) and IPEDS, combined with a novel dataset collected from university websites and AAU membership. The study employs Latent Profile Analysis (LPA) using IT variables to classify institutions into a four-class model that is then contextually examined using IT and university factors.

This study reveals key insights into IT configurations in elite institutions, demonstrating a dichotomy between large centralized and decentralized departments and underscores the challenges in calculating the costs of decentralized IT due to data limitations. It highlights the benefits of centralization for cybersecurity. Further, it finds the absence of a one-size-fits-all reporting structure for CIOs and advocates for their strategic inclusion in decision-making processes. Additionally, the importance of specialty functions within IT departments is emphasized, suggesting institutions tailor these roles to their missions, with project management identified as a critical function across all institutions.

This study investigates IT configurations across higher education, uncovering distinct patterns in elite institutions and revealing challenges in accurately capturing decentralized IT costs and configurations. It identifies the overrepresentation of doctoral institutions and variability in EDUCAUSE data reliability as areas affecting research outcomes. Recommendations for future research include employing more representative samples, enhancing data accuracy, and deepening understanding of decentralized IT through partnership and collaborative research. Finally, the study suggests examining the unique IT strategies of elite universities and the role of specialty functions within higher education IT departments, offering a foundation for further studying and improving IT governance and strategy at colleges and universities.

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Chapter 1: Introduction

Information Technology (IT) is the use of computers, software, networks, storage, and other technology to manipulate, process, store, and retrieve data. IT is a relatively young field, starting in the latter half of the twentieth century, followed by astronomical growth over the past twenty-five years (Hilbert, 2014). Indeed, wireless networks were new and cumbersome in the year 2000, today's smartphone did not gain significant prominence until Apple released the iPhone in 2007, and the proliferation of sharing tools for media and collaboration has only exploded. For example, companies such as Microsoft, Box, Zoom, Slack, and Dropbox offer real-time communication between distributed users around the globe (Bianchi & Sousa, 2016; Gannon, 2013; Hashem et al., 2015). In short, IT has become a ubiquitous part of daily life for individuals in the U.S. (Ransbotham et al., 2016).

In addition to its impact on individuals, IT also plays a critical role in organizations. Specifically, IT automates manual processes, improves collaboration, provides support in decision-making by handling large datasets, and can build a firm's competitive advantage through novel methods of exploiting technology (Banker et al., 2011; Brown & Magill, 1994; Chun & Mooney, 2009; Coltman et al., 2015). In practice, IT is the combination of hardware in the form of networking to connect computers and storage that run complex enterprise applications, the "complex computer programs that underpin the operations of most large businesses" (Gannon, 2013, p. 50). This collection of infrastructure for networking and computing and software for enterprise systems is operated by specialty technicians who are the primary interest in this study. The role of IT extends into higher education where the impact resonates through students' interaction with technology, changes in the landscape of teaching and learning, growth in administrative activities, and the realm of research.

IT plays a similar, if not even more significant, role in today's modern colleges and universities (Aiqun, 2018; Al-Kurdi et al., 2018; Bianchi & Sousa, 2016; Gumport & Chun, 1999). Researchers have acknowledged the widespread proliferation of technology and its use among college students for learning, entertainment, and social connection (Laird & Kuh, 2005; Rashid & Asghar, 2016). Let us turn to an example of a fictional student to illustrate this. Sophia lives on a residential campus while attending college. Luckily, Sophia does not have an early class and connects wirelessly to the college network to attend a 10:00 AM Zoom video appointment with her advisor. After her Zoom appointment, Sophia logged into the Learning Management System (LMS) to check if she had any notes from her professors or new assignments. Afterward, she checks her email and thinks again that she receives too many from all around campus – she may reply to a survey about communications preferences – later. She walks to the dining hall with friends, scans her ID, and the dining software system tracks her meal plan. This simple example shows transformations in teaching and learning through an electronic LMS and video appointments, much of which theorists predicted in the late 1990s.

From a teaching and learning perspective, Gumport and Chun (1999) discussed the three arenas in which technology could impact higher education: (a) fundamentally changing how and where knowledge is created and stored, (b) the process of teaching and learning by altering the when, how and where teaching occurs, and (c) the social organization of teaching and learning in higher education into more individualistic opportunities. Gumport and Chun argued that technology could fundamentally alter the delivery of instruction, and their predictions have become a reality. For example, the rise of capabilities and methods in online teaching has created additional technology needs for recording and delivering courses, creating a corresponding need for the skills to manage the technology that delivers and stores courses (Martin et al., 2020).

While students like Sophia interact with IT at a personal level, IT systems also play a crucial role behind the scenes in managing the administrative complexities of modern universities. Gumport and Pusser (1995) explored the rise of college administrative needs through a case study of the University of California. They found a disproportionate rise in “Administration” as it grew over 400 percent over 25 years as opposed to instruction, which only grew 175 percent. Similarly, European researchers have observed a comparable growth pattern in administrative structures at colleges and universities (Baltaru & Soysal, 2018; Rhoades & Sporn, 2002). As administration grows, so does the need for mechanisms to coordinate and organize functions. For example, the electronic software category called Enterprise Resource Planning (ERP) system helps to streamline and coordinate human resources, financial processes, operational activities, and student information in one electronic system. Further, ERPs represent significant institutional financial and human resource investment that affects many aspects of an institution during and after implementation (Althonayan & Althonayan, 2017; Monk & Lycett, 2016; Sullivan & Bozeman, 2010). For example, Althonyan and Althonayan illustrated that an ERP requires specialized IT resources to expand capabilities, maintain existing functions, install security patches, and ensure systems availability.

In addition to the growth of consumer systems like wireless technologies and software, the nature of knowledge creation has also been transformed. For example, large and specialized supercomputers were crucial to researchers in the monumental discovery of the Higgs-Boson particle (Adam-Bourdarios et al., 2015).

The growth in technology, software, and hardware needs for students, administrators, and researchers corresponds to a growing need for IT staff and structures to maintain these systems. While the growth of technology in higher education has impacted teaching, learning, research, and administrative processes, this transition is not without its challenges. As universities continue to navigate the landscape, they face challenges that test resilience and adaptability to meet needs. As colleges and universities face increased pressures across many fronts, including declining enrollments, decreased funding, and increased scrutiny, all of which increase organizational uncertainty, they used technology to adapt (Blumenstyk, 2023; Sanchez, 2023; Taylor & Cantwell, 2018; Whatley & Castiello-Gutiérrez, 2022; Wingard, 2022). For example, colleges and universities responded to these uncertain environments by expanding online course delivery, increasing hybrid learning options, expanding credentials, and increasing grant-funded research activities (Altbach, 2011; Babu, 2022; Barringer et al., 2020; Ellis, 2020; Fox & Nikivincze, 2021).

Perhaps the most concrete recent example of how to respond to uncertainty with technology was the college- and university-wide adaptations to address the rapid onset of the COVID-19 pandemic, which relied heavily on IT departments. During this time, IT played a significant role by helping build flexible solutions such as online and hybrid course options for teaching, implementing tools such as Zoom, and building out the infrastructure for case management and contact tracing (Blankenberger & Williams, 2020; Damijana et al., 2020; Losina et al., 2021). The shifts were necessary during the pandemic because faculty, students, and staff could no longer be in close contact with each other without risking spreading the disease further. Still, colleges and universities cannot operate without tuition (Blankenberger & Williams, 2020). Therefore, courses needed online delivery, workers needed remote access from home to the campus, and staff needed methods to track COVID cases (Benito et al., 2021; Damijana et al., 2020; Lemoine & Richardson, 2020; McNamara, 2021; Perz et al., 2020). Recent research has provided concrete empirical evidence that IT departments played a crucial role during the pandemic and that IT department organizational design played a role in student satisfaction (Park et al., 2023). Specifically, the study found that the centralization level of the IT department enhanced the execution of the response to the pandemic as more centralized IT departments could respond more rapidly to the pandemic by marshaling resources. Given the ubiquity and need for technology, IT plays an increased role in colleges and universities, raising the question of where the IT department fits in today's colleges and universities. However, addressing this question regarding how IT fits in today’s colleges and universities requires examining the higher education organization, which I will turn to now.

Colleges and universities are complex organizations with faculty conducting teaching, research, and service with a bureaucracy needed to support all ancillary needs, including managing student academic records, investment management, public relations, housing, recreational sports, billing and finance, and parking (Birnbaum, 1989; Birnbaum & Eckel, 2005; McClure & Anderson, 2020; Weisbrod et al., 2008). Many of these aspects of these organizations require specialized hardware or software for the efficient delivery of services (Al-Kurdi et al., 2018; Bianchi & Sousa, 2016; Coen & Kelly, 2007; Sullivan & Bozeman, 2010). The IT department is a collection of IT professionals with various technical and non-technical skills to manage the specialized hardware and software (Luftman & Kempaiah, 2007; Reich & Nelson, 2003; Rockart et al., 1996; Todd et al., 1995). Turning back to the earlier example, Sophia, who has connected to the wireless network, participated in a Zoom meeting, accessed the LMS, and swiped her dining card. The functional skillset needed to build and maintain a wireless network vastly differs from the LMS software administration skillset. Thus, one way to think about the IT department is as a collection of units and functions that its leadership must logically organize to offer services effectively.

As IT has become more necessary to organizations, so has the role of the Chief Information Officer (CIO) as the leadership apex of the IT organization. With the rise of the CIO, researchers have investigated the importance of the relationship of the CIO to the other members of the top management team (Smaltz et al., 2006), the importance of the CIO to strategy alignment (Coltman et al., 2015), and the necessary skills of a successful CIO (Dlamini, 2013). However, most of the research into CIOs is focused outside of higher education, and the only exception is the limited research on the needed qualities and relationships of the higher education CIO (Brooks & O'Brien, 2019; Pinho & Franco, 2017). Regardless of industry, literature does stress the importance of the placement of the CIO in an organization, such as reporting to the top officer or the CFO (Dlamini, 2013; Grover et al., 1993; Liu et al., 2020; Park et al., 2023). The evolving role of the CIO raises a crucial question at colleges and universities: just how integrated is the CIO into the leadership of colleges and universities?

The placement of the CIO, specifically assuring them "a seat at the table," was highlighted as the number one issue in EDUCAUSE[1]'s annual list of IT issues describing trends and the "way technology is helping to create the higher education we deserve" (Grajek et al., 2022). Why? The introduction says that "if an institution wants to be successful, people who understand the institution as well as technology and data—that is, people like today's IT leaders—need to be involved in strategic planning and decision-making" (Grajek et al., 2022). So, then, does IT have a seat at the table? In 2019, EDUCAUSE asked where the CIO reported at colleges and universities. At the time, 29% of CIOs surveyed directly reported to the institution's president (Brooks & O'Brien, 2019). On the other hand, a 2020 EDUCAUSE quick poll of 243

[1] This is a higher education IT research organization (https://www.educause.edu/)

IT leaders found that 60% of CIOs were members of the president's cabinet, though the survey did not specifically question reporting relationships.

The authority of a CIO is a function of their reporting relationship to either the president or an individual who reports to the president (e.g., CFO), the level of centralization of the IT functions, and the availability of financial resources (Park et al., 2023). The present study seeks to clarify colleges and universities' choices concerning IT leadership, centralization of functions, and resources. Further, it explores mechanisms to determine if institutions see IT as a strategic priority or simply administrative overhead necessary to ensure operations.

There is only one recent journal article exploring the reporting relationship of the CIO in colleges and universities (Park et al., 2023). The study finds that two factors yielded the best outcome in student satisfaction methods: CIOs of highly centralized organizations and CIOs are presidential cabinet members. Industry research also supports a shift in the reporting relationship of the CIO. For example, a 1989 research study found that most CIOs did not report to the CEO but instead reported to an individual who reported to the CEO (Raghunathan & Raghunathan, 1989). In contrast, in 2011, most had flipped to reporting directly to the CEO; this change potentially indicates the increased prominence of the overall IT department to organizations in non-higher education industries (Banker et al., 2011).

Beyond the CIO, IT researchers have tended to examine IT at an enterprise level and focused more on the capabilities produced by IT, the consequences of IT, and alignment with business needs instead of the functions (Chan, 2008; Hughes, 2006). For example, researchers have examined centralization and decision rights (Sambamurthy & Zmud, 2000; Zmud, 1984), how IT relates to the rest of the organization (Brown & Magill, 1994), management of IT skillsets and talent (Luftman & Kempaiah, 2007), and leveraging IT capabilities (Sambamurthy

& Zmud, 2000). While all valuable, the aggregate treatment has also left a dearth of understanding of the IT organizational structures (Peppard, 2018). While industry-based research can help understand IT trends, higher education is a unique and complex enterprise that warrants further attention. For instance, numerous parallels and divergences exist between the technological requirements of higher education institutions and those of the broader industry (EDUCAUSE, 2020; Park et al., 2023). Similarities include essential needs such as networking, computing, enterprise administrative applications (e.g., student information systems, human resources, payroll, and finance), support and training services, and information security. However, higher education distinguishes itself with unique demands for educational technology, research computing, and specialized applications tailored to specific academic and administrative departments.

There are several gaps in the literature relating to the study of IT at colleges and universities. For example, the small amount of literature available centers on the CIO (Dlamini, 2013; Pinho & Franco, 2017), IT governance in colleges and universities (Bianchi et al., 2021; Bianchi & Sousa, 2016; Coen & Kelly, 2007), the effects of IT centralization during uncertain conditions (Park et al., 2023), and the impact of IT decentralization on information security incidents (Liu et al., 2020). This leaves a gap in the literature examining the patterns and structures of the IT department in higher education as well as the reporting relationship of the CIO and the functional areas of higher education IT. The gap is not dissimilar to the gaps in the literature and understanding of the larger overall structure of higher education organizations (Barringer & Pryor, 2022; Kezar et al., 2020).

In sum, the limited research that does exist has focused on IT governance, CIO roles, and large system implementations and fails to address the structures and functions of IT (Aiqun, 2018; Althonayan & Althonayan, 2017; Baldridge et al., 1991; Bianchi & Sousa, 2016; Brooks & O'Brien, 2019; Coen & Kelly, 2007; Dlamini, 2013). Therefore, this study will address the gaps in IT literature and IT in higher education literature by conceptualizing and evaluating the structures and functions of the IT departments at colleges and universities.

Problem Statement

The role of IT in higher education institutions is evolving rapidly mainly due to changes during the COVID-19 pandemic. Nevertheless, there remains a significant gap in understanding the role and organizational structure of IT in higher education. While EDUCAUSE's 2018 Top Issues report suggested "repositioning or reinforcing the role of IT leadership as a strategic partner" in achieving institutional goals, there is a notable scarcity of peer-reviewed research explicitly addressing the organization of IT within colleges and universities (Grajek et al., 2018, p. 28). The lack of study leaves an underdeveloped understanding of IT's role in today's changing educational landscape.

There is also a lack of understanding of how IT is organized to support and enhance institutional missions. Consequently, we lack an empirical understanding of where IT resides within the higher education hierarchy and to whom the CIO reports. Without this knowledge, exploring the relationships between institutional reporting choices and outcomes such as student retention and research productivity is problematic. Building on this knowledge base sets the stage for future research to understand if IT is a strategic asset to colleges and universities.

Literature suggests that hierarchies, including the higher education IT department, matter inside and outside universities (Baldridge et al., 1991; Barringer & Pryor, 2022; Berger, 2002; Birnbaum & Eckel, 2005). Further, the hierarchy directly represents what positions exist and how they are grouped into units to provide the basis for formal authority (Bolman & Deal, 2021;

Mintzberg, 1979). In practice, Berger (2002) built upon prior research to suggest that organizational structures at colleges and universities affect student learning outcomes. While Berger's study was unrelated to IT hierarchies, a deeper understanding of IT at colleges and universities can set the stage for future studies to examine IT as a factor in outcomes. For example, investigating LMS adoption at differing universities could be beneficial. Further, understanding the placement of IT within the hierarchy may inform the research into LMS adoption.

Several studies examine academic departments through a resource lens to describe how they may influence budgetary considerations or react to program reductions through influence or power (Cameron et al., 1987; Gumport, 1993; Pfeffer & Salancik, 1974). There are only a handful of studies of academic structures and hierarchy; however, each is focused primarily on the structure of academic departments due to their centrality of advancing the institutional mission, dictating degrees offered, and teaching students (Barringer & Pryor, 2022; Pryor & Barringer, 2021). In addition, there are studies on the administrators of colleges and universities primarily focused on the growth and role of the administrative function (Gumport & Pusser, 1995; McClure, 2016; Rhoades & Sporn, 2002). The studies highlighted above use various lenses and frameworks to consider power, size, and structure, which are also relevant to this study. Additionally, Rhoades and Sporn (2002) examined several European and American case studies. They discussed "managerial professionals" who are "[n]either professors nor administrators…have professional associations, conferences, journals, and bodies of knowledge that inform their practice, but they lack the independence of faculty" (p. 16). However, very few of these studies examine the structure of anything within colleges and universities beyond an academic department. This study expands our understanding of college and university structures by addressing a non-academic IT unit within these complex organizations.

Finally, it is crucial to understand if IT is strategically integrated or merely another function. Research outside of higher education has shown direct and indirect relationships between IT and a firm's strategic performance (Coltman et al., 2015). This study aims to clarify the organizational role of IT in colleges and universities, which is fundamental to teaching, learning, and research today. By examining the placement and structure of IT departments, this research will illuminate how IT is positioned as a strategic or operational element within the complex landscape of higher education.

Purpose of the Study

This quantitative study examines the organizational structures of IT departments in higher education from a structural perspective, illuminating IT's role and strategic importance. This builds on existing research on structure and hierarchy, both generally and specifically in higher education, underscoring the significance of structures and hierarchies as they are integral to decision-making and authority (Baldridge et al., 1991; Giessner & Schubert, 2007; Pusser, 2003). To address this gap, I ask two research questions in this study:

Research Question 1: How is the top-level management of IT departments organized in higher education institutions?

Research Question 2: Which factors are associated with variations in the organizational structure of IT departments at colleges and universities?

Research Question 1 seeks to shed light on the structures of IT departments and how these units are situated within universities. Understanding to whom the CIO reports and the structure of the IT subunits is essential, as it reflects the IT department's authority, resources, and strategic alignment. For instance, whether a CIO reports to the president or the CFO can significantly influence the IT department's scope and priorities. Additionally, this question aims to identify IT departments' various technology functions, such as learning technologies, administrative technologies, or research computing, highlighting their role in supporting the university's mission.

Research question 2 builds on the insights from the first research question to assess and understand the differences between universities' IT structures. Further, it evaluates potential influencing factors like the institution's research profile, sector, size, location, or ranking. This question adds to the literature that assesses how patterns of structures vary across different colleges and universities (Barringer & Pryor, 2022). It also explores the extent of technology centralization in universities and the factors that may drive such organizational choices. Together, these research questions aim to deepen our collective understanding of IT’s organizational structure in colleges and universities, thus providing insights into how IT departments are organized and managed in response to various institutional contexts and needs.

Research Design & Contributions

The present study leverages existing secondary datasets (e.g., EDUCAUSE and IPEDS) with a novel dataset collected from university websites to assess these research questions. It utilizes a quantitative approach because it offers an opportunity to use a dataset to generalize the larger population of colleges and institutions while empirically examining the placement of IT relative to the president and the horizontal subunits in the IT department. Specifically, this study evaluates patterns in the structures and hierarchies using Latent Profile Analysis (LPA). LPA is a technique used to identify underlying subgroups or classes in a population based on patterns of variables (Barringer & Pryor, 2022; Spurk et al., 2020). It then examines the characteristics of the colleges and universities in these clusters to determine how these college or university characteristics are related to the IT structural profiles of these institutions.

This work makes several contributions to higher education IT management and organization. First, this study provides an in-depth examination of IT structures at colleges and universities, focusing on the broader institutional context. This perspective is crucial for understanding how IT fits into the strategy of colleges and universities. Further, it has future implications for IT governance and organizational design. Second, this study contributes to developing a more comprehensive and nuanced dataset from a large and diverse sample of higher education institutions. The same dataset could inform additional research into higher ed and IT. Third, it will discern if there is a significant variation in the IT structures of higher education or if they are relatively homogenous. The analysis can help shed light on the diversity of IT management approaches in differing institutional settings, which can help inform further research. Finally, this study endeavors to identify the distinguishing characteristics of IT departments at colleges and universities instead of other industries based on the functions provided. Overall, the contributions of this study offer future frameworks for studying IT organizational patterns and characteristics.

Organization

This dissertation is organized into five chapters, each building upon the other. This first chapter sets the stage for the study by outlining the motivation, problem of practice, and specific research questions. Further, it establishes the context and lays the groundwork for the subsequent chapters. Chapter Two reviews relevant literature for IT, functions of the IT department, the Chief Information Officer (CIO), university leadership, and university decision-making. Chapter Three outlines the research approach, specific research design, and methodology for the present study. Chapter Four highlights the findings and results, including (a) a preference towards centralization in smaller institutions, (b) a trend towards decentralization for elite research universities, and (c) an increasing trend of the CIO reporting to the president. Finally, Chapter Five concludes the study and outlines implications and suggestions for future researchers, including (a) research into the outcomes of centralization efforts, (b) a deeper study into IT at elite research universities, and (c) additional studies on IT governance and decision mechanisms at colleges and universities. Each chapter in this dissertation contributes to a deeper understanding of IT at colleges and universities.

Chapter 2: Literature Review

The present study seeks to answer two research questions about colleges and universities' information technology (IT) organizations. First, how is the top-level management of IT departments organized in higher education institutions? For instance, does the senior IT leader[2] report to the President, Chief Financial Officer, Provost, Chief Business Officer, or another person? Second, which factors are associated with variations in the organizational structure of IT departments at colleges and universities? For instance, are organizations of similar size organized in the same fashion?

Additionally, is IT organized differently at institutions with differing missions? Colleges and universities need IT for records management, wired and wireless networking, supporting research, supporting teaching and learning, and remote delivery, all of which are integral to the daily functioning of higher education organizations. Given the need for IT in colleges and universities, understanding the structures of these units will further clarify the value of IT to colleges and universities while building new research into an understudied field.

I have divided the literature into two primary areas within this chapter: IT literature and Higher Education structures literature. IT has grown and evolved over the past six decades, making it ideal for examining this from a historical perspective, as I do here because each evolution shapes the role of IT and its relationship to the larger organization (Gannon, 2013; Peppard, 2018). As capabilities increased and technology became more consumer-friendly, researchers and practitioners explored ideal organizational structures, functions, curriculum, and

[2]This study will examine the reporting relationship irrespective of the title of the top Information Technology professional because there are several potential titles, such as Chief Information Officer, Chief Technology Officer, or Information Technology Director.

hiring needs (Blanton et al., 1992; Brookshire et al., 2007; Diane, 2003). The literature on IT is addressed before the literature on college and university structures for two reasons. First, most of the IT literature is outside the university context and does not engage with the literature on higher education. Thus, treating the literature separately provides valuable context from the larger IT field before addressing IT within the context of higher education.

The literature on higher education structures explores leadership, administration, decision-making processes, institutional pressures (i.e., isomorphism), and resource dependencies. It is structured in this fashion because a university is a unique enterprise shaped by its unique characteristics and leadership and bifurcated governance structure (Altbach et al., 2005; Baldridge et al., 1991; Birnbaum, 1991; Birnbaum & Eckel, 2005; Pusser, 2003). The characteristics and leadership will, in turn, shape how the IT unit is structured at colleges and universities. I will conclude by bringing IT and higher education structure literature together to address how both influence the structure of IT at colleges and universities.

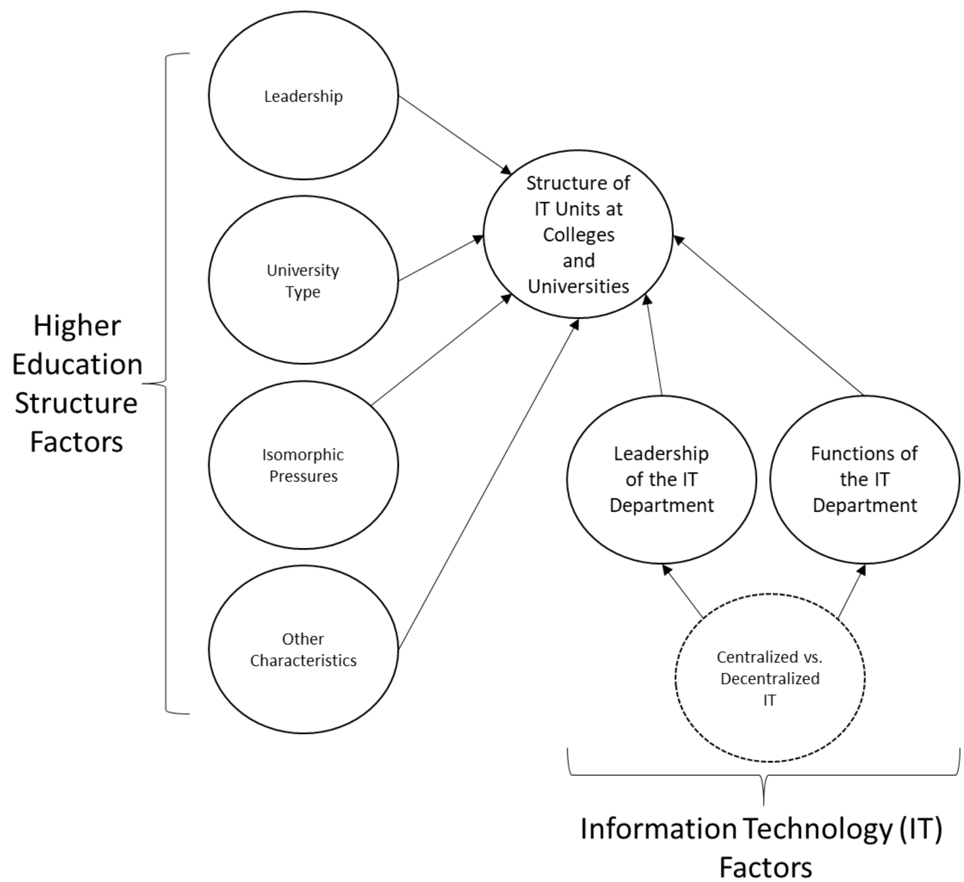
However, before turning to the literature, I first address my conceptual model, which provides context for understanding my larger arguments throughout this literature review. Further, it combines the literature on IT and higher education structures to provide an understanding of the factors that influence IT structures in colleges and universities.

Conceptual Model

I argue here that two sets of factors influence the structure of IT units at colleges and universities. By structure, I mean the reporting relationship of the leader of IT and the subunits that report to the leader. The two sets of factors are Information Technology (IT) and higher education factors, shown by the horizontal and vertical brackets, respectively, in Figure 2.1. I argue that IT factors exist across IT departments irrespective of the industry because of commonalities of needs such as hardware and software. On the other hand, higher education factors shift the IT needs beyond the commonality of all IT departments to what is unique in the higher education industry. For instance, a university may require a student information system, whereas Amazon would not.

Figure 2.1

Conceptual Model

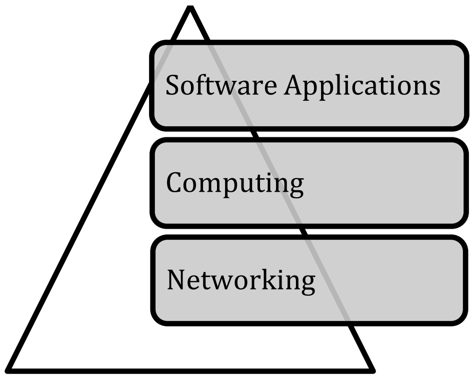


Three IT factors influence the higher ed IT structures. First, the IT department's leadership, usually embodied via the Chief Information Officer (CIO), influences the IT department. The role of the CIO has also evolved in conjunction with technology capabilities (Banker et al., 2011; Chun & Mooney, 2009; Grover et al., 1993; Peppard, 2018; Pinho & Franco, 2017). The CIO is central to the leadership of the IT department because they represent the organization’s apex, with the authority to make choices about functions, personnel, activities, and projects. For example, a highly strategic CIO may have the influence to be moved to report directly to the president. In contrast, a more administratively focused CIO may continue to report to the CFO.

Second are the functions of the IT department, which were introduced briefly on page 2 and elaborated upon on page 7 in Chapter 1. The IT department’s standard functions include networking, computing, and building or buying software (Leidner & Kayworth, 2006; Peppard, 2018; Rockart et al., 1996; Todd et al., 1995; Zammuto et al., 2007). Benamati and Lederer (2008) defined IT as “any hardware or software used to build, operate, or maintain and organization’s [IT] applications.” Thus, the three significant functions offered by the IT department are (a) the communications infrastructure necessary for computers to communicate, (b) the computing infrastructure needed to process transactions, and (c) the software applications that run on the communications and computing infrastructure (Benamati & Lederer, 2008; Blanton et al., 1992; Brown & Magill, 1994). A modern example will help to illustrate this. Email is a software application that must run on a server, and computers need networking to connect to the server that runs the email software. Figure 2.2 provides a visual description of a layered pyramid on which the software application is the apex, and I use these functions to synthesize across the literature.

Figure 2.2

Essential Functions



Third is the circle titled Centralization vs. Decentralized IT. When fully centralized, all IT personnel report to one individual, which I call the CIO here. When fully decentralized, IT reports to their respective business units instead of to a CIO. For example, a university's engineering and law school deans each choose to hire an independent IT department responsible for networking, computing, and software for their respective schools. The two IT departments have created decentralized IT because each is responsible for a subset of the university's overall needs. Further, EDUCAUSE, the higher education IT research organization, administers an annual survey to IT departments in higher education, and the survey instrument defines centralized IT as "[t]he centralized IT services and support organization reporting to the highest-ranking IT administrator/officer in the institution" (EDUCAUSE, 2020).

Researchers have explored different levels of centralization, decentralization, and the subsequent needs for coordination (Blanton et al., 1992; Brown & Magill, 1994; DeSanctis & Jackson, 1994; Evaristo et al., 2005; Peppard, 2018; Zmud, 1984). This research study acknowledges that there is usually a spectrum of centralized/decentralized IT at colleges and universities. However, the literature on this issue is essential because it dominated much of the discussion in the 1990s and is relevant enough for EDUCAUSE to consistently use as a survey question in their most recent survey. Additionally, IT may or may not be centralized in colleges and universities and is explored in this study.

All three of these together influence the structure of IT departments in colleges and universities by understanding the antecedent of centralization/decentralization choice, who leads the department, and the functions of what the IT department does. I address these factors in the next section of the chapter as I discuss the IT literature.

The second set of factors is university characteristics. Existing higher education literature outlines several factors that I argue will likely influence the IT structures of colleges and universities. Each of these is introduced briefly below before being elaborated on in the third section of this chapter.

The first circle is university leadership, comprised of the Board of Trustees and the President, each with different responsibilities (Association of Governing Boards of Universities and Colleges, 2010; Barringer, Taylor, et al., 2022; Birnbaum & Eckel, 2005; Carpenter-Hubin & Snover, 2017; Freedman, 2017; Hendrickson et al., 2012). Underneath the president is the administration and the professional core, dividing the work of a university into the bureaucratic hierarchy charged mainly with operations and the professionals charged with teaching, research, and service (Baldridge et al., 1991; Eckel, 2000; Gumport, 1993; Mintzberg, 2010). The leadership of a university is important because it sets the strategy and direction of an institution, thus influencing the IT department. For example, a board may establish a strategic objective to increase online programs. The president then forms a committee of relevant parties and includes the CIO as a key committee member because online programs require various technologies. The leadership of universities is not specifically measured in this study, but to whom the CIO reports is a significant factor in the present analysis. For example, one higher education CIO participant in a study noted the importance of working with the president and board (Dlamini, 2013).

The second circle is university type. For example, the needs of a lone research university may differ from those of a research university as part of a system (Altbach, 2011; Zhang & Ehrenberg, 2010). A research university is more complex than a multinational corporation due to the varying needs, departments, centers, resources, funding sources, athletics, and potential medical facilities (Altbach, 2011; Cantwell & Taylor, 2015; Zhang & Ehrenberg, 2010). On the other hand, a private baccalaureate institution has a different set of needs because it may not have technological needs for secure research, laboratories, or large data sets. Therefore, the level of research may also play a part in institutional IT choices. Two mechanisms are used in the present analysis: the Carnegie Basic Classification and membership in the American Association of Universities (AAU)[3].

The third circle represents isomorphic pressures that may influence an institution's choices (Baldridge et al., 1991; DiMaggio & Powell, 1983; Milliken, 1987). The various isomorphic processes—structural, cultural, and mimetic—can structure how the organizations are structured, build similarities in cultural values, and copy practices of others viewed as successful. Isomorphic pressures are not measured as part of the quantitative study but are assessed as part of the results.

The fourth circle represents the other characteristics that may influence the structure of IT units at colleges and universities. These are the lesser researched factors such as size, control (public/private), age, and location (Sandmann & Weerts, 2008). For example, it may be that public rural IT departments are in a different part of the organization than a private urban

[3] https://www.aau.edu/

university. The IT department in higher education does not operate in a vacuum wholly insulated from leadership, administration, the professional core, or decision-making. Thus, it is influenced by these sets of factors. These factors are primarily demographic data that all institutions receiving Title IV funds enter into the Integrated Post Secondary Education Data System (IPEDS)[4] at the National Center for Educational Statistics (NCES) to be used in the contextual analysis of the results. The variables from the IPEDS dataset are Carnegie Basic Classification, Sector (e.g., Public Private), Geographic Region, Degree of Urbanization, Student FTE, and Institutional Expenditures.

The Information Technology Department

The conceptual model described above proposes that the extent of centralization impacts the leadership and functions of the IT department. In many respects, the decisions surrounding the level of centralization are antecedents to the IT department's leadership, functions, and organization. I will discuss each below, starting with the level of centralization.

Coordination and Centralization vs. Decentralization

A significant section of the literature on IT seeks to understand where IT should fit in the organization and the subsequent coordination mechanisms that can arise depending on the choice. A fictional example from the early 2000s will be helpful to clarify. In the fictional example, Home Depot, a seller of home improvement goods, decided to compete in the e-commerce space by selling goods on a new website called homedepot.com. Who hires and manages the programmers? Is it the IT department or the new business unit responsible for homedepot.com? Who buys and administers the servers on which homedepot.com resides? Who

[4] https://nces.ed.gov/ipeds/

answers questions when problems arise? The literature explores these questions through case studies and surveys and attempts to understand the two models' relative success.

Centralization vs. Decentralization. The original, or default, type of IT organization was simply the computing department, operating under many names such as the Management Information Systems (MIS) or Data Processing (Chun & Mooney, 2009; Ives & Olson, 1981; Zmud, 1984). There was only one department simply because there was only one computer, generally large enough to fit within a single room and specialized for specific tasks, unlike the general-purpose computers we use today. As computers became ubiquitous, researchers wondered if decentralized IT could increase competitive advantage (Blanton et al., 1992; Brown & Magill, 1994; DeSanctis & Jackson, 1994; Zmud, 1984). Decentralized IT refers to a structure in which decision-making and management responsibilities are distributed among different business units rather than centralized within one IT department. Responsibilities like budgeting, staffing, IT systems, and infrastructure are separated in a decentralized IT situation.

Some researchers of the 1980s and 1990s promoted decentralization for competitive advantage while others sought to understand the results (Rockart, 1988; Rockart et al., 1996; Rockart & Morton, 1984; Zmud, 1984). For example, Rockart (1988) argued that line managers, leaders over a significant revenue area, become increasingly responsible for large technology projects instead of being led by IT departments. Rockart cited the example of the OTIS elevator company in which George David, Head of North American Operations, envisioned a network of elevators that would automatically report to a centrally linked dispatch center whenever there was a fault or issue. David oversaw the solution's efforts and significantly improved a loosely coupled maintenance and repair operation through computing. Rockart argued that "as information technology becomes increasingly significant in business operations, its use should be shaped by the managers running the business" (1988, p. 60). Rockart's argument, like others of the time, was that the business understood the business needs and should dictate what technology followed. Thus, the closer technology is to the line manager, the more relative to the actual "needs" of the business. Researchers examined the organizational impacts of decentralization in several specific case studies below that will be elaborated on and summarized.

The first specific example is Cross et al. (1997) who studied highly decentralized British Petroleum in a case study. First, BP acquired many companies with differing technologies, creating architectural barriers to sharing information. Second, total IT costs skyrocketed during the 1980s as varying units supplied their IT. Third, the lack of coherent technology architecture served as a "straitjacket" to organizational change. As a result, BP centralized IT at the corporate level, created a standard technology architecture (known as Information Management Principles), and outsourced lower-level technical functions. The result netted reduced overall IT costs by $228 million, highlighting the potential costliness of decentralized IT.

In a second example, DeSanctis and Jackson (1994) presented a Texaco case study in the late 1980s and early 1990s. Texaco deliberately chose a decentralized IT structure and enacted coordination mechanisms across units. Like the BP example, Texaco faced incompatible technical architectures and systems. For example, different business units selected incompatible desktop applications, used multiple email systems, employed different networking solutions that prevented file sharing, and the resulting lack of communications across business units hampered productivity. Instead of centralization, Texaco countered the differing standards by creating a cross-functional team called the Information Planning Group (IPG) comprised of 16 individuals from the business unit IT functions, division-level IT groups, and the corporate information technology department. In addition, Texaco charged the coordinating group with the standardization of application development processes and procedures, data processes and procedures, IT resource allocation, IT asset management, and human resource management. As a result, Texaco chose some level of decentralization while using organizational coordination to reduce complexity.

In a third example, Currie (2012) studied the United Kingdom and its attempt to create a single national health record for all citizens over a ten-year longitudinal study. The study lists the many challenges the effort faces and includes decentralized IT as one factor. The researchers indicated that "source data suggested that IT had developed in the NHS as a decentralized and fragmented activity over several decades… a centralized policy initiative, the NPfIT was designed to change this by creating 'ruthless standardization'" (Currie, 2012, p. 242).

There is no doubt that the earlier OTIS Elevator example demonstrated that innovation at the business level could yield remarkable results. However, the three above examples highlight that decentralization can create complexity, add costs, and potentially hamper productivity. Early researchers predicted that some coordination activities would be needed, and the researchers of the early 2000s proposed new mechanisms addressed in the next section (Blanton et al., 1992; Evaristo et al., 2005; Rockart, 1988; Rockart & Morton, 1984; Sambamurthy & Zmud, 2000; Zmud, 1984).

Coordinating Mechanisms. Researchers in the early 2000s presented coordinating mechanisms as a means to coordinate the planning and activities of decentralized IT to combat issues of incompatibility and interoperability (Blanton et al., 1992; Chen, 2007; DeSanctis & Jackson, 1994; Guillemette & Pare, 2012; Peppard, 2018; Sambamurthy & Zmud, 2000; Zammuto et al., 2007; Zmud, 1984). Coordination mechanisms are designed to ensure communications and collaboration across different business units or teams using one or more of the following mechanisms: (a) governance or oversight, (b) standardization and best practices, (c) communications and collaboration, and (d) budget and resource coordination. For example, the earlier discussed Texaco case study highlighted standardization and best practices as a coordination mechanism (DeSanctis & Jackson, 1994). As another example, researchers found a positive relationship between using communication and collaboration tools for coordination in a quantitative survey of new product development projects. The study demonstrated that the tools improved the speed and effectiveness of building new software products, realizing IT investment faster (Chen, 2007).

Coordination has become somewhat simpler due to technological improvements introduced by DeSanctis and Jackson (1994). For example, the researchers suggested that computer-based sharing options such as document sharing, email, bulletin board, and conferencing systems would improve horizontal coordination. However, many of those technologies were in their infancy at the time. Technology has now progressed to the point where there are many communication mechanisms today. For example, Slack and Microsoft Teams offer instant message communications to individuals or entire teams. The technology is accessible and readily understandable by people of all skill levels. Tools with similar capabilities did not exist until the last decade. In another example, technologies such as Box, Dropbox, and Microsoft OneDrive offer nearly everyone simple document sharing, instantaneous collaborative editing, and version control. Finally, email and SMS text messaging enable near real-time communications across all platforms.

The shift towards more compatible computing has simplified much of the complex integration needed in decades past. However, the change is not universal. For example, Liu et al. (2020) captured “IT heterogeneity” by differing hardware types in data centers and Operating

Systems in use (e.g., Mac, Windows, Linux) when investigating IT centralization and security breaches. Nonetheless, Evaristo et al. (2005) suggested that compatibility, capability, and hardware standardization improvements of the early 2000s simplify communication and coordination. Therefore, they argued that the question of decentralization was not about communication and coordination but about who makes decisions about IT activities.

Decision Rights. By the early 2000s, researchers had moved away from much of the discussion surrounding centralization/ decentralization and instead focused on the decision rights surrounding IT activities (Boar, 1998; Evaristo et al., 2005; Peppard, 2001, 2018; Sambamurthy & Zmud, 2000). Decision rights refer to the responsibility and authority to make IT projects and operations decisions and are critical because IT is a finite resource of human capital and technology. Decisions surrounding IT activities represent capital investment, potential revenue, or cost savings. The literature explored (a) decentralized decision rights where the business determined priorities, (b) centralized decision rights where IT determined priorities, or (c) some shared combination between business and IT units. In the early 2000s, researchers suggested the latter combination model be called a "federal" model in which much of the decisions regarding standards come from the central IT group, and much of the guidance and oversight of projects supporting business activities be driven by the business (Orlikowski & Barley, 2001; Peppard, 2018; Rockart, 1988; Rockart et al., 1996; Sambamurthy & Zmud, 2000; Smaltz et al., 2006).

By the early 2000s, the debate of centralization/ decentralization had effectively concluded by researchers studying corporations outside of the higher education context, with the field agreeing that there was undoubtedly a central IT department with the potential for some decentralization. What is not answered is the potential levels of centralization/decentralization at colleges and universities. The research then turned to what IT delivered. In other words, what would be the functions of IT regardless of where IT is situated? The following section explores the literature addressing the functions of the IT department.

Functions of the IT Department

What does the IT department do exactly? What are the products and services offered and supported? The products and services have evolved considerably over time, which is evident in the research literature. Rockart (1988) provided an overview of the four waves of information technology up to the late 1980s: (a) the accounting era, (b) the operational era, (c) the informational era, and (d) the wired society. These broad eras describe the evolution of technology through (a) large single-use computers during the accounting era in the 1950s and 1960s, (b) the advent of large manufacturing resource planning computers in the 1970s supporting operations, (c) the revolutionary desktop computer and databases in the early 1980s, and (d) the networking of computers starting in the late 1980s. The fifth wave, which started in the early 2000s, could be called the *wireless age.* During this wave, computing has become ubiquitous, handheld, always available, and contains virtually limitless storage and processing capabilities. I elaborate on these eras below to illustrate how the IT department's functions have evolved in concert with the eras.

Functions Through the Eras. In the 1960s and 1970s, the primary function of IT was to produce the output of large batch processing. Punch cards with programming instructions would be brought in and processed in batch mode (Gannon, 2013; Peppard, 2018). For example, large computers initially helped run batches like payroll, and the output would be the calculated and printed payroll checks. While the primary function of IT was the output, the computer professionals were responsible for the computer's design, programming, and operation (Ives & Olson, 1981; Rockart, 1988; Zmud, 1984). It was an era of relative stability for the IT organization, which was typically organized into four functions: (a) software development, (b) operations, (c) technical services, and (d) administration (Gannon, 2013; Rockart, 1988; Rockart et al., 1996; Zmud, 1984). The literature mentions additional direct or ancillary functions and agrees that software development/ programming was one of the primary functions when there was no marketplace to buy off-the-shelf software (Gannon, 2013; Peppard, 2018; Zmud, 1984). The literature also agreed that IT would support hardware and networking (Boaden & Lockett, 1991; Todd et al., 1995).

The 1980s and 1990s witnessed the creation of a marketplace for applications, distributed desktop computers, expanded data storage, and the relational database offered new opportunities. As a result, the literature began exploring how firms and IT could exploit these new conditions for a competitive advantage (DeSanctis & Jackson, 1994; Gannon, 2013; Ives & Olson, 1981; Peppard, 2018; Zmud, 1984). In other words, the functions of the IT department have evolved in conjunction with changing capabilities. For example, Evaristo et al. (2005) referred to this age as the “feature-intensive period” when the internet was new and new capabilities were emerging regularly. A study of the leaders of IT departments in the early 1980s found the following functions: (a) operations, (b) new hardware, (c) maintenance/modification, (d) new applications, (e) new systems software, (f) new control software, and (g) administrative (Ives & Olson, 1981). The distinguishing characteristic that defined the wired age was the personal computer and the subsequent ability to network it to other computers for communication.

I earlier proposed that the 2000s be known as the wireless age; however, the literature may call it the consumerization era or the digital era (Gannon, 2013; Sambamurthy & Zmud, 2000). The advent of the digital economy represents the introduction of smartphones, cloud computing, and the convergence of computing, content, and communication industries necessitating ancillary functions of the IT department (Gannon, 2013; Peppard, 2018; Sambamurthy & Zmud, 2000; Zammuto et al., 2007). Consumerization refers to the increased availability and affordability of mobile computing as powerful and simpler computing became available. The convergence of computing, communication, and content industries characterizes the digital economy. I argue that wireless communication overarches the ability to acquire powerful computing and the intersection of technologies for the digital economy. Regardless of the name, the growth of cloud computing, new software, and mobile apps has added to the functions of IT.

Peppard (2018) and Zammuto et al. (2007) suggested that rapid technology evolution and the cost of implementations have added additional functional needs to the IT department, including (a) strategy development, (b) technology implementation, (c) project management, (d) information security, and (e) managing vendor investments. I will describe each in turn because they are each important to successful IT implementation and operations. Strategy development refers to an overall plan for how an organization will use technology to reach its goals and objectives. Technology implementation refers to the technical skills and staffing needed to successfully implement off-the-shelf or programmed software. Project management is the planning, coordination, and execution of projects related to new software implementation, hardware implementation, or other technology systems. Project management typically involves building a project plan, resource scheduling, and stakeholder communications. Information security is fundamental today and is required to secure data, intellectual property, and financial information. In other words, information security protects assets. Finally, technology is costly, and one ancillary function of IT is managing the cost and vendor investments in technology.

A helpful example of the need for additional IT functions in the higher education industry is the need to implement and maintain an Enterprise Resource Planning (ERP) system. Generically, an ERP system is "designed to offer generic functionality for use by many companies, not custom-built solutions for a specific organization…to accommodate organizational variation, these systems are configurable, but not infinitely malleable" (Volkoff et al., 2007, p. 833). In higher education, an ERP is the core system operating the Student Information System used for enrollment, academic records, and course catalogs. Further, the ERP is extended to the core Human Resources system used to maintain employee records and execute payroll. Finally, the ERP includes the financial system, processing transactions, and maintaining the general accounts ledger. An ERP is a multi-million-dollar initial investment with ongoing costs and vendor management requiring complex upgrades (Althonayan & Althonayan, 2017). Thus, the ERP must be supported by strategy, planning, budgeting, and project management. Before we conclude the functions, we will turn to what is taught at colleges and universities before turning to job postings.

Functions Evident in IT Curriculum. Another way to examine the functions of the IT department is to explore what researchers and practitioners proposed as a university curriculum for those entering the IT field. Early technologists, usually math-minded volunteers or other departmental outcasts received on-the-job training. There was little formal university curriculum until the Association for Computing Machinery (ACM) released a proposed curriculum in 1968 (Gannon, 2013; Nunamaker et al., 1982). As described in an updated version in 1982, the curriculum is visualized in Table 2.1, adapted from Nunamaker et al. (1982)**.**

The curriculum shown here bears similarities to several functions above, and I will map the two. For example, IS6 refers to networking; IS1 and IS2 are related to computing; IS3, IS4, IS7, and IS8 are related to software; and IS10 is related to project management.

Table 2.1

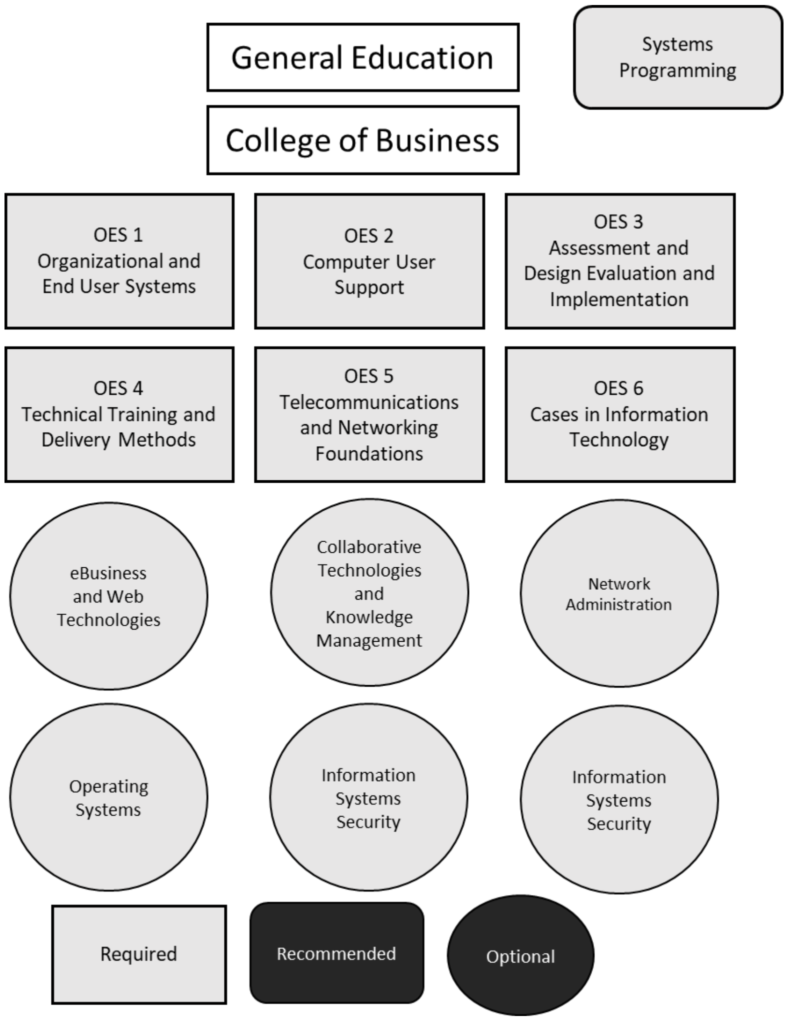
Association of Computing Machinery Curriculum

Num	Description	Num	Description
IS1	Computer Concepts and Software Systems	IS6	Data Communication Systems and Networks
IS2	Program, Data, and File Structures	IS7	Modeling and Decision Systems
IS3	Information Systems in Organizations	IS8	Systems Design Process
IS4	Database Management Systems	IS9	Information Systems Policy
IS5	Information Analysis	IS10	Information Systems Projects

A different organization, the Organizational Systems Research Association (OSRA), proposed the End User Information Systems (EUIS) curriculum models in 1986, 1997, and 2007 (Brookshire et al., 2007; O'Connor, 1996). The most recent, produced by Brookshire et al. (2007), proposed an "information systems curriculum for the 21st century" (p. 81). The introduction for the curriculum states that "this curricular philosophy includes creating products and processes via a purposeful application of knowledge, experience, and resources to meet the needs of users" (Brookshire et al., 2007, p. 82). It includes six core courses, six optional courses, an internship, and one highly recommended course and is visualized in Figure 2.3 (Brookshire et al., 2007, p. 82). The rectangles represent core courses, the circles optional courses, and the rounded rectangles represent strongly recommended courses.

Figure 2.3

End User Information System Curriculum



The 1982 ACM curriculum emphasizes programming and software development, while the 2007 EUIS curriculum focuses on the training and support functions of the IT organization. For example, the ACM curriculum proposes a Program, Data, and File Structures course. On the other hand, the EUIS literature recommends courses on Technical Training and Computer User Support (Brookshire et al., 2007; Nunamaker et al., 1982). Both curriculum models support the three primary functions of IT: networking, computing, and software while highlighting the need for support mechanisms in the form of training and user support. Further, the EUIS curriculum recommends an option for an Information Security class.

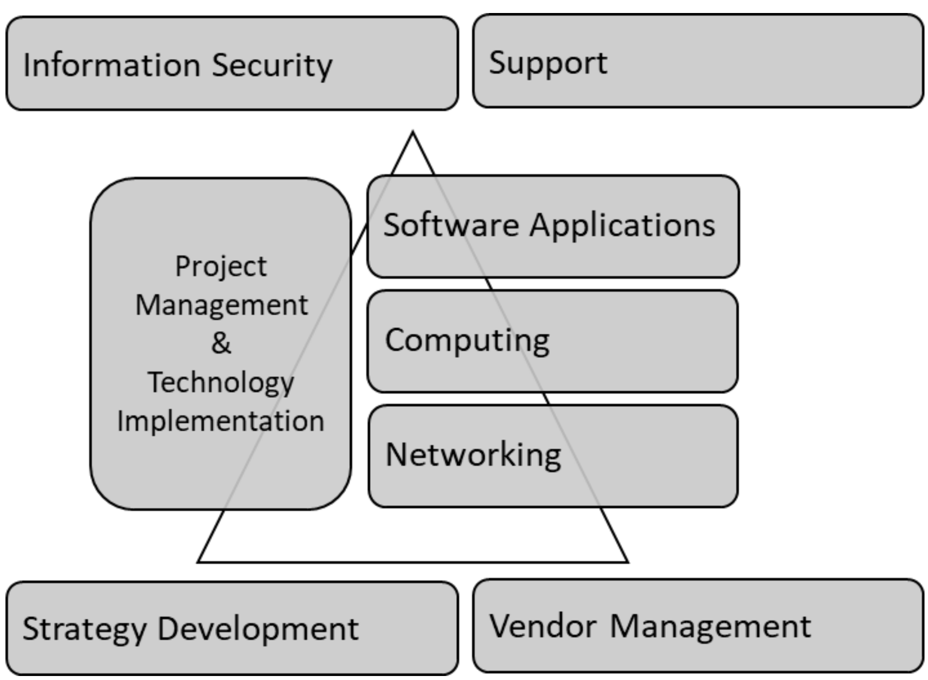
Functions Evident in Job Postings. Job postings are a third way to gain insight into IT functions because they list the skills explicitly needed and thus are an additional source of information in addition to the historical and curricular lenses outlined above. Naturally, technical skill requirements have changed over the past 60 years, yet the literature indicates that interpersonal and communication skills are crucial (Diane, 2003; Kai et al., 2002; Todd et al., 1995). For example, researchers studied the phrases in job advertisements from 1970 to 1990 and found that communication skills were effectively absent from the early ads and increased dramatically in 1990; there were 0 communication skills phrases in 1970 as opposed to 51 in 1990 (Todd et al., 1995).

Researchers use job studies to synthesize current needs and recommend potential changes to the curriculum by studying internet job portals like Monster.com and Dice.com (Chia-An & Shih, 2005; Diane, 2003; Kai et al., 2002). Both Diane (2003) and Chia-An and Shih (2005) use the End User Information Systems (EUIS) curriculum as the lens for the study. For example, Diane (2003) offered a qualitative survey study that delves into the job experiences of recent Information System Technologies graduates from a midwestern college that had adopted the 1996 EUIS curriculum. It is a relatively small sample of 66 returned surveys, though it gathered significant information from the responses. The study's results found the following primary functions of the respondents: (a) technical end/user support, computer programming, database design/development, networking, web development, systems analysis, information management, and information security (Diane, 2003, p. 63). Chia-An and Shih (2005) confirmed results that were consistent with the Diane study. In other words, the job postings have been consistent with the curriculum models offered above.

Functions Summary. Figure 2.4 represents an updated version of the original pyramid by synthesizing the functions over time, additional functions needed to operate IT, curriculum models, and job postings. Strategy development and vendor management are at the bottom, representing the foundation of decisions. Project Management and Technology Implementation span Networking, Computing, and Software Applications because project management coordinates new technology implementations or updates. Finally, Information Security is at the top because it protects an organization's information assets, and Support is the team providing support for software, computing, and networking. The figure does not necessarily predict how the organization will be organized, but it does represent the potential primary and ancillary functions of IT.

Figure 2.4

Essential and Ancillary Functions



Now that we have examined the core and ancillary functions, we turn to the leader responsible for the IT department.

The Chief Information Officer

The senior IT leader can carry several titles, including chief information officer (CIO), director of IT, vice president of IT, or chief technology officer. Today, the CIO title is widely used, and I will use it for consistency irrespective of the timeframe (Banker et al., 2011, p. 489; Chun & Mooney, 2009; Pinho & Franco, 2017; Reich & Nelson, 2003; Smaltz et al., 2006). The title of CIO emerged in the 1980s as technology capabilities increased and grew as technology played a more significant role in a firm's competitive advantage (Banker et al., 2011, p. 488; Ives & Olson, 1981). In other words, the IT department provided technology solutions to serve an organization's various activities. For example, Gannon (2013) highlighted a McKinsey and Company 2011 report stating that IT has a more significant role in competitive environments repeatedly disrupted by new technologies. The CIO leads the department, and I will demonstrate that the literature shows the importance of the CIO's influencing strategy.

The Strategic CIO. The role of the CIO has evolved significantly since the 1950s when they were primarily focused on managing mainframe computers for extensive data processing (Ives & Olson, 1981; Rockart, 1988). During the 1970s and 1980s, the CIO became more integral to business strategy as technology evolved from only extensive data processing to manufacturing and enterprise resource planning (Althonayan & Althonayan, 2017; Zammuto et al., 2007). Rockart (1988) argued that the IT department leadership must educate themselves about the business and functions for IT to be of strategic value due to the changes of the earlier mentioned four waves of technology.

Recent research highlights the importance of the strategic CIO in an organization because of the prevalence of various technologies in all areas (Banker et al., 2011; Chun & Mooney, 2009; Pinho & Franco, 2017; Reich & Nelson, 2003; Smaltz et al., 2006). CIOs are “deeply embedded in business organizations, helping CEOs strategize and business unit leaders to implement strategies” (Chun & Mooney, 2009, p. 323). In other words, the CIO helps business leaders identify and implement technology solutions that drive innovation and improve business performance. If the CIO is deeply embedded in the business and helps CEOs strategize, then where should they report?

CIO Reporting Structure. To whom does the CIO report? The answer, as with the earlier sections, showcases the evolution of IT over time. For example, Ives and Olson (1981) studied the reporting relationship between the leader of the technology department and the CEO. The small sample (6) used in their study is a weakness; however, it is still illustrative of the leadership of the IT department in the 1970s and 1980s because it shows that the CIO was not generally a member of the CEO's leadership team. Only one CIO reported to the CEO, and the remainder reported two or three levels down from the CEOs within their organization. The findings indicate that organizations did not view IT for strategic importance at the time.

The literature now supports the CIO reporting to the CEO (Pinho & Franco, 2017; Reich & Nelson, 2003; Smaltz et al., 2006). A recent study examined longitudinal historical data over two decades across several industries to predict the ideal reporting relationship of the CIO to either the CEO or CFO (Banker et al., 2011). The model draws upon Porter's five forces of competition to determine if a firm is either a product differentiator or a cost leader (Banker et al., 2011; Porter, 1983). Then, the model examines firm performance over two distinct periods, the early 1990s and 2003, before attempting to predict the reporting relationship of the CIO. Results show that the CIO tends to report to the CEO when the firm is a differentiator firm, and the CIO reports to the CFO in a cost leader firm irrespective of industry.

When a CIO reports to the CEO, it helps ensure they can communicate the value of IT to the CEO and the CEO's management team (Banker et al., 2011; Leidner & Kayworth, 2006; Smaltz et al., 2006). Further, the CIO can help drive innovation, improve efficiency, and find new growth opportunities with other senior leaders of an organization. However, is the same true for IT in higher education? This section has explored factors that influence the structure of the IT department: first, coordination and the tension of centralization versus decentralization; second, the functions of the IT department; and third, the CIO as the head of the IT department. These three factors contribute to the overall configuration of the IT department.

The Overall IT Department

Researchers predicted that IT would be decentralized three decades ago, and there was debate about what role the senior IT leader would play in the organization (Rockart, 1988; Zmud, 1984). The arguments reasoned that technology was becoming simpler and managers needed control of their information and software applications. Ultimately, an organization's need for consistency and compatibility demonstrated a need for a centralized IT department to provide many or all IT functions. The IT department provides organizations with networking, computing, and software services, though they need additional functions to deliver the core services. For example, examining curriculum and job postings showed additional functions, including support, project management, and information security. In addition, the CIO is the leader of the IT department and is charged with interfacing with senior leaders to help drive solutions that improve efficiency and operations or drive new capabilities. The consistent theme throughout the literature is the continued rise in IT needs across organizations which I argue is also true in higher education. I now turn to this literature to assess how it aligns with general IT literature.

The University – A Unique Enterprise

While the first section was focused on IT, irrespective of colleges and universities, this section includes relevant examples of IT to illustrate the reasoning for this study. Universities are complex and are represented by bureaucratic departments, academic departments, researchers, and independent research centers (Altbach, 2011; Babu, 2022; Barringer & Pryor, 2022; Bess et al., 2007). I organize this section through four lenses that can impact the configuration of IT: (a) leadership and decision-making, (b) focus/type, (c) isomorphic pressures, and (d) internal characteristics.

Leadership represents the activities needed to operate a university, for which the IT department is critical. For example, the university needs financial systems to process payments, pay suppliers, and track revenue and expenses. On the other hand, the university also needs an LMS to conduct teaching and learning and potentially research information systems supporting the academic enterprise.

A significant distinction among colleges and universities is participation in sponsored research, creating a difference between baccalaureate, master's, and doctoral institutions (Pryor & Barringer, 2021; Rosinger et al., 2016; Taylor & Cantwell, 2018; Zhang & Ehrenberg, 2010). For instance, with their heavy focus on research, doctoral institutions may require more sophisticated IT infrastructure and systems to support data-intensive research activities compared to baccalaureate or master's institutions where the focus might be more on teaching and learning technologies.

Further, theorists predict that colleges and universities look to perceived successful institutions and replicate behaviors for legitimacy (DiMaggio & Powell, 1983; Fay & Zavattaro, 2016; Liao, 1996; Morphew & Hartley, 2006). This phenomenon could lead to adopting similar IT strategies and structures across institutions even when they may not align perfectly with individual institutional needs or contexts.

Finally, the internal characteristics of colleges and universities in the United States are heterogeneous, with varying resources, locations, ages, and sizes (Taylor & Cantwell, 2018; Thelin, 2019). For example, Harvard University boasts a multiple billion-dollar endowment capable of supporting significant technology acquisitions. In contrast, a small regional public university would not have the same resources. Conversely, the University of Alaska presents unique needs distinct from those of the University of Arizona. There is little doubt that all these factors will influence institutional behaviors, including the IT department.

University Leadership

The leadership of colleges and universities sets the overall strategy, mission, and vision with wide-ranging impacts, including technology needs. (Baltaru & Soysal, 2018; Bianchi & Sousa, 2016; Birnbaum & Eckel, 2005; Dlamini, 2013). A university is typically a bifurcated enterprise comprising an administrative organization serving the institution's operational needs and an academic organization conducting teaching, research, and service (Association of Governing Boards of Universities and Colleges, 2010; Hendrickson et al., 2012). On the one hand, the administration of a modern university operates nearly as a city within a city by providing housing, dining, parking, and activities, all as part of the overall educational mission, and each component will have technology needs (Rouse, 2016). On the other hand, technology is needed to support teaching, learning, and research (Bianchi et al., 2021; Bianchi & Sousa, 2016).

Therefore, technology needs within a university are multifaceted, reflecting the diverse needs serving both the administrative and academic wings.

The heart of the academic enterprise is built around shared governance as outlined in the American Association of University Professors *Statement on Colleges and Universities* (AAUP, 1966; Hendrickson et al., 2012). It outlined the roles and limits of university boards and leadership and the responsibilities of academic governance. The concept of shared governance ultimately influences what, where, and who is taught which may, in turn, shape the needs of technology. For example, a new online program may require additional technology (Martin et al., 2020). Thus, the leadership of colleges and universities are three pillars of governance that directly impact the strategy and needs of an enterprise and, consequently, the IT needs.

In short, the president's goal is to ensure financial health and the faculty's overall programmatic health. In the context of the present study, the Board of Trustees is relevant because it may set overall goals that influence leadership. Finally, faculty governance drives the heart of the academic enterprise and is relevant to the study because it dictates teaching research and service activities. Still, the university president oversees several decisions that may directly affect IT.

University President. The president of a university is the ultimate face of the university and is tasked with assembling a team, making personnel decisions, budgeting, addressing academic matters, raising funds, relating with governmental entities, and relating with the board (Birnbaum & Eckel, 2005; Hendrickson et al., 2012; Ingram, 1993). The president has the ultimate authority in building the team of units that report to them. The provost, also called Vice President for Academic Affairs, typically reports to the president and is expected to interact with the board concerning academic functions. Typically, the president presides over all administrative and bureaucratic processes, and the provost or chief academic officer is responsible for the core academic functions (Carpenter-Hubin & Snover, 2017; Hendrickson et al., 2012).

The president frequently appoints leaders to be called the cabinet, council, inner circle, or primary administrative team (Neumann, 1991). In contrast, the president may inherit a cabinet. However, few studies examine the cabinet at colleges and universities, and future research could explore the cabinet in more detail (Holcombe et al., 2021; Kezar et al., 2020). One of the few studies on cabinets offered the following typical senior leadership positions reporting to the president: (a) Vice President of Students, (b) Vice President for Academic Affairs, (c) Vice President for Research, (d) Vice President for Human Resources, (e) Vice President for Business and Finance, (f) Chief Investment Officer, (g) Chief Legal Officer, (h) Chief Information Officer, (i) Chief External Affairs Officer, and (j) Vice President for Development, (k) Vice President for Enrollment Management, and (l) Chief Diversity Officer (Carpenter-Hubin & Snover, 2017). The authors note that there is no single pattern of administrative configurations and offer no prescription for the best structure.

In contrast, *Student services: a handbook for the profession* provides a sample organization chart with (a) Athletic Director, (b) Chief Counsel, (c) Provost, (d) Vice President for Administration, (e) Vice President for Alumni and Development, (f) Vice President for Information Technology, and (g) Vice President for Diversity and Equity (Schuh et al., 2017). Both examples include the CIO as a position reporting to the president (Carpenter-Hubin & Snover, 2017; Schuh et al., 2017).

Regardless, it is ultimately up to a president to make the hiring decisions of their direct reports and any substantive organizational changes they deem necessary, assuming they have the political ability to make changes. For example, President R. Gerald Turner of Southern Methodist University chose to elevate the CIO department to report directly to him in 2015 (Rallo, 2015). In the announcement, President Turner stated that the move "will allow us to move into a new era of information technology advancement and support to underscore the campus-wide importance of IT" (Rallo, 2015).

The current study, therefore, seeks to ascertain the typical positioning of the CIO within the hierarchy of colleges and universities to explore whether the CIO is typically a senior leadership position. Thus, the study can both shed light on the positioning of the CIO, which is underexplored in the literature, and set the stage for further research into IT organizations in higher education where the CIO is part of the cabinet.

Board of Trustees. The ultimate legal responsibility for governance rests within the Board of Trustees for a university (Association of Governing Boards of Universities and Colleges, 2010). Collectively, the board's responsibility is to (a) set and monitor the overall mission and purpose, (b) appoint and monitor the president, (c) allocate resources, (d) review and approve academic program proposals, and (e) adjudicate matters when necessary (Carpenter-Hubin & Snover, 2017; Ingram, 1993). Depending on control, a board can vary in size from small to large, and appointments vary depending on public and private institutions (Barringer, Taylor, et al., 2022; Ingram, 1993). For example, private university boards tend to self-select successors, while governors or legislators appoint public university trustees. The AGB specifies the board's importance in establishing clear lines of authority and decision-making responsibility throughout the university and primarily interacts with the President (Birnbaum & Eckel, 2005; Hendrickson et al., 2012; Ingram, 1993). Additionally, a board must buffer between the external environment and the institution while spanning barriers by building external partnerships (Barringer & Riffe, 2018; Barringer, Taylor, et al., 2022).

The board influences a college or university's mission, vision, and strategy, ultimately shaping many initiatives and activities. For example, the board could choose a direction requiring coordinated IT effort (Kezar et al., 2020). Additionally, the board could influence where IT is placed because it can dictate the university strategy that, in turn, could impact the needs of the IT department. Finally, board functions such as audit, security, or oversight may elevate the potential for IT departmental placing (Ingram, 1993). The current study does not measure a board's influence on IT configuration as data on this are not available within the sources used for this project. However, it is essential to recognize the potential for board influence on IT systems and the positioning of the CIO.

Decision Making. University leadership and decision-making go hand in hand, and the dual control of academic and administrative units causes a bifurcated decision-making environment. On the other hand, the administrative hierarchy tends to follow a more standard bureaucratic model in which the hierarchy prevails (Baldridge et al., 1991; Gumport & Pusser, 1995). Moreover, given the bifurcation of universities with a professional core of faculty and the bureaucratic administration as discussed by (Birnbaum, 1988) and the "organized chaos" described by Baldridge et al. (1991), it is logical that a university is more chaotic and may be subject to loose coupling. This complex environment means that the CIO must operate within the organized chaos.

Weick (1976) argued that looking only at an organization's formal structures within educational institutions will miss the less formal systems that produce results irrespective of the organized anarchy around them. Weick described the attributes of loosely coupled organizations as (a) lacking coordination, (b) no single clear path to similar results, (c) absence of regulations, and (d) slow feedback times. Moreover, Weick described the lack of coordination as a function of the academic and bureaucratic processes (Baldridge et al., 1991; Birnbaum, 1991; Birnbaum & Eckel, 2005). These characteristics of loosely coupled systems create environments where IT must be both adaptable and responsive to adapt to a continuously changing environment.

Some roles span the boundary between the bureaucracy and the professional core. For example, Mech (1997) described the needs placed upon the chief academic officer, who may lack formal authority but is a “team manager in a collegial organization trying to develop and maintain a smooth-running operation” p. 291. Therefore, a CIO reporting to a chief academic officer may be part of the team trying to “maintain a smooth-running operation” and this may also influence the resources available to the CIO (Mech, 1997, p. 291).

IT theorists explored the reporting relationship, the level of centralization impact, and how they may impact overall decision rights, which influence IT activities and resource allocation (Smaltz et al., 2006). There is a minimum of three placement options for the IT department in a college or university that leaders, presumably the president, can decide between, including (a) reporting to the president, (b) reporting to the provost, and (c) reporting to the chief financial officer (CFO). When considering the location of the IT organization, an institution chooses the CIO's authority and the IT department's focus. For example, Banker et al. (2011) found that firms that valued cost efficiency tended to place the IT organization under the CFO, whereas differentiators placed IT under the CEO. What about when IT reports to the provost? Is it to support research or teaching and learning, or is it representative of a pattern of a type of university?

Mintzberg (2010) described the functional core as the critical component of the professional bureaucracy. Indeed, problematic technology and professionalism are two fundamental premises of Baldridge's discussion of alternative governance models in higher education (Baldridge et al., 1991). The professional administrator is a liaison between the professionals and external parties, especially at higher levels in the organization (Mintzberg, 2010). For example, an academic dean is considered a professional administrator rather than a faculty member and is a buffer between upper-level administration and departments. However, the IT department cannot exclusively serve the bureaucracy or the professional core and must perform all technology needs (Bianchi et al., 2021; Bianchi & Sousa, 2016; Coen & Kelly, 2007). In other words, who tells IT what to do? Again, the multifaceted needs and pressures are a function of the decision rights afforded to the CIO and the IT department. Not all colleges and universities are the same, though, and the heterogeneous nature of institutions may influence IT needs.

Birnbaum (1989) outlined the Cybernetic Theory that integrates existing governance models in colleges and universities, suggesting that bureaucratic, collegial, political, and anarchical subsystems function simultaneously to create self-correcting institutions. When describing the type of CIO needed at a university, Dlamini stated that CIOs "must not only be technologically savvy but must also understand governance and the real purpose of higher education" (2013, p. 114). Thus, the higher education CIO must operate within the context of the higher education system to choose activities and allocate resources.

The various decision-making modes outlined above can influence and also be influenced by IT. For example, a more complex institution may create conditions where a CIO must operate in a political environment. Further, decentralized IT may suggest the need for IT governance to coordinate services and activities (Bianchi et al., 2021; Bianchi & Sousa, 2016). This study does not explicitly investigate relationships between differing governance mechanisms and IT because it would significantly broaden the scope of this study and may need a different methodological approach. However, an organization's decision-making norms are essential to other contextual factors influencing IT functions and operations. For example, the varying governance mechanisms could affect IT resources, project prioritization, and IT strategies. I address avenues for future research into IT governance at colleges and universities in the concluding chapter of this study.

Path Dependency. IT decision-making and structures are influenced by path dependence, where prior decisions not only inform the current state but also shape the realm of future possibilities due to complexity. For instance, Peppard (2001) emphasized the role of path dependency in achieving high-performance information systems, stating, “there is a significant element of path dependency in creating high performance from [IT]” p. 266. He elaborated that the current state of an IT organization is contingent upon its investment history, resource allocation, knowledge development, learning levels, and the evolution of software and hardware. Similarly, in their study of knowledge sharing at two academic institutions, Howell and Annansingh (2013) discovered that “institutional culture and path dependency play a major role in the willingness and response of institutions to generate and share knowledge” (p. 37).

A concrete example of path dependence is the University of Washington’s migration of their financial system to the Enterprise Resource Planning product, Workday. The institution is migrating from a product developed in 1974 to a more modern accounting system (University of Washington, 2018). The transformation is five years running, and the project has cost over $340 million. In other words, a software system developed over five decades ago shaped current technology needs at the University of Washington. This is important because past choices influence the IT department's leadership and activities. However, it is not addressed here because it requires historical examination and a different analytic method. Weick (1976) discussed colleges and universities as loosely coupled systems, and how loose coupling reduces the need to respond to all changes and may foster perseverance though there may be little regard for what is perpetuated. Loose coupling could influence the level of centralization at a college or university and may create the need for governance or coordinating mechanisms. Mintzberg (1979) described two hierarchies that emerge in loosely coupled systems: bottom-up as a democratic system and top-down as a bureaucratic system. Researchers have empirically measured where bottom-up and top-down influences may impact actions.

Barringer et al. (2020) found a positive association between bottom-up engagement and structural commitment to interdisciplinary research at universities with medical schools. In contrast, top-down support and bottom-up engagement are more interrelated at universities without medical schools. Similarly, bottom-up factors in IT can include faculty and staff feedback on technology needs, grassroots adoption of specific technologies, or recommendations from IT staff based on operational experiences and technical expertise.

Consequently, it becomes evident that IT strategies and operations can be profoundly shaped by a combination of factors, including organizational culture, the complexity of prior decisions, the decision-making landscape, and entrenched technological and process-oriented pathways. Considering these multifaceted influences, it becomes essential to understand how university IT departments adopt structures and strategies that not only navigate the intricate landscape of organizational culture and path-dependent histories but also proactively engage with both top-down directives and bottom-up feedback that fosters an adaptable, efficient, and aligned organization that meets the evolving needs of the academic community.

Resource Dependency

Tolbert (1985) studied the intersection of resource dependency and institutionalism to build a relationship between the funding sources and the types of administrative offices present at institutions. Tolbert predicted that private, not-for-profit universities would create private funding offices (e.g., donor relations) to increase revenue flow from private supporters. In contrast, the study predicted that publicly controlled institutions would create offices designed for government relations. The study confirmed that funding sources strongly predict administration differentiation at colleges and universities.

This present study expands the view of Tolbert's study to consider two different types of resource dependency. First is the distinction between public and private universities and their potential influence on the structure of IT. Second, do sources of revenue impact IT structures? Universities charge tuition, collect donor revenue, and research universities receive grant funding. Therefore, a university's type and focus may influence the IT structure. For example, public universities have used foundations for donor relations, potentially dispensing the need at the university level and creating a separate IT organization.

University Type

Despite their heterogenous nature, all colleges and universities share everyday needs such as building maintenance, access to teaching and learning technologies, and attracting and retaining talent. For example, Weingartner (2011) drew analogies to the needed tasks of "cooks who prepare meals in the dining hall, specialists who maintain the gardens and roofs, secretaries who fill in forms and type reports, and many more" (p. 5). However, the unique research needs may truly distinguish the structure of IT at colleges and universities. For example, McClure and Anderson (2020) studied the fundraising challenges of regional public universities (RPUs) compared to research-intensive counterpart institutions and found that RPUs faced more difficulties in fundraising. Altbach also discussed how large research institutions “contribute to culture, technology, and society and international institutions that link to global intellectual and scientific trends” (2011, p. 65).

The Carnegie Classification of Institutions of Higher Education lists several classifications and subclassifications of colleges and universities (Indiana University Center for Postsecondary Research, n.d.). I focus on the Basic Carnegie Classification rather than the others (e.g., instructional program, enrollment profile, size, and setting) because it effectively classifies institutions by focus and delineating an additional source of resources (e.g., sponsored research). The first of the larger groups are Doctoral Universities that award at least 20 research/scholarship doctoral degrees, including two research levels and professional doctorates. Second, there are Master’s Colleges and Universities that award at least 50 master’s degrees and fewer than 20 doctorates. Though not less important, the remaining classifications include Baccalaureate Colleges, Associates Colleges, Special Colleges, and Tribal Colleges, and each type of institution’s technology needs may likely differ. For example, a Baccalaureate College is focused on teaching and learning, while a Doctoral University has an expanded focus, including teaching, learning, and research. Further, graduate education costs more than undergraduate education, which may also increase technology needs (McLendon et al., 2009).

Research universities, which are among the doctoral universities, prioritize the creation of new knowledge and that comes at a price. For instance, Altbach (2011) stated that sophisticated information technology is required for the modern research university. Further, Altbach said that the cost is not only the implementation of the technology but its subsequent maintenance and management, which implies implementation and operational IT proficiency are necessary. For example, while analyzing cybersecurity breaches and IT centralization, Liu et al. (2020) highlighted the distinction between research and non-research activities. They argue that heavy research institutions typically foster a culture heavily inclined toward innovation by prioritizing academic freedom and a high degree of autonomy that naturally extends to their approach to implementing and using IT systems. Unlike teaching universities, where efficiency might be the driving force, research universities tend to emphasize flexibility. This prioritization often leads to more decentralized IT governance structures, creating a more complex IT environment.

Additionally, the literature suggests that research adds to the workload (Anderson et al., 2011; Harris, 2019; Lang, 2005; O'Meara et al., 2008; Trower, 2010; Zhang & Ehrenberg, 2010). Finally, studies show that research costs more and requires more technologically dependent courses (McLendon et al., 2009). The present study examines potential distinctions between research and non-research colleges and universities to find patterns and differences in IT structure. Research brings in resources and needs for supporting functions such as IT software and hardware, requiring more significant IT resources.

The second research question examines factors that may influence structures at colleges and universities. While this exploration does not focus on time-based factors to examine IT over time, it presents an opportunity to explore similarities and differences among various cases. This study aims to uncover the patterns and insights that can inform IT governance and organizational models at colleges and universities, considering past decisions and influences from the top and bottom of the organization. In addition to institutional focus, colleges and universities mimic institutions they see as more successful as a mechanism to increase relative prestige.

Isomorphic Pressures

Do universities tend to look like each other, and do their organizational structures tend to become homogenous over time? More specifically, are IT departments at universities more homogenous? Some theories say yes (DiMaggio & Powell, 1983; Gumport & Pusser, 1995; Meyer & Rowan, 1977), and others say no (Kraatz et al., 2010; Kraatz & Zajac, 1996). The term *isomorphism* is used to describe "a constraining process that forces one unit in a population to resemble other units that face the same set of environmental condition[s]" (DiMaggio & Powell, 1983, p. 149; Hawley, 1966). For example, Baltaru and Soysal (2018) found that administrative growth at European universities was not directly tied to needs (e.g., student growth) but instead supported isomorphic growth patterns. Researchers such as DiMaggio and Powell (1983) examined isomorphism in the context of colleges and universities, and they posit three isomorphic forces that are at work within the field of higher education: (a) coercive, (b) mimetic, and (c) normative (Harris, 2013; Harris & Ellis, 2020). I elaborate below on how each of these three isomorphic pressures could influence IT at colleges and universities.

Coercive isomorphism comes from legitimacy issues, social pressures, laws, mandates, and standardization (Currie, 2012; DiMaggio & Powell, 1983; Fay & Zavattaro, 2016; Hallett, 2010; Orlikowski & Barley, 2001). For example, all universities are subject to Title IX of the Education Amendments of 1972 and generally have an institutional office dedicated to it. One example of coercive isomorphism concerning IT was the United Kingdom's National Health Service policy to move 50 million people to an electronic health record (Currie, 2012). In the example, the policy required adopting a specific technology within a certain period, which indicates coercion. A second example is Texas Governor Greg Abbott’s recent order banning TikTok on all university-owned devices (McGee, 2023). This directive meant that all publicly funded institutions in Texas were required to remove TikTok from all computers and phones and disallow transmission of TikTok content on networks (McGee, 2023). The public institutions in Texas must comply with the ban or risk potential repercussions, including decreased funding from state agencies, thus exhibiting responses to coercive isomorphic pressures.

Mimetic isomorphism, the process of organizations adopting structures and behaviors from others in response to uncertainties, plays a crucial role in university IT decision-making (DiMaggio & Powell, 1983; Milliken, 1987). This phenomenon often occurs in contexts where goals are poorly understood, leading organizations to emulate practices perceived as successful or legitimate. Fay and Zavattaro (2016) explored marketing and branding strategies from 2006 to 2013, finding that 66% of institutions embarked on national rebranding trends, indicating that mimicry or mimetic isomorphism was shaping the strategies of colleges and universities. Further, the study highlighted how universities adopted branding strategies by looking to local peers. These decisions, influenced by mimetic isomorphism, reflect a desire to align with trends in technology and management. An example of situations where IT investments are also driven by prestige, similar to branding initiatives, is evident when a university advertises advanced research infrastructure to attract students and researchers. Overall, mimetic isomorphism in IT reflects an approach to managing uncertainty by closely observing and emulating the practices of peer and aspirant institutions.

Normative isomorphism is associated with the professional core. It is when organizations become similar to one another through the adoption of similar norms, values, and practices, for example, as a function of shared membership in the same professional organization(s) (Currie, 2012; DiMaggio & Powell, 1983; Liao, 1996; Meyer & Rowan, 1977; Milliken, 1987; Morphew & Hartley, 2006; Orlikowski & Barley, 2001; Tolbert, 1985). An example of normative isomorphism would be the licenses accountants need to become Certified Public Accountants (CPA). IT departments in higher education may be influenced by normative isomorphism. For example, the EDUCAUSE organization is an example of structuration in the higher education IT field, and its mission states, "EDUCAUSE is a nonprofit association whose mission is to advance higher education through the use of information technology." Additionally, EDUCAUSE provides platforms for universities to align their IT capabilities with sector standards in conjunction with higher education IT research. Another example is EdTech Magazine, which focuses on technology issues within higher Education. Both represent patterns of coordination across universities because of participation in committees, regular conferences, and research publications, which, in turn, create norms and practices further indicating a pattern of normative isomorphism (Currie, 2012; DiMaggio & Powell, 1983; Liao, 1996; Meyer & Rowan, 1977; Milliken, 1987; Morphew & Hartley, 2006; Orlikowski & Barley, 2001; Tolbert, 1985).

DiMaggio and Powell proposed that "the more ambiguous the goals of an organization, the greater the extent to which the organization will model itself after organizations that it perceives to be successful" (1983,p. 155). Therefore, I argue that we should expect to see isomorphic pressures impacting college and university IT structures for three reasons.

First, a state system may mandate college or university IT functions like information security; thus, the state plays a role via coercive isomorphism. Evidence of state-level coercive isomorphism could be surfaced by differences between public and private institutions or by similarities in public institutions in various regions. Second, a college or university may mimic aspects of an institution it deems superior, an example of mimetic isomorphism. For example, SMU maintains a peer and aspirant list of institutions it “seeks to be comparable in characteristics and quality” (SMU, 2023). Third, I have shown above that EDUCAUSE has become a professional organization for those in higher education IT. In this role, EDUCAUSE has the potential to influence IT departments at colleges and universities through normative isomorphism. For example, EDUCAUSE published an article describing colleges and universities undergoing digital transformation, which EDUCAUSE describes as “a journey from analog, legacy models to new digital processes” (Phillips & Williamson, 2019). The article highlights the University of California Davis, the centralization of IT, and its rethinking of organizational structure to add product managers who would oversee software. In this case, UC Davis looked to private industry to mimic a successful practice, and EDUCAUSE subsequently published an article about it, which could encourage followers. Distinguishing between mimetic and normative isomorphic factors within the bounds of this study is challenging because it is a point-in-time examination, meaning that the factors that ultimately yielded the current configuration are not studied. Instead, this study seeks to understand better how IT departments are structured at colleges and universities at this point. Still, it does not seek to document the isomorphic signals, like the article above. Instead, I provide potential research avenues based on the study's findings.

Internal Characteristics

In addition to leadership and field-level isomorphic pressures, research has shown that the internal characteristics of colleges and universities can influence their structures and behaviors (Barringer et al., 2019; Taylor & Cantwell, 2018). For example, control (public/private), prestige, location, and size have been shown to shape the resources available, level of selectivity, demand for seats, availability of seats, and access for historically underprivileged populations (Taylor & Cantwell, 2018; Thelin, 2019). I address each of these in turn.

First, the control or sector of an institution, i.e., if it is a public or private nonprofit, shapes institutional choices and activities (Kezar et al., 2020; Tolbert, 1985). For example, I earlier demonstrated that Texas recently banned the popular app TikTok on state equipment and networks requiring public colleges and university IT departments to take necessary measures to ensure the application was blocked from devices and the network (McGee, 2023; Texas Department of Information Resources, 2023). However, the same ban does not impact private colleges and universities in Texas. In other words, a seemingly small directive to block an app can show variations between public and private non-profit colleges and universities. Differences between public and private institutions have also been shown to impact the choice of administrative offices (Tolbert, 1985). This finding suggests that there should be differences in the IT structures of public and private colleges and universities in my analysis.

Second, research has also shown that a more prestigious university has greater access to resources and flexibility (Taylor & Cantwell, 2019). For example, Taylor and Cantwell (2018) found two categories of elite universities, elite and super elite, that are significantly less reliant on tuition than all others. The same study also concluded that generally, public megaversities were “designed by state policymakers to sit atop the hierarchy of public higher education” (2018, p. 10). A public megaversity sitting atop the hierarchy would have access to ample resources, influencing the IT department's size, scope, and level of centralization. For example, flexible resources of higher prestige colleges and universities could create a climate for more decentralization to support specialized needs.

Third, the location of a university may influence organizational decision-making. For example, Sandmann and Weerts (2008) examined boundary expansion between land-grant and urban research universities and concluded that younger urban research universities expand boundaries through innovative partnerships. Innovative partnerships require technology through access to software, sharing of data, or security. Further, the authors' conclusion is indicative of the importance of location. Further, Taylor and Cantwell (2018) highlight that land-grant institutions benefitted from the land exploited by indigenous people and gained an early advantage. The early advantage is expressed in terms of the size and resources available to institutions, which, in turn, fuel innovative activities that increase IT needs. In the present study, location is a combination of two factors: region and urbanicity, both of which influence the environmental responses of institutions.

I have explored the factors of the IT department outside of the context of higher education and have highlighted the unique characteristics of higher education. Now, I combine both and explore the IT department at colleges and universities.

Bringing it Together – IT and the University

The IT section of this chapter focused on the evolution of the IT department, its functions, and its leadership; the university section examined leadership and unique characteristics that may influence the higher education IT department. Building on the foundations explored in the above sections, this section addresses the relatively underexplored terrain of IT in higher education by synthesizing recent literature into a more comprehensive picture. In this way, I provide additive information for each of the IT components explored earlier: (a) Coordination and Centralization vs. Decentralization, (b) Functions of the Higher Education IT Department, and (c) the Higher Education CIO while synthesizing the unique characteristics of colleges and universities.

Coordination and Centralization vs. Decentralization

Two recent studies empirically measured the influence of centralization at colleges and universities using proxies to frame the effectiveness of centralized IT. First, a recent study examined digital resilience and emergency response to the COVID-19 pandemic. Park et al. (2023) studied the pivotal role of centralized IT in managing the crisis by using RateMyProfessor scores as a proxy for student satisfaction. By analyzing data from 463 U.S. higher education institutions, the study revealed that institutions with centralized IT were better equipped to adapt to the pandemic, particularly in sustaining student satisfaction with courses. Second, a study examining 504 U.S. higher-education institutions over four years discovered that institutions with centralized IT experienced fewer cybersecurity breaches when compared to less centralized institutions (Liu et al., 2020). The authors attribute the findings to the effectiveness of organization-wide security protocols that can be more uniformly implemented and monitored under a centralized system instead of decentralized settings where autonomy and flexibility in IT usage might compromise security standards. Both studies highlight the significant influence of centralization decisions at universities while demonstrating that there are less centralized universities.

This present study measures centralization levels at universities. However, similar to the approach taken by Park et al. (2023) who studied IT resilience during COVID-19, it does not address IT governance mechanisms at colleges and universities. Specifically, the authors noted that IT governance was excluded by stating, “our findings do not speak to the federal mode of IT governance where central IT and local units assume different levels of authority for different types of IT decisions” (Liu et al., 2020, p. 467). The study of IT governance would require a different methodological approach that is excluded from the bounds of this study.

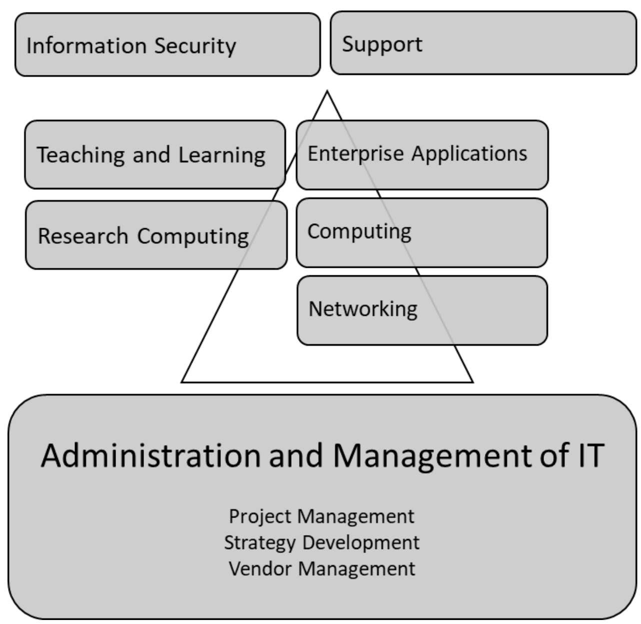
Functions of the Higher Education IT Department

The literature on the functions of IT delved into the standard functions that may exist irrespective of industry, yet higher education has needs unique to the environment. For example, in their analysis of centralized IT responses during the pandemic, Park et al. (2023) offered a refined perspective on the expenditure domains outlined in the annual EDUCAUSE Core Data Survey. Their model incorporated seven distinct expenditure domains, each aligning with specific areas of the EDUCAUSE survey. These domains offer insight into the potential functions of IT and include: (a) Administration and Management of IT, (b) Enterprise Information Systems (IT)/Infrastructure, (c) Communications Infrastructure, (d) IT Support Services, (e) Educational Technology, (f) Information Security, and (g) Research Computing which I describe in turn below. First, Administration and Management of IT encompasses the IT department's operational functions such as budgeting, planning, and human resources management. Next, Enterprise IS/Infrastructure refers to the computing hardware and the essential enterprise software, like the student information system. Communications Infrastructure involves the wired and wireless networks essential for person-to-person communication (e.g., telephony) and computing infrastructure connectivity. The fourth domain, IT Support Services, addresses the support and training services offered to faculty, staff, and students. Additionally, Support includes the help desk, where calls and in-person technical issues are addressed. Educational Technology is the fifth domain, covering technologies such as distance learning support, Learning Management Systems (LMS), library systems, and classroom technology. The sixth domain, Information Security, includes account management, security design and planning, and implementation. Finally, Research Computing represents the seventh domain, focusing on specialized needs such as research data storage, high-performance computing, and discipline-specific technology requirements.

By integrating insights about standard industry IT functions with the technology domains highlighted above, we can construct a more comprehensive framework of potential functional areas unique to colleges and universities, as demonstrated in Figure 2.5.

Figure 2.5

Higher Education IT Functions



Here, the unique needs become more apparent. For example, it is not only software applications but enterprise applications and academic educational technology, each serving a unique institutional need. Similarly, computing is divided into two unique areas: enterprise computing, which supports general operational needs, and research computing, which caters to the specialized demands of academic research. Furthermore, functions like Project Management, Technology Implementation Strategy Development, and Vendor Management converge under the broader IT Administration and Management umbrella, as demonstrated in Figure 2.5. The present study seeks to understand if the functions in Figure 2.5 are prevalent, meaning there is an association between organizational choice and expenditure domains.

In Figure 2.5, the distinction of needs between other industries and higher education becomes more evident, highlighting the unique need to support teaching, learning, research, and standard functions like HR, finance, and payroll systems. Here, the pyramid's foundation is the Administration and Management of IT, where the CIO deploys resources. Thus, the CIO's role is pivotal in determining which activities to pursue, where to invest in technology, and how to prioritize the diverse functions to support the multifaceted goals of the institution.

The Higher Education CIO

I have demonstrated that colleges and universities are complex organizations with diverse needs, creating competing priorities for IT resources. Thus, the scant literature about CIOs in higher education tends to focus on qualities and skills. First, Dlamini (2013) examined the role of the CIO at colleges and universities, specifically AAU members. The article emphasizes the need for a CIO to be strategic and adaptive while understanding the unique attributes of higher education explored earlier. For example, the study highlights that a higher education CIO needs to understand university leadership and governance. Second, Pinho and Franco (2017) quantitatively studied the CIO at Portuguese institutions by examining the traits of a CIO and found that conscientiousness and openness contributed positively to IT innovation. Both studies examine the qualities needed for a CIO to operate and succeed within the context of higher education, which is outside the scope of the present study. Instead, this study addresses the placement of the CIO in the hierarchy, and I address potential research opportunities based on the results in the conclusion of the study.

The Higher Education IT Department

There is indeed a professional core and a professional bureaucracy, as described in the decision-making section of the literature review, and IT structures are a part of this (Mintzberg, 2010). However, a college or university board still appoints a president, who, in turn, decides who the provost will be; the provost will also have oversight and decision authority over who becomes the dean and so on (Hammond, 2004). In other words, there is still a hierarchy; the hierarchy matters, and the IT department is within that hierarchy.

Hammond (2004) noted the lack of research into how different hierarchies could affect decision-making. The limited research into college hierarchies primarily centers on the professional core of programs, departments, schools, and colleges (Barringer & Pryor, 2022; Hammond, 2004). For example, Barringer and Pryor (2022) noted the absence of study of actual academic structure as opposed to traditional proxies such as degrees conferred by research universities and found six distinct profiles across institutions. Barringer and Pryor (2022) showed that institutions can be structured differently, even within a single institutional type. Thus, if there is variation in academic departments within a single type of institution, there should be variation in IT departments across a range of institutional types. The question becomes what are the different structures and what are those differences related to?

The focus of this study is to address the question of what the structure of IT is in a university. Somewhere in the hierarchy is an IT department. The unclear goals, loosely coupled systems, isomorphic pressures, and varying decision mechanisms suggest different patterns may be present (DiMaggio & Powell, 1983; Meyer & Rowan, 1977; Weick, 1976), but no research to date addresses this question. All colleges and universities must have some component of Information Technology (IT) because it is a fundamental requirement for the operations of a modern higher education institution. Historically, a student's record was stored in a filing cabinet, including admission applications, class records, disciplinary records, and other pertinent information. Today, similar records are stored in various software applications on servers that reside on campus and with cloud computing, such as Software as a Service (SaaS). About IT, Peppard (2018) stated, "In today's information and technology-driven environment, an organization is unlikely to exist without I[T]; I[T] themselves cannot exist outside of their organizational context" p. 97. Thus, I expect a university to have a minimum of one IT department that I consider the *central IT department*. However, a university may have more than one IT department, indicating some level of IT decentralization. This study seeks to understand this question or centralization or decentralization, CIO reporting, functions of the IT department, and how those occur in different patterns across colleges and universities with different internal characteristics.

Chapter 3: Data and Methods

The present study seeks to answer two research questions about IT in higher education. First, how is the top-level management of Information Technology departments organized in higher education institutions? Second, which factors are related to variations in the organizational structure of IT departments at colleges and universities? As outlined previously, there is a lack of empirical understanding of IT within higher education. Thus, the present study seeks to expand our knowledge of higher education and IT specifically by addressing where IT is located within colleges and universities and the organization of its subunits.

I built a novel dataset that includes college and university IT data and institutional characteristics to address both research questions and build on the understanding of colleges and universities by examining IT. The novel dataset creates the richest set of available data on IT at universities, drawing on primary data collected from college and university websites in conjunction with existing secondary data from IPEDS, AAU, and EDUCAUSE. Using this data, I found differences in IT at institutions using several continuous and categorical variables in the dataset.

In a quantitative approach to this analysis, I leveraged similar methodologies that have examined structures to find typologies at colleges and universities (Bahr, 2011; Bahr et al., 2011; Barringer & Pryor, 2022). While this study does not attempt to replicate existing studies, it uses a similar data and methodology approach by testing for relationships among multiple variables, allowing for correlations and pattern evaluation (Creswell, 2014). However, the quantitative method does not allow me to address both the stories and the context behind the IT organizational structure choices that I could gain through a qualitative methodology (Creswell, 2014; Merriam & Tisdell, 2015). For example, the quantitative method will not answer why the

IT department reports to the CFO or when it occurred. However, it can address the patterns in IT structures in colleges and universities and assess factors related to those patterns, which is the core aim of this research.

In this chapter, I first outline the cases I will be focusing on as well as the datasets and variables used, including primary datasets from EDUCAUSE and IPEDS in conjunction with data collected from college and university websites. The variables are summarized on page 83 in Table 3.5. Next, I describe the data compilation and analysis methodology, including a description of the analytic method of latent profile analysis, model variables used in that analysis, and the additional contextual variables used to interpret those results. I also address limitations and positionality before discussing my findings in Chapter 4.

Cases

The target population includes four-year public and private non-profit colleges and universities. I exclude for-profit colleges and universities because their mission and vision are distinct from those of non-profit ones (Iloh, 2016). Further, I exclude community colleges because they have differing mission, measurement, and success criteria from four-year institutions (Bahr, 2011; Clotfelter et al., 2013). However, a similar analysis of only community colleges could be an avenue for future research. Finally, four-year public and private non-profit colleges report similar measures to IPEDS and EDUCAUSE, building a diverse US population of colleges and universities.

The sample for the present study is four-year non-profit private and public institutions that have responded to the EDUCAUSE CDS survey. The sample begins with institutions participating in the 2022 EDUCAUSE CDS survey of 465 public, non-profit, and for-profit universities. I then restrict the dataset to baccalaureate, doctoral, and master’s colleges and universities, thus eliminating 101 institutions. I address the specific set of universities included in the EDUCAUSE data, along with the possible biases that result from this, below when I discuss this dataset in more detail. This list of 340 institutions was the starting point for collecting institution website data. EDUCAUSE is the only known current national dataset representing IT at colleges and universities, making it a crucial component of my study. Further, as I elaborate below, it is robust because it includes detailed financial and human capital data. The selection is as comprehensive as possible because it represents institutions of all sizes and regions in the United States.

Datasets and Variables

There are four components to the dataset in this research study: (a) the EDUCAUSE dataset, (b) IPEDS, (c) CIO and IT reporting data collected from institutional websites, and (d) AAU membership information. Below, I outline the context and origin of each dataset component, including the variables used in the analysis that come from each component.

The EDUCAUSE and IPEDS datasets are secondary, while the website data is original. Secondary datasets have several advantages. First, the data is readily available and is not changing; thus, it is nonreactive (Singleton & Straits, 2005). Second, secondary data reduces the time and cost of research. However, secondary data on certain variables of interest for analysis is sometimes unavailable. Therefore, I also had to rely on primary data collection from university websites. Building data from websites for research purposes is growing, and institutions with ".edu" domain suffixes can be considered more credible (Baker & Blissett, 2017; Booth et al., 2016; O'Leary, 2017; Pryor & Barringer, 2021). For this study, the IT organizational information on my universities of interest was unavailable anywhere except on university websites. The combination of original data collection and secondary data has been crucial to the success of this analysis, as using both allowed me to create a novel dataset that had not been created previously and was necessary for addressing my research questions.

EDUCAUSE

The first dataset I discuss is from EDUCAUSE, a higher education technology association committed to advancing higher education (EDUCAUSE, 2021b). It is a fee-based organization comprising 1,600 institutions and over 100,000 IT professionals working in higher education IT. The organization offers several programs and services to IT organizations in higher education, including (a) research, (b) publications, (c) benchmarking and assessment, (d) toolkits, (e) events, (f) communities, (g) professional learning, and (h) professional development. EDUCAUSE was formed in 1998 through a merger between two professional organizations, CAUSE and Educom, representing "more than 60 years of combined service to the higher education information technology community" (EDUCAUSE, 2023).

One of the core components of the benchmarking and assessment service at EDUCAUSE is the Analytics Service, which collects and analyzes research data for member colleges and universities (EDUCAUSE, 2021b). A significant part of the analytics service is the annual Core Data Survey (CDS) in which member institutions are invited to complete a survey about institutional demographics, central IT staffing, financing, and services. A second component of the CDS is the Institutional Profile that asks an institution for a budgetary range and degree of centralization, allowing organizations to create "peer groups" for comparison and benchmarking purposes. The institutional profile contains questions about student FTE range, central IT budget range, and degree of IT personnel centralization. We first start with the participants who have completed a CDS at any time in Table 3.1 compared to the total number of

US institutions according to their 2023 Carnegie Basic classification[5] (EDUCAUSE, 2021a). Tables 3.2 and 3.3 narrow the sample further by first illustrating institutions that have completed an institutional profile and then completed the 2022 CDS, which is the group analyzed in this study.

Table 3.1

Core Data Services Participants All Time

Institution Type	Participant	US Total
Associate's Colleges	228	948
Baccalaureate Colleges	208	735
Doctoral Universities	303	466
Master's Colleges and Universities	310	669
International	95	0
Specialized Colleges and Other Institutions	130	1121
Total	**1,274**	**3,939**

EDUCAUSE incentivizes organizations to participate in the survey by offering access to data, insights, and reports generated due to the CDS. The survey cost is sharing data and the time taken to complete. The high response rate of the surveys is approximately 30%, which offers a large sample of institutions, in this case, and a healthy response rate. Researchers have suggested that low response rates combined with nonresponse bias can produce significant errors in survey usage (Singleton & Straits, 2005). Thus, the response rate of 30% aids in overcoming the potential for significant errors.

[5] https://carnegieclassifications.acenet.edu/institutions/

However, even with this reasonable response rate, there is still the potential for selection bias since colleges and universities are opting into the survey (Bethlehem, 2010). Thus, it is important to acknowledge the reasons for nonresponse. First, the institution has chosen not to participate in EDUCAUSE at all. For example, membership could be cost-prohibitive for specific institutions. Second, the institution could decide not to share data deemed proprietary. For instance, an institution may consider staff and budgeting information exclusive and inappropriate to share. Third, the institution lacks organizational slack and/or time to complete the survey. Table 3.2 shows how the sample narrows by showing the number of institutions that have completed an institutional profile, which is crucial to this study because it includes information on the centralization level of the IT department. However, completing an institutional profile does not guarantee a corresponding completion of the Core Data Survey because, as stated above, the institution could have created a profile for a previous survey. Again, the institutions with a completed profile are compared with the total number of institutions matching the same Carnegie Basic classification.

Table 3.2

Core Data Services Completed Profile 2022

Institution Type	**Count**	**US Total**
Associate’s Colleges	179	948
Baccalaureate Colleges	205	735
Doctoral Universities	346	466
Master’s Colleges and Universities	228	669
Specialized Colleges and Other Institutions	81	1121
Total	**1,099**	**3,939**

The EDUCAUSE institutional profile and the 2022 CDS datasets are crucial to this study, and only institutions that have responded to both are included in the sample. Thus, the institutions that have not responded for whatever reason will not be included in the study. The data gathering and analysis section below will provide additional context for the sampling plan. Of the 1,274 CDS participants over all periods, 465 institutions completed the survey in 2022. Finally, further reducing the dataset to only baccalaureate, masters, and doctoral institutions left 340 institutions for analysis. Narrowing to this set of three institutional types was necessary because they are each similar in that they provide four-year degrees as opposed to the predominately two-year associate institutions. Table 3.3 provides an overview of the public and non-profit colleges and universities remaining in the sample, along with the total of US institutions matching the same Carnegie Basic classification.

Table 3.3

Core Data Services Baccalaureate, Masters, Doctoral Institutions

Institution Type	**Count**	**% of Sample**	**US Total**	**% of US Total**
Baccalaureate Colleges	66	19%	735	39%
Doctoral Universities	182	54%	466	25%
Master's Colleges and Universities	92	27%	669	36%
Total	**340**		**1,870**	

Table 3.3 shows there is an underrepresentation of baccalaureate colleges and an overrepresentation of doctoral universities compared to the overall US population of universities. This is a product of response bias and is discussed in the limitations and analysis sections below.

EDUCAUSE CDS data is available to member institutions participating in the survey and falls under the EDUCAUSE Acceptable Use Policy[6]. The policy states that the data may be published and presented in "professional publications, public documents, and public presentations so long as that data has been sufficiently aggregated to prevent re-identification of participating institutions and appropriate acknowledgment of EDUCAUSE Analytics Services is included." My institution, Southern Methodist University, is a current member of EDUCAUSE, granting the right to utilize this data for aggregation and analysis. The approval email of the SMU institutional office, Michael Hites, Ph.D., and the EDUCAUSE administrator can be found in Appendix – G. Further, the dissertation committee determined that the use of the EDUCAUSE data, being secondary non-individual level data, did not fall within the parameters of human subjects. Thus, no Institutional Review Board (IRB) submission was required during the proposal defense.

EDUCAUSE data offers the richest dataset on higher education IT organizations. Nevertheless, the present study cannot rest on that sole dataset because it lacks additional demographic and contextual information on colleges and universities. Therefore, I have supplemented the EDUCAUSE datasets with original data collection and additional secondary datasets for this research. I first discuss the variables from the EDUCAUSE data before turning to these other datasets.

The variables from EDUCAUSE CDS and Institutional Profile represent the size, scope, and centralization of IT at colleges and universities. Each variable I use in my analysis is described below, and the variable name is in *italics* for ease of reference. The Data Compilation

[6] https://www.educause.edu/research-and-publications/research/analytics-services/aup

and Analysis section below provides additional information on how these variables are used in my analysis and findings.

Central IT Spend is a figure reported on the EDUCAUSE CDS and is the one-year total operating expenditures for the central IT department. It includes software, hardware, personnel, and other expenses to keep centralized IT running. Central IT spending represents an institutional investment in IT and is crucial to understanding the relative spending for IT in relation to overall expenditures. I use this as both a raw number and a percentage of total spending to enable comparisons between institutions of differing sizes. For example, a 1% versus 20% spend in IT as a percentage of overall institutional expenditures potentially represents two different IT organizations. This captures the resources devoted to IT in colleges and universities and speaks directly to resource dependency, which was discussed in Chapter 2 on page 49. Furthermore, this captures investment in centralized IT, which was discussed in Chapter 2 on page 22.

Central IT FTE is a figure reported on the EDUCAUSE CDS as a raw full-time equivalent (FTE) count of the number of staff members reporting to an institution's highest-ranking IT administrator/officer. This metric is helpful because the IT department's size represents a significant IT investment component. First, it captures the scope and investment in the human capital of the centralized IT department in an institution, discussed in the centralization section in Chapter 2 on page 22. It speaks to the CIO authority discussed in the CIO section in Chapter 2 on page 36 because a more extensive staff indicates greater authority and resources. Third, it does not answer the functions offered by the IT department, but it is one part of an indicator of the functions offered because more functions require more staff. During the analysis, I examine Central IT FTE per 1,000 Institutional FTE because it allows more accurate comparisons across institutions. Further, it allows us to assess whether institutions prioritize investment in central IT compared to each other.

IT Percent Central is within the EDUCAUSE Institutional Profile. It estimates the percentage of overall IT centralized into the single department reporting to the highest-ranking IT administrator/officer. The survey question has five possible answers: (a) 0-24%, (b) 25-49%, (c) 50-74%, (d) 75-99%, and (e) 100% centralized. For example, an institution that is 100% centralized indicates that all IT staff report to the highest-ranking IT administrator/officer. Conversely, an institution that reports 0-25% centralized indicates highly decentralized IT where IT is spread throughout the institution. As I discussed in the literature review, the trend of decentralized IT waned in the early 2000s in for-profit firms (Blanton et al., 1992; Evaristo et al., 2005; Rockart, 1988; Rockart & Morton, 1984; Sambamurthy & Zmud, 2000; Zmud, 1984). *IT Percent Central* is used for contextual analysis; I capture the scope of the centralized IT department and the overall institutional tolerance for decentralized IT in the Centralization vs. Decentralization section on page 22. It further indicates the coordinating mechanisms discussed in the Coordinating Mechanisms section on page 25 because greater decentralization indicates a greater need for coordination and potential governance mechanisms. Finally, it is an indirect indicator of decision rights discussed in Chapter 2 – Decision Rights on page 27. More centralization indicates greater decision rights afforded to the CIO and central IT organization.

A dummy variable called *Highly Centralized* is created for institutions greater than 75% centralized in the model to simplify a complex variable and create a mechanism to benchmark institutions. I created this dummy variable by transforming the *IT Percent Central* variable listed above, where 1 represents an institution reporting 75%-99% or 100% centralized. Further, it allows later contextual analysis to focus on the extremes. Finally, it allows an assessment of potential indicators of isomorphic factors.

Decentralized IT FTE represents IT full-time equivalent employees who do not report to an institution's highest-ranking IT administrator/officer. This variable is not reported as consistently to EDUCAUSE as the above variables; thus, it is ineffective for usage in a model. However, it is used in the contextual analysis to compare average staff sizes for what was reported to the CDS to allow me to provide more information on the levels of centralization, the potential need for coordination, and the decision rights afforded to the central IT group.

IPEDS

The Integrated Post Secondary Educational Data System (IPEDS) is the second dataset in this analysis. It provides data on institutional characteristics and context that helps to provide a more holistic understanding of how IT structures differ across universities. IPEDS is generated from surveys conducted annually by the National Center for Education Statistics (NCES). IPEDS collects, analyzes, and reports data on universities, colleges, community colleges, and vocational schools for institutions participating in Title IV federal financial aid programs must report data to IPEDS (National Center for Education Statistics, 2022).

IPEDS collects data about (a) institutional characteristics, (b) institutional pricing, (c) admissions, (d) enrollment, (e) student financial aid, (f) degrees and certificates conferred, (g) persistence, and (h) institutional resources. I use components of three sections of the IPEDS data. First, I use institutional characteristics which include information on the type (Carnegie Classification), control (Public/Private), location (Geographic Location and Institutional Setting), and size of institutional FTE (Institutional FTE) of colleges and universities. These are important because they provide institutional context for understanding the IT structures of these institutions. I also use data from the finances section to account for spending on the part of the colleges and universities and to standardize the proportion of the spending variables in the EDUCAUSE finance metrics. Third, I use data on student full-time equivalents (FTE) to control for the proportion of IT staff sizes in the EDUCAUSE variables. I elaborate on the specific variables from the IPEDS data below. EDUCAUSE arranges its dataset by a unique identifier and the IPEDS unitid. Thus, the institutions have been matched between the EDUCAUSE and IPEDS data using the IPEDS unitid.

The 2022 Basic *Carnegie Classification* captures institutional type by distinguishing between baccalaureate, master's, and doctoral colleges and universities. I use the 2022 classification because it closely matches the EDUCAUSE dataset and aligns with the original data collection described below. An institution is classified as baccalaureate when it awards at least 50 percent baccalaureate degrees and fewer than 50 percent master's or 20 percent doctoral degrees per year (Indiana University Center for Postsecondary Research., n.d.). In contrast, an institution classified as a master's institution awards at least 50 percent of master's degrees and fewer than 20 percent of doctoral degrees per year. Doctoral institutions have three potential categories: very high research activity (R1), high research activity (R2), and doctoral/professional universities (D/PU). R1 and R2 are "institutions that awarded at least 20 percent research/scholarship doctoral degrees and had at least $5 million in total research expenditures" (Indiana University Center for Postsecondary Research., n.d.). The level of research at an institution is used as a contextual component in the analysis because, as I noted in the literature review, a research university is a large enterprise with diverse needs that may influence the IT unit (Altbach, 2011; Ellis, 2020). I created a dummy categorical variable to distinguish (a) baccalaureate, (b) master's, (c) doctoral, (d) doctoral – high research, and (e) doctoral—very high research.

Public/Private is the sector variable of an institution reported to IPEDS and is divided into public, private not-for-profit, and private for-profit. Private for-profit institutions are excluded from the present study because they have missions and goals distinct from public and private not-for-profit institutions. The variable measures whether an institution is a "classification of whether an institution is operated by publicly elected or appointed officials (public control) or by privately elected or appointed officials and derives its major source of funds from private sources (private control)."[7] In other words, this variable indicates the institution's sector and provides institutional context. Further, the variable indicates sources of funding beyond tuition and sponsored research. Therefore, I created a dummy variable called *Public*, where 1 indicates a public institution and 0 indicates a private-not-for-profit institution.

Geographic Location and *Institutional Setting* are two geographic indicators reported to IPEDS. The location of a college or university could impact the institution's culture, resources, student body, and academic programs. Consequently, the differences in location and setting can impact IT. *Geographic Location* is the IPEDS region in which an institution resides. *Institutional Setting* refers to the institution's location reported as the degree of urbanization to IPEDS. There are four primary categories: (a) City, (b) Suburb, (c) Town, and (d) Rural. I collapsed the variable into urban (city and suburb) and rural (town and rural) and coded one (1) is urban, and zero (0) is rural. Both indicators provide context into the geographic location and may indicate regional, urban/rural, or state differences in IT.

[7] https://surveys.nces.ed.gov/ipeds/public/glossary

I did explore utilizing accrediting regions in the analysis. However, the data source proved problematic to analyze and understand within the timeframe of this study. For example, the U.S. Department of Education dataset contained over 53,000 rows with over 70 accrediting agencies[8]. Future analysis could include accrediting regions to determine if any isomorphic or other factors may influence IT in different regions.

FTE measures the institution's size by counting all Full-Time Equivalent students. I use this measure in two different ways. First, I use it to standardize *Central IT FTE per 1,000 FTE* to compare institutions of various sizes. Second, I use size as a contextual variable to draw comparisons of institutions of similar sizes.

IPEDS classifies *Institutional Expenditures* as core expenses and includes costs for (a) instruction, (b) research, (c) public service, (d) academic support, (e) student services, and (f) institutional support for scholarships and fellowships. I use *Institutional Expenditures* to normalize IT *e*xpenditures and raw institutional size. I now turn to original data collection.

Original Data Collection

The third dataset is a novel dataset I collected from institutional websites to capture IT organizational information unavailable via EDUCAUSE, IPEDS, or other known datasets. Utilizing university websites to obtain data on colleges and universities has become more common in recent years (Barringer & Pryor, 2022; Barringer, Taylor, et al., 2022; Leahey et al., 2019; Morphew & Hartley, 2006). In addition, the use of university websites "is consistent with a growing body of research that utilizes websites as sources of information about HEOs' structures, policies, practices, and missions" (Barringer & Pryor, 2022, p. 375).

[8] https://ope.ed.gov/dapip/#/download-data-files

There are two components to the dataset collection: one additive and one original. The additive dataset is the Association of American Universities membership, and the novel dataset is from university websites.

Elite Status is represented by membership in the Association of American Universities (AAU) membership list as collected in August 2023 to align as closely as possible with other data collection and the age of the secondary datasets. The 65 AAU member universities "collectively help shape policy for higher education, science, and innovation; promote best practices in undergraduate and graduate education, and strengthen the contributions of leading research universities to American society" (AAU, 2023). I use AAU as a proxy for elite status for several reasons. First, the membership criteria are highly selective based on stringent criteria, including quality of students, high research output, quality of faculty, and excellence in academic programs (Ali et al., 2010). Second, AAU institutions are well-resourced, with higher endowments and revenues (Barringer & Pryor, 2022). Third, research output at AAU institutions is high (Cantwell & Taylor, 2015). I relied on the name from the IPEDS dataset and the name on the membership list to match universities and stored it as a binary yes/no variable.

The original dataset was constructed at the college/university level to map onto the other two datasets and provides unique information about the IT structures of these organizations. Specifically, I started with the list of institutions in the EDUCAUSE data. I organized by IPEDS unitid numbers to ensure I could easily merge this data with the other two datasets. The data was stored using Microsoft Office 365 SharePoint Online using a custom-developed list and collection form, and it is in Appendix A. I located the university website using Google Search and then found the IT-specific website using search terms such as "university name IT." For example, a Google search for SMU IT returns the IT Help Desk and the Office of Information Technology websites as the first two search results.

Once I located the relevant website, I determined if a *CIO Reports* directly to a president or a different university area because reporting to the president represents more power than reporting to someone who reports to the president. I determined where the CIO reported across these universities by relying on multiple strategies, as university websites vary widely. First, I employed search terms on the website, including President, Leadership, Cabinet, and Org Chart. The most preferable indicator was an organizational chart indicating the reporting hierarchy. The second method was examining the presidential cabinet members, though cabinet membership does not always indicate the direct reporting relationship. In these instances, I used comparable titles to triangulate the level of the CIO. For example, the titles of Vice President and Chief Information Officer compared with Vice President and Chief Financial Officer were indicators of similar levels when both are on the cabinet, and in this case, both were considered to be reporting directly to the president.

If the CIO was absent in the cabinet or the relationship was unclear, I turned to organizational charts for the Chief Financial Officer (CFO), Chief Operating Officer (sometimes called an Executive Vice President), and the provost. Data gathering demonstrated the most likely configurations of CIO reporting to the (a) president, (b) CFO, (c) Provost, or (d) COO. I recorded the specific role the CIO reports to in the relevant column for that institution using a dropdown list to ensure data consistency. I also noted the website I used to obtain that information, the date retrieved, and any notes about the institution.

Second, I determined the *CIO Distance,* the number of levels away from the president a CIO reports. I used this in conjunction with the collection of the *CIO Report* metric because I had determined to whom the CIO reports, which allowed me to backtrack the number of levels from the president. For example, the distance is coded as one (1) if the CIO reports to a COO, who then reports to the president. Conversely, if the CIO reports to the president, the value is coded as zero (0). Like the *CIO Report*, *CIO Distance* is a measure of CIO Power. I noted the website I used to obtain that information and the date on the SharePoint form. I transformed this to a dummy variable indicating if the CIO did not report to the president, *Not Reporting to the President*.

I also collected the reporting level of the Enrollment Management (EM) at the same time as I collected the CIO reporting information using the same methodology to determine if any organizational factors make the institution different from others as evident by anomalies in the reporting structures of both EM and the CIO. I recorded *EM Distance* similarly and concurrently with the CIO variables described above. This choice is because enrollment management is a crucial function and has grown over the past two decades (Hossler & Bontrager, 2015). Table 3.4 demonstrates the difference between the enrollment management (EM) function and the CIO, starting where the EM role is higher than the CIO, and demonstrates that over 50% are at the same level, suggesting equal organizational standing among the two roles. Further, it highlights the importance of both roles to institutions, though the slightly higher tendency of the CIO to be one level higher may be indicative of the importance of technology.

Table 3.4

CIO and Enrollment Management Distance from President

EM Higher		**Equal**	**CIO Higher**
Two Levels	One Level	Same Level	One Level
1	66	177	78
0.31%	20.50%	54.97%	24.22%

Further, 99% were within one organizational level of each other, indicating validity in the collected CIO data. The Enrollment Management leader data was not used in the analysis but provided a validity check on the CIO reporting.

Similarly, I recorded if the CFO or COO reports to anyone but the president to triangulate if there is any variation to a “typical” reporting structure by using the same distance methodology where zero [0] indicates reporting to the president. Further, I continued using organizational charts, cabinet membership on the website, organizational websites (e.g., the provost home website), and titles. I recorded the distance *CFO Distance* and *COO Distance* in their respective columns on the same SharePoint form. It is important to note that COOs are less common, and I only located 59, though there may be a similar function in what is termed Executive Vice President (EVP). The Chief Financial Officer and the Chief Operations Officer represent the powerful scope of administrative operations at colleges and universities because of their access to resources and oversight of operations, respectively.

The fourth piece of data collected is the *CIO Direct Report Count*, which measures the number of direct reports to the CIO and measures the size and scope of the IT department. The number of direct reports was determined using several avenues. The first and preferred method is an organizational chart of the IT department or an organizational chart that contains the leadership and functions of the IT department. In this case, each direct report that was not an administrative assistant was counted. The second method, if the first was unavailable, was to locate information on the website delineating the areas of the organization. For example, the SMU IT About Us webpage offers the five subunits reporting to the CIO (SMU). The third and more time-consuming method was to locate an institution directory and use titles to determine direct reports. For example, three similarly titled Directors in IT would indicate three direct reports. The smallest institutions typically required the third method. There were a small number of instances where interpreting titles to determine direct reports was problematic, and in those cases, the total IT department was counted. I also noted the website I used to obtain that information, the date, and any relevant notes on the SharePoint form.

The fifth piece of data collected was the *Specialty Functions* reporting to the CIO, which I completed concurrently with determining the *CIO Direct Reports*. I have argued that the industry IT department's default functions include networking, computing, and software (Leidner & Kayworth, 2006; Peppard, 2018; Rockart et al., 1996; Todd et al., 1995; Zammuto et al., 2007). Indeed, data collection continued to support the default functions represented and a pattern of specialty functions closely aligned with the EDUCAUSE investment domains I discuss in Chapter 2 on page 31. I term these *Specialty Functions* because they appear exclusive to higher education, or they do not appear at all universities. I arrived at the specialties by collecting each department's names in columns labeled "IT Department 1," "IT Department 2," and so on. For example, the SMU IT About Us webpage lists the following functions: (a) Academic Technology Services, (b) Data and Application Services, (c) Infrastructure, (d) Planning and Customer Service, and (e) Security. Those are then matched to the potential functions using a drop-down list that I maintained and added to when necessary. The complete code list can be found in Appendix B.

Specifically, four repeated specialty functions emerged in higher ed IT, including (a) Project Management, (b) Academic Technology, (c) Research Computing, and (d) Analytics. Several other specialty functions were initially considered, including (a) Vendor Management, (b) Compliance, (c) Strategy, and (d) Cloud Computing, yet they did not meet the consistent naming criteria and were less frequently observed in data collection. I collected this data and subsequently created a variable called *Specialty Count* to sum the number of specialties present at a given institution. I use both *specialty functions and specialty counts* in the analysis.

Dataset Summary. Table 3.5 below describes the concept, definition, potential values, source, and type for all the above variables. The *concept* column lists the idea of interest that the variable is measuring. The *coding* column describes how I coded the variable within the dataset. The *source* column indicates if the data has been retrieved from EDUCAUSE, IPEDS, or website data. Next, the *type* column describes how I intend to use the variable relative to the analysis. Two potential options exist for the type column: model or context. I will use model variables within the analytic technique and contextual models to add richness to the overall analysis. The process is described in more detail as I discuss the analysis and specific models below on pages 84 and 94.

The table is closely aligned with the contextual model. First, all model variables are related to the Structure of IT at Colleges and Universities. The IT contextual variables are related to Centralized vs. Decentralized IT, Leadership of the IT Department, and Functions of the IT Department. Beginning with AAU Status, I am examining the Higher Education Structure Factors of Leadership, University Type, and Other Characteristics. There are no measures present that are indicators of isomorphic patterns. Instead, I discuss them as part of the pattern analysis.

Table 3.5

Dataset Summary

Concept	Name & Definition	Coding	Source	Type
IT Scope	Central IT FTE	Central IT Employees	EDUCAUSE CDS	Model
IT Centrality	Highly Centralized (greater than 75%)	No = 0 Yes = 1	EDUCAUSE CDS	Model
CIO Power	Not Reporting to President	President = 0 Not President = 1	Institutional Website	Model
CIO Portfolio	Specialty Count	0 to 4	Institutional Website	Model
CIO Portfolio	CIO Direct Report Count Number of direct reports	Number of CIO direct reports	Institutional Website	Model
IT Scope	Central IT Percent Spend	Central IT Spending/Institutional Spending	EDUCAUSE CDS and IPEDS	Contextual
IT Scope	Central IT Spend	Central IT Spending	EDUCAUSE CDS	Contextual
CIO Power	CIO Report To whom does the CIO report	Reports To: President Provost CFO COO Other	Institutional Website	Contextual
CIO Portfolio	Specialty Functions Specialty Functions Reporting to the CIO	Academic Technology Analytics Project Management Research Computing	Institutional Website	Contextual
Concept	**Name & Definition**	**Coding**	**Source**	**Type**
IT Centrality	IT Percent Central Percentage of centralization as estimated on CDS institutional profile.	Degree IT of Centralization 1 0-25% centralized 2 25-50% centralized 3 50-75% centralized 4 75-99% centralized 5 100% centralized	EDUCAUSE CDS	Contextual
IT Centrality	Decentralized IT FTE Number of distributed IT staff as a percentage of student FTE	Distributed IT staff	EDUCAUSE CDS	Contextual
Elite Status	AAU Membership	AAU Membership in 2023= 1	AAU Website	Contextual

Institution Size	**FTE**	**Total Student FTE**	**IPEDS**	**Contextual to standardize**
Institutional Focus	Carnegie Classification Basic (2022)	Doctoral University (Very High) Doctoral University (High) Doctoral Professional Masters Baccalaureate	Carnegie Classifications Website	Contextual
CFO Power	CFO Distance How many levels deep is CFO	Number of reporting levels from president. Reporting to president = 0	Institutional Website	Contextual
COO Power	COO Distance How many levels deep is COO	Number of reporting levels from president. Reporting to president = 0	Institutional Website	Contextual
	EM Distance How many levels deep is the Enrollment Management Leader	Number of reporting levels from president. Reporting to president = 0		
Institution Size	FTE	Total Student FTE	IPEDS	Contextual to standardize
Institution Place	Geographic Location	Region	IPEDS	Contextual
Institution Place	Institutional Setting	Urban Rural	IPEDS	Contextual
Institution Control	Private college/university	Public = 0 Private = 1	IPEDS	Contextual
Total Expenditures	Institutional Expenditures Summation of core expenditures	Summation of Core Expenses	IPEDS	Contextual

Data Compilation and Analysis

As I noted above, the dataset was collected and organized by the IPEDS unitid because it offers a single unique “key” for each institution and will avoid any duplication. Data was collected into a Microsoft SharePoint Online list for easy capture and storage.

I collected and stored all datasets separately and compiled them using STATA statistical software. The EDUCAUSE dataset is available to institutional users on its website in a visual format and was downloaded as a Microsoft Excel file organized by IPEDS unitid. The CDS and

Institutional Profile are retrieved as a combined file with all survey answers listed in columns per institution, and the file layout is like IPEDS. Finally, I used the most recent IPEDS and EDUCAUSE datasets to mirror closely the timeframe of website data collection.

I gathered IPEDS data from the NCES website. The dataset is available as a download annually in a preliminary and final format, and I used the most recent final format. Further, the data is available as a STATA file and is organized by IPEDS unitid. I collected the university website data into a Microsoft SharePoint file and organized it by IPEDS unitid, including the source web page for each data element described above. Finally, I compiled the EDUCAUSE, IPEDS, website, and AAU datasets into a unified dataset using STATA. In sum, I collected the data into SharePoint online, Microsoft Excel, or STATA files, combined them into a single file, and imported them into STATA for my analysis.

Latent Profile Analysis. I hypothesize that there are differences in structure, size, funding, and scope based on potential institutional contexts and characteristics. However, these differences may or may not exist. Therefore, a deductive-oriented approach is complex since there is no direct hypothesis to confirm. Instead, I applied an inductive, bottom-up approach that allowed me to explore the patterns within the data, given that prior research on what these structures and patterns may be is absent from the literature.

This type of analysis yields itself to an inductive approach such as Latent Profile Analysis (LPA). LPA is a statistical technique used to identify distinct classes or subgroups within a population based on the observed data (Spurk et al., 2020). LPA aims to identify subgroups based on patterns of multiple observed variables, such as the IT measures mentioned above. The dataset is a combination of IT variables and institutional characteristics set up an analysis that identifies patterns in IT structures while allowing for the generalization of types of universities.

LPA is particularly useful for this analysis because it allows for the incorporation of both continuous and categorical variables within a single model (Spurk et al., 2020).

LPA has been used to group higher educational institutions in various studies by seeking patterns and profiles not readily observable in the dataset. I note four examples here. First, Taylor and Cantwell (2018) used an LPA model with four variables to build a series of profiles of higher education institutions, ultimately finding seven different profiles that mapped the higher education landscape and quantified the declining relative value of institutions that serve historically underserved populations. Further, the study highlighted the value of well-resourced elite institutions that provide good value yet serve few seats. The present study similarly yields classes (e.g., profiles) that differentiate institutions.

Second, Weerts and Cabrera (2018) used a similar type of analysis, Latent Class Analysis (LCA), to categorize alums based on their on-campus student activities. They found four engagement profiles during collegiate years and then analyzed contextual factors to gather insights into the participants' desire to donate and donation history. For example, they determined that the student government leader class believed at a higher percentage that their university needed their donation. This study uses a similar methodology by which institutions are placed into classes and are subsequently analyzed on contextual factors. Third, Rosinger et al. (2022) used observable variables such as per FTE state funding and per FTE spending on aid in conjunction with LPA to build classes of institutions based on the unobserved factors of higher education funding approaches. Their model built three profiles: low subsidizers with high tuition and targeted aid, moderate subsidizers, and broad subsidizers with low tuition. This study also classifies institutions with observed variables into the unobserved structures of IT departments at colleges and universities.

Finally, Barringer and Pryor (2022), in a study that is most like my own, employed LPA to examine the academic structures of colleges and universities, exploring colleges, schools, divisions, and departments. The present study is similar in that it examines the structures of the IT department. Further, the study examined subunits similar to how the functions of the IT department are collected and analyzed. A difference is their use of changes over time and movement from one profile to another. Future studies could investigate IT changes over time, including measures such as staff, spending, and level of centralization.

In sum, LPA has become a popular analysis technique when studying colleges and universities assessing differences and inequalities across institutions, structural aspects of organizations, models of state funding for higher education, trustee connections, and alumni giving (Barringer & Jaquette, 2018; Barringer & Pryor, 2022; Barringer et al., 2019; Rosinger et al., 2022; Rosinger et al., 2016; Weerts et al., 2014). The ability of LPA to assess and categorize based on multiple characteristics makes it particularly suited for this study.

As described above, the EDUCAUSE dataset comprises 340 colleges and universities representing baccalaureate, master's, and doctoral institutions. Within this population are subpopulations of institutions with varying missions, visions, locations, and unique histories that form a heterogeneous group of institutional types. I described several studies above where LPA or a similar LCA was first used to build classes based on observed variables, and then each class was classified and described. Therefore, LPA assumes some level of population heterogeneity wherein multiple subsamples are within the larger population/sample being studied (Spurk et al., 2020).

To estimate these models, I used the STATA statistical program and the *gsem* command in conjunction with the *logit*, *poisson*, *lclass()* parameters because they produce the model that estimates the probability of a college or university fitting a particular class and its relationship to other classes. This command structure is consistent with existing research in higher education and is also the usage of the same commands in STATA (e.g., Barringer & Pryor, 2022; Barringer, Riffe, et al., 2022; Rosinger et al., 2022).

Model Assessment and Fit. When using LPA, it is crucial to determine how profiles will be assessed and validated; therefore, I describe my approach before turning to what is included within the models I estimated. A recommended approach to model construction is beginning with a single class, increasing the classes in each step, and evaluating the model fit at each stage (Weerts et al., 2014). There are several ways to assess the fit of the model, including Akaike information criteria (AIC), Bayesian information criterion (BIC), the Lo, Mendell, and Rubin (LMR) test (Barringer et al., 2019; Lo et al., 2001; Rosinger et al., 2022; Weerts et al., 2014), and the proportion of cases classified into different profiles with a certain level of confidence (Barringer & Pryor, 2022; Taylor & Cantwell, 2018). All the tests operate under the logic of expanding the number of cases one at a time until the likelihood of improvement for an additional case stops or declines. I address the utility of each in turn. First, the AIC is a function of the maximized likelihood and the number of classes, and the BIC measure is similar and includes the number of observations in the function. Generally, lower numbers for both are an indicator of model fit. For example, Rosinger et al. (2022) selected three profiles because of a significant reduction in AIC and BIC numbers between two and three profiles.

Further, they described that the four-, five-, and six-class models offered minimal improvement in the AIC and BIC values with no membership improvement between the three and four-class models. Alternatively, the LMR test compares neighboring models (i.e., k-1 comparing to k-class models) and provides a p-value indicative of statistical fit (Barringer et al., 2019; Nylund et al., 2007; Spurk et al., 2020; Taylor & Cantwell, 2018). For example, Taylor and Cantwell (2018) used a similar technique to estimate the difference distribution that resulted in a seven-case model with a $p < 0.01$. In addition, Barringer et al. (2019) continued adding cases from one to five comparing the LMR test; however, they ultimately rejected the fifth case model not because of continued improvement in fit ($p \approx 0.0445$) but because the sixth case did not add overall information to the analysis. This and the approach of others suggest that multiple model fit assessments are often used in combination to determine the most appropriate number of classes. Finally, proportional allocation is the proportion of cases that are members of a particular class as a percentage of overall cases (Magidson & Vermunt, 2001; Masyn, 2013; Nylund et al., 2007; Taylor & Cantwell, 2018; Vermunt, 2010). For example, if a single profile only has 1-2 universities it is unlikely that this profile is capturing a substantively distinct sub-population within the data and therefore the model with one fewer latent class should be used. I ultimately chose to utilize AIC and BIC scores for model assessment because researchers indicate that AIC and BIC scores are more desirable for smaller sample sizes (Rosinger et al., 2022).

Model Variables. My goal is to understand how IT structure varies across institutions by incorporating variables that capture various aspects of the IT structures of colleges and universities drawn from the original data collection and the EDUCAUSE data described above. The concepts described below include CIO power, CIO portfolio, IT scope, and IT centrality. For each underlined <u>concept,</u> the associated *variable(s)* are listed.

First, <u>CIO power</u> is the concept that captures the institutional power of the CIO as a function of reporting relationship because placement higher in the hierarchy wields higher power (Giessner & Schubert, 2007). *Not Reporting to the President* is a binary variable indicating if the

CIO does not report to the president. This variable was generated from the *CIO Reports* variable used in the context analysis. This variable can be considered part of the vertical dimension of where IT is placed, and while both variables are similar, they provide differing contexts. Ultimately, *Not Reporting to the President* yielded the best model results.

The second key concept of interest is the CIO portfolio, which captures both the size and scope of the work for the CIO. In other words, what functions does the central IT unit perform? Two variables capture these two dimensions. First, the *CIO Direct Count* is the number of direct reports to the CIO, and the *IT Specialty Count* is the summation of the presence of the IT specialties of (a) Academic Technology, (b) Analytics, (c) Project Management, and (d) Research Computing. These variables can be considered a horizontal dimension of centralized IT, and both are included in the models presented in Chapter 4.

IT scope is the size and resources expended within the central IT organization, which can be considered the size of the intercepting vertical and horizontal dimensions and is captured by *Central IT FTE.* This measure represents the raw size of the central IT organization at a college or university and the investment in IT through human capital. While Decentralized IT FTE is reported to EDUCAUSE, it is not as consistently documented. Therefore, it is used as a contextual variable.

Finally, IT centrality is a college or university's IT centralization or decentralization level. It is important because it describes the degree to which the institutional IT authority is centralized. IT centrality is measured in this model through a derived variable called *Highly Centralized*, indicating institutions with 75% or greater centralization levels. The centrality concept comprises three variables, *IT Percent Central* and *Decentralized IT FTE,* collected from the EDUCAUSE dataset. I now turn to the contextual variables that are used after the LPA model analysis.

Contextual Variables. In this study, LPA identifies distinct profiles within the dataset, thus revealing different IT structures across colleges and universities. Once the profiles are estimated using STATA, I analyze each profile with contextual variables, including elite status, control, geographic control and institutional setting, expenditures, and size, which I elaborate on below.

The STATA *by:* command is one mechanism to analyze a contextual variable after a class assignment. For example, let us assume that the class assignment variable is called *CFourFinal* and the analysis variable is *AAU*. The command series *by CFourFinal: tab AAU* yields four tables, one for each class, with the frequencies of membership in the AAU where the value one (1) is membership and (0) is not membership. The contextual variables I explore come from the entire dataset and include EDUCAUSE, IPEDS, and original data collection. I elaborate on both the concept and *variable* below.

I explored several contextual variables that were of potential interest yet did not yield any distinct patterns relevant to this study. I list these first before describing the variables used in the analysis. First, no distinct patterns were revealed from CFO power *(CFO Distance)* and COO power *(COO Distance)*. Instead, the reporting distance of the CFO and COO did not influence the IT department. Further, there was no distinct variation in the CFO and COO distance patterns.

Additionally, I explored several potential model variables that ultimately did not yield a successful LPA model. I present these examples in the Model and Data Analysis section below by describing models that did not present a solution. For example, Central IT Spend and Central

IT Percent Spend concepts were initially promising for model variables; however, when included, the models would not successfully converge. Therefore, they were removed from the model and explored with the contextual variables.

The concept of IT Scope includes *Central IT Spend* and *Central IT Percent Spend*. *Central IT Spend* is the total expenditures of the centralized IT organization and represents the overall resources afforded to operations and implementations. Larger organizations with higher FTE counts need additional resources to operate. Therefore, we compare institutions with *Central IT Percent Spend*, which is *Central IT Spend* divided by *Total Expenditures*, thus yielding a relative number allowing comparisons between and within classes.

The concept of CIO Power and the variable *CIO Report* is the categorical variable indicating to whom the CIO reports. This variable allows for a deeper analysis of where the CIO reports as opposed to the model variable indicating if the CIO does not report to the president. Further, it is an indicator of the strategic placement of IT at an institution.

CIO Portfolio records the four emergent *Specialty Functions* introduced in Chapter 2 on page 59 and discussed in more detail in the Original Data Collection section of this chapter on page 81. The four specialty functions in alphabetical order are: (a) Academic Technology, (b) Analytics, (c) Project Management, and (d) Research Computing. Institutions could have one or more of these specialty functions within the department's top level. More specialty functions represent a more extensive scope, whereas fewer represent a more standardized department.

IT Centrality includes the *IT Percent Central* as a categorical variable and the *Decentralized IT FTE* count. These are used to observe patterns of the structural differences between highly centralized IT departments and the staffing allocated to decentralized IT.

Elite Status is proxied by the variable *AAU Membership*. As I describe in the Original Data Collection section of this chapter on page 77, AAU members are elite in student and faculty quality, research output, and excellence in academic programs. AAU universities have more resources and can expend more resources. Thus, they are more flexible in their choices of configuring IT. Similarly, Institutional Focus is represented by the *Carnegie Level*. As I described in the IPEDS section on page 74 in this chapter, the Carnegie Basic Level classifies institutions into (a) Doctoral University (Very High), (b) Doctoral University (High), (c) Doctoral Professional, (d) Masters, and (e) Baccalaureate. For instance, a baccalaureate institution's primary focus is on four-year degrees, which necessitate specialized research computing. Conversely, a research university may have specialized research computing needs.

Institution Size and *FTE* are the number of students that must be supported. A larger student body influences the needs of IT first by scale. Higher capacity networks are needed to handle the traffic of mobile devices, laptops, computers, and servers. Similarly, more FTE means more faculty and staff FTE are needed to support the student population. *FTE* allows for comparisons of *Central IT FTE* as a proportion *FTE* to measure size differences.

Institutional Place includes *Geographic Region* and *Institutional Setting*, representing the IPEDS region in which the college or university resides and the degree of urbanism, respectively. The *Institutional Setting* is either urban or rural, while the *Geographical Region* includes the Far West, Great Lakes, Mideast, New England, Plains, Rockies, Southeast, and Southwest. The concept and the variables represent the heterogeneity of the setting of colleges and universities across the United States. For example, when studying the decline in academic fields over time, Brint et al. (2012) found that geographic context had less influence on declines. In the context of this study, I think the degree of urbanization will influence IT structures because rural areas tend to have less access to technologies such as wireless and high-speed internet services. In other words, there could be less technology needs in rural areas.

<u>Control</u> represents whether the college or university is public or private, indicating the source of resources and potential constraints, which were noted above. This variable is important because public institutions may have mandates like reporting that do not constrain private institutions. On the other hand, large public research institutions may have more resources driving more IT needs.

Finally, <u>Total Expenditures</u> are the sum of all *Institutional Expenditures* and are the core expenses reported to IPEDS. Using *Institutional Expenditures* allows for proportional examination of *Central IT Expenditures* to *Institutional Expenditures.* This contextual variable allows for the examination of overall resource allocation for IT. For example, Institutions with more resources should have higher IT expenditures.

Model and Data Analysis. I created a correlation matrix of all variables to examine potential relationships that may impact the model through collinearity – a situation where two highly related variables impact model development. Table 3.5 lists the variables across both the vertical and horizontal axes. The closer a variable to 1 demonstrates a positive relationship, the closer a variable to -1 indicates a negative relationship. In the cases where the variable name matches, they are correlated at 1.00, like percentspend and percentspend in the first column of the first row. Generally, a coefficient between 0.3 and 0.7 (or -0.3 and -0.7) indicates a moderate correlation, and I highlighted areas with a moderate or strong (above 0.7correlation coefficient. There is a moderate positive relationship between specialty count and the presence of each specialty, which is intuitively expected since the specialty count is connected to the presence or absence of each specialty – ultimately specialtycount was used. The strongest relationship is between the ciodistance and nosportingpres variables, and ciodistance was ultimately discarded from the model entirely. This choice also removed the moderate relationships with report_prov and report_cfo by consolidating reporting into a single variable.

Table 3.6

Correlation Matrix

	percentspend	itstaffsize	academictech	researchcompute	analytics	projectmgt	specialtycount	ciodirects	ciodistance	report_prov	report_cfo	report_pres	notreportpres
percentspend	1.00												
itstaffsize	-0.16	1.00											
academictech	-0.04	0.15	1.00										
researchcompute	-0.18	0.38	.15	1.00									
analytics	-0.08	0.23	.08	0.18	1.00								
projectmgt	-0.08	0.16	.00	0.14	0.13	1.00							
specialtycount	-0.15	0.28	**0.57**	**0.59**	**0.56**	**0.56**	1.00						
ciodirects	-0.17	0.33	0.04	0.23	0.11	0.18	0.23	1.00					
ciodistance	-0.04	-.02	-0.02	0.12	0.04	-0.06	0.03	-.01	1.00				
report_prov	-0.10	0.07	0.21	0.10	0.00	0.01	0.15	0.06	0.01	1.00			
report_cfo	0.07	-.09	-0.02	-0.11	-.03	-0.03	-0.16	0.01	-.01	-0.26	1.00		
report_pres	0.02	.04	0.01	0.01	0.06	0.04	-0.06	-.05	0.02	**-0.34**	**-0.58**	1.00	
notreportpres	-0.05	-.02	-0.03	0.11	0.05	-0.06	0.02	-0.01	**0.99**	0.01	-0.02	0.02	1.00
highlycentralized	**0.34**	**-.37**	-0.06	-0.28	-.10	-0.12	-0.22	-.21	0.07	-0.07	0.12	-0.03	0.07

I evaluated several model types, including a variety of variables. For instance, *IT Percent Spend* was expected to produce differences and drive the model, but its use did not yield a meaningful distinct set of classes or converge beyond three classes. Table 3.6 below summarizes the eight iterations of models attempted, with the column headers indicating the iteration number. The rows indicate the variables used in their native STATA lowercase form. The variables are used in a particular model when highlighted in grey, not used when highlighted in white, and highlighted in black if they did not exist during that specific model iteration. Within each iteration, several combinations of each variable were used. I will describe the logic behind each iteration below.

Table 3.7

Model Iterations

	Model 1	**Model 2**	**Model 3**	**Model 4**	**Model 5**	**Model 6**	**Model 7**	**Model 8**
percentspend								
itstaffsize								
academictech								
researchcompute								
analytics								
projectmgt								
specialtycount								
ciodirects								
ciodistance								
report_prov								
report_cfo								
report_pres								
notreportpresident								
highlycentralized								

Model 1 was an attempt to use all proposed model variables and could colloquially be called the "kitchen sink" model, including *IT Percent Spend*, *Specialty Functions*, *CIO Directs*, and *CIO Reports* in three variables in binary form. Model 2 represents a simplified version that removed the *Specialty Functions* and added *CIO Distance.* Intuitively, this would not be a robust model because it included reporting distance and to whom the CIO reported. In other words, there was a collinearity between the variables included in this model, which is why it was not used. Model 3 focused exclusively on IT factors, as did Model 4.

The fifth model focused on size and reporting, but this was the model where it became evident that *IT Percent Spend* was likely a problematic variable. Here, I examined a way to use Percent Centralized in the model, achieved in subsequent models by creating a variable *Highly Centralized*, indicating 75% or greater centralization. Model 6 included the changes and several reporting variations. For example, several models were run to report directly to the president, CFO, and provost, both together and individually. While this iteration could yield three class solutions, creating a dummy variable of *Not Reporting to the President* (notreportpresident) led to an effective model. Models 7 and 8 are similar with the removal of *IT Percent Spend* in the successful model. The final successful model included *IT Staff Size, Highly Centralized, Not Reporting to President, Specialty Count*, and *CIO Direct Count* and was selected because it consistently generated successful convergence through multiple iterations and generated four and five classes.

Below are the exact commands and parameters run in STATA, where the bolded K is the number of specified classes. I began with K = 2 for a two-class model and increased until the model could not successfully converge.

```
gsem (itstaffsize <-) (highlycentralized notreportpres <-
,logit) (specialtycount ciodirects <-,poisson), lclass(c K)
iterate(2000)
```

The model converged at each iteration until six classes were specified; then, several troubleshooting steps were employed, including increasing the number of iterations, modifying seed values, and changing seed and start values. The first troubleshooting method is simply to increase the number of iterations using *iterate(n),* where n is the number of iterations. I tested n values up to 20,000. Another troubleshooting mechanism is to adjust the starting numbers by using the command *startvalues(randomid, draws(45), seed(60)),* where the starting value for each observation is assigned a random number. Further, there are 45 random draws where the best log-likelihood is selected from the iterations, and the seed is used to initialize the random number generator. However, the troubleshooting steps did not produce a converged six-class model. Thus, I evaluated models in classes two, three, four, and five because the model had reached the limits of the variations between classes.

To assess the model fit of the models with 2-5 classes, I utilized AIC and BIC scores using the command *estat lcgof* subsequent to the model run. I utilized AIC and BIC scores instead of LMR due to the lower number of cases in the sample, which is consistent with the literature (Rosinger et al., 2022). Table 3.6 lists the values in columns through each of the classes. In this case, AIC values continue to drop through all classes, with only a slight incremental improvement between the fourth and fifth classes. On the other hand, BIC values decrease through the four-class model and increase slightly in the five-class model and is highlighted in gray below.

Table 3.8

AIC and BIC Score for Classes

	2 Class	3 Class	4 Class	5 Class
AIC	7321	7231	7175	7163
BIC	7367	7300	7267	7274

Successful model fitting includes determining the homogeneity of a given class as well as how distinct each class is from the others (Masyn, 2013). This process involves estimating the posterior probability of class assignment for each case (university) using a set of commands. First, the *predict classpost_C**k***, classposteriorpr* command is run where the bolded **k** is the number of classes (e.g., Two, Three, etc.). The asterisk (*) generates a prediction for each of the classes. In the case of the four-class model, the command is:

```
predict classpost_CFour*, classposteriorpr
```

The next command generates the percentage likelihood of a case belonging to a class by generating a new variable with the highest percentage. In this case, the command is:

```
egen classpost_CFourCmax=rowmax (classpost_CFour1
classpost_CFour2 classpost_CFour3 classpost_CFour4)
```

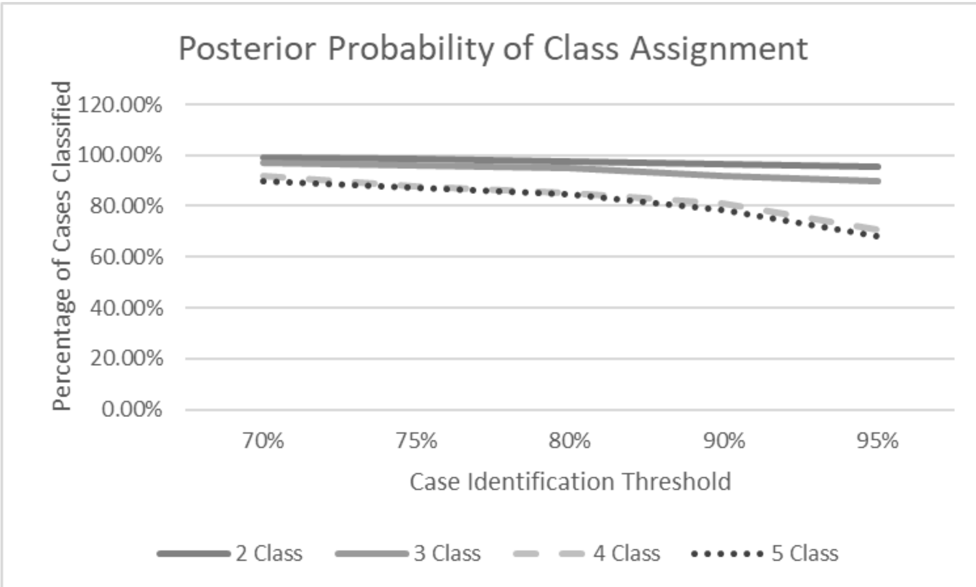
The probabilities can then be assessed by using the count command. For example, the following command assesses the probability of greater than 70%

```
count if classpost_CFourCmax >.70
```

The probability indicates how well each university fits into a particular class, with a value of 1 indicating it belongs entirely in that class with no overlapping. In contrast, a 0.7 indicates that it mostly belongs to that class, but 0.3 of that case resides in other classes. A higher probability of belonging to a specific class with low probabilities for the other classes is considered ideal. Researchers consider a high probability (>70%) of class membership to be the minimum acceptable criteria for model acceptance (Masyn, 2013; Weerts et al., 2014). As classes are added, the probabilities are expected to decrease as potential probabilities of belonging to multiple classes increase as you increase the number of classes. For example, nearly 98% of the cases are classified with at least a 70% probability, indicating that the model has appropriately found separation into distinct classes. Here, I examine the difference between the four- and five-class models to determine the appropriate model to select. Figure 3.1 demonstrates that the four-class model outperforms the likelihood of class assignment across all percentages when compared to the five-class model by highlighting the probability threshold in the X-axis and the percentage of cases that meet the threshold in the Y-axis.

Figure 3.1

Posterior Probability of Class Assignment



After evaluating the probability of membership in a specific class, researchers can assess the sizes of classes relative to each other. Next, I turn to the number of cases assigned to each class as a percentage of the total to assess the population sizes to determine if there are enough cases to make a meaningful class analysis. Table 3.7 demonstrates a shift of two percentage points from Class 1 in the four-class model compared to the five-class model, and there are no other distinctions across those two classes, continuing the trend favoring the four-class model. For this reason, as well as the lack of improvement in both posterior probabilities and BIC score, the four-class model was chosen and used in the present study.

Table 3.9

Percentage of Population Class Membership

	Model			
Class Membership	2 Class	3 Class	4 Class	5 Class
1	91%	87%	70%	2%
2	9%	11%	22%	68%
3		1%	7%	22%
4			1%	7%
5				1%

Membership to a class is assigned using a set of commands after generating a new variable called CFourFinal. The assignment commands assign by each class as demonstrated in the command below:

```
recode CFourFinal .=1 if
classpost_CFourCmax==classpost_CFour1
```

After assigning class membership, the next step is to examine the model and contextual variables within each class to describe the properties unique to each and discover differences between the classes, ultimately yielding the unobservable features determined by the model. STATA offers several mechanisms to examine variables by a larger population after first sorting the variable used to store the class assignment. Therefore, I use the command *sort CfourFinal*, which contains a value of one (1) through four (4). Once sorted, all institutions in class 1 are grouped together, and so on. A simple first step is listing class membership using the *list* command. For example, the output from *list unitid institution* yields output like Figure 3.2.

Figure 3.2

STATA output

```
. list unitid institution

     +---------------------------------------------------------+
     | unitid                                      institution |
     |---------------------------------------------------------|
  1. | 228529                        Tarleton State University |
  2. | 433660                     Florida Gulf Coast University |
  3. | 217907                                Coker University |
  4. | 131283               The Catholic University of America |
  5. | 110529     California State Polytechnic University, Pomona |
     |---------------------------------------------------------|
  6. | 173142                          Bethany Lutheran College |
  7. | 156286                            Bellarmine University |
  8. | 164216                               Washington College |
  9. | 195474                                    Siena College |
 10. | 194310                                  Pace University |
     +---------------------------------------------------------+
```

Taking the example further, we can assess properties like control using a similar command, *list unitid institution control*. The output then appends either Public or Private not-for-profit to the output. It is challenging to understand populations using only the *list* command. Therefore, another mechanism now that the population is sorted is to use the *by* command in conjunction with other commands, which effectively tells STATA to perform the same actions for each subset (class). One is the *tab* (tabulate) command, which is ideal for categorical variables. For example, the following command provides the count and percentage of public and private institutions in each class:

```
by CFourFinal: tab control
```

STATA then provides the results in an output table per class, indicating each class's count and percentage of private, not-for-profit, and public colleges and universities. In this example, STATA returns 88 public (36.21%) and 155 private (63.79%) institutions in Class 1, and so on.

The subsequent chapter will illustrate that the percentage of public institutions is smallest in Class 1 and is above 75% in the three other classes.

While the *tab* command is acceptable for categorical variables, continuous variables such as Central IT Staff size are in the dataset. For these, we turn to the *sum* (summarize) command. For example, the command below yields the observations, mean, standard deviation, minimum, and maximum for each class:

```
By CfourFinal: sum itstaffsize
```

The results indicate that each class has differing mean staff sizes ranging from 45 in Class 1 to 709 in Class 4. Should we need additional details, the command *",detail" is* appended to provide median and other information. Similar commands can also visualize the results, such as scatter graphs, histograms, and bar charts that further describe the properties of the populations in each class, detailed in the subsequent chapter.

Missing Data Treatment. Care was taken to ensure that the five model variables, *Central IT Staff Size, Highly Centralized, Not Reporting to President, Specialty Count, and CIO Directs*, contained no missing data or that missing data did not influence model results.

The EDUCAUSE variables of *Central IT Staff* Size and *Centralization Level* contained two instances of missing data. First, Arcadia College did not report a central IT staff size to EDUCAUSE for 2022 but did report in 2018. Testing revealed no changes to model output when including or excluding the previously reported staff size. Second, St. Michael's College did not report a *Centralization Level* in the EDUCAUSE Institutional Profile. However, the college reported a small staff size, making it highly likely to be a *Highly Centralized* institution. Again, testing revealed no class changes when this data point was included or excluded.

The model variables gathered from university websites include *Not Reporting to President, Specialty Count,* and *CIO Directs.* I could not locate IT website information (*Specialty Count* and *CIO Directs)* for sixteen universities. I was permitted to contact each CIO, requesting the number of direct reports and their functions. I received responses from ten of the sixteen universities and added them to the dataset. The following six institutions did not respond:

Chatham University
Hobart and William Smith Colleges
Norwich University
Sewanee: The University of the South
University of Northwestern, St. Paul
Yeshiva University

In these cases, I estimated the number of *CIO Directs* using the average of similar IT department staff sizes. Additionally, the *Specialty Count* was estimated similarly. Notably, the institutions were smaller and should be an avenue for future IT researchers at colleges and universities.

Limitations

I note six limitations of the data used in this analysis. First, EDUCAUSE data is a voluntary opt-in survey of institutions, which lends itself to selection bias. The sample demonstrates bias through overrepresenting doctoral universities compared to baccalaureate and masters institutions. Consequently, these findings do not fully capture the IT structures at these institutions. All baccalaureate and most masters institutions were placed in the first class, report smaller IT staff sizes, and are highly centralized. This might reflect the nature of participating institutions rather than the overall trend in baccalaureate and masters institutions. Thus, when generalizing results to all of higher education, we must be cognizant that there could be structure variations in the underrepresented groups.

Second, the EDUCAUSE data is also subject to human error in entry, either by inadvertent misrepresentation of an answer or by data entry. I compared the 2018 and 2022 CDS staff sizes using Microsoft Excel's highlight cell feature. Here, I noted 69 institutions that did not respond to the 2018 CDS thus I was unable to confirm across multiple years. In these instances, I attempted to triangulate the combination of spending and staff size compared to other institutions. Next, I noted differences greater than 10% in either direction, indicating staff reductions or additions. Here, I noted 116 institutions with size differentials greater than 10%. I examined the differentials of smaller institutions (<50) because a small number of staff changes generates a disproportionally large change. For example, one institution's IT staff was reduced from 43 to 38, a 12% reduction that seems reasonable. For the remaining institutions with differentials greater than 10%, I noted and attempted to triangulate through a combination of website data and the combination of staff and spending. However, I did not eliminate cases due to the smaller sample size. Nevertheless, much has changed since 2018, including the COVID-19 pandemic and the associated fiscal challenges where many positions were eliminated or not filled. Thus, there remains the potential for error.

Third, EDUCAUSE reports note that data on decentralized IT is elusive and not as consistently reported in the CDS (Lang, 2016). Therefore, the only decentralized variable that was ultimately included in the analysis was *Decentralized IT FTE*. Furthermore, the variable was only included in the analysis of the output of the four-class model. Future researchers should investigate mechanisms to gather additional decentralized data on IT at colleges and universities.

A fourth reliability concern is that each of the EDUCAUSE CDS budget and FTE questions also asks a question clarifying the accuracy of the answer. The choices include Accurate, Loose Estimate, and Unable to Estimate. Of the 465 available EDUCAUSE responses, 269 are accurate, 160 are loose, and 36 are unable to estimate. The mixed levels of accuracy can lead to variability of the results. For example, accurate responses introduce a level of certainty that loose and unable to estimate do not. Consequently, I employed the minimum amount of EDUCAUSE staff and financial data in the analysis. Future research could utilize the full dataset where accurate responses are marked.

Fifth, IPEDS provides a data quality section describing potential limitations. Because institutions receiving Title IV funds are expected to complete the IPEDS package, there is a low probability of selection bias and non-response. The other possible errors are related to the availability of needed data, misinterpretation of definitions, and operational mistakes. However, most errors relate to program completions, which are not part of the present study. Since program completions are unrelated to the present study, there should be no impact on using IPEDS data for the contextual analysis.

Sixth, website data is as good as the most recent published change. For example, an organizational change may have occurred and not yet be reflected on the institutional websites. Relying on website data means accepting the risk that some data could be outdated or incomplete, impacting both model and contextual variables. To address this potential issue, I employed the same methodology for each website by checking for published dates and last updated timestamps. Further, I attempted to triangulate the data through multiple methods, such as using organizational charts and the data on web pages. The same methodology was performed when compiling the Association of American Universities list from its website.

Despite these limitations, this study attempts to accurately explore the patterns and structures of IT in colleges and universities. This research helps set the stage to examine other factors in IT at colleges and universities.

Positionality

I have spent 30 years in varying roles in Information Technology, including technical support, server management, and software applications. My experiences have shaped my viewpoint on where the CIO should report and IT organizational structures and reporting lines. My perspective will not impact data gathering because there is little room to interpret website reporting information. However, this experience means I have an insider understanding of IT, which will be a strength when analyzing and describing the results. That said, I must ensure that results are provided that can be interpreted by individuals not involved in IT.

Conclusion

This research study seeks to understand IT in better detail at four-year public and private nonprofit institutions. The strength of this analysis is the creation of a unique dataset gathered from university websites combined with the unique and rich EDUCAUSE dataset. IPEDS augments the dataset to yield a contextual analysis that explores the unique factors at colleges and universities that may influence the IT department. Next, the dataset was combined in STATA to explore combinations of variables for LPA models to produce a four-class model. The result will be a novel dataset representing the IT department at colleges and universities. The dataset then lends itself to modeling the best approach for various profiles based on institutional characteristics using LPA. Finally, the analysis leads to a more complete understanding of IT structure and IT centralization at colleges and universities.

The next chapter will provide an overview of the patterns and structures of IT in higher education before turning to the results of the four-class model to answer the first research question. It then turns to the contextual analysis of the classes to attempt to answer the second research question.

Chapter 4: Findings

The present study examines the organizational structures of IT departments in higher education institutions. I begin with the two research questions. The first seeks to understand how top-level management of IT departments is organized in higher education institutions. This question is explored through data collected from 340 public and not-for-profit universities that participated in the 2022 EDUCAUSE Annual Core Data Survey (CDS). These data are analyzed using Latent Profile Analysis (LPA), a statistical technique that uses observed variables to group populations into classes that can be generalized.

The second research question seeks to understand the external factors that may relate to the structure of IT departments in higher education. I contextualized the findings from the LPA using data from the EDUCAUSE CDS, Integrated Postsecondary Education Data System (IPEDS), and additional website data collection. Specifically, I use descriptive analysis techniques for each class generated from the LPA, including means, histograms, scatterplots, and bar charts, because a combination of tables and visuals provides a rich analysis of the results.

This chapter is segmented into four sections. First, I explore top-level IT departments to generalize the overall findings about patterns of IT reporting at colleges and universities. Second, I present the results of the LPA analysis and describe the properties of each of the four classes using the model variables. Third, I examine contextual factors of the results from the LPA analysis in each of the four classes, highlighting the unique factors of each class. Finally, I summarize the results before proceeding to the concluding chapter of this study.

Top-Level Management of IT Departments

This section addresses the top-level management of IT departments. Here, I examine the reporting hierarchy of the CIO, the number of direct reports to the CIO, and the presence or absence of specialty functions within IT. This analysis provides a deeper understanding of the CIO's placement in university hierarchies while adding to the knowledge of the size and functions present in the IT department. Generalizing the overall population provides the characteristics of the overall population in this study.

Top Level Management

The CIO’s power is influenced by the individual they report to (Applegate & Elam, 1992; Raghunathan & Raghunathan, 1989). Table 4.1 demonstrates that the president (N = 138) is the most frequent position to which the CIO reports, followed by the CFO (N=111), and is consistent with the literature. For example, 70% of CIOs report to the president or CFO; this suggests a degree of isomorphism amongst colleges and universities consistent among private firms (Smaltz et al., 2006). Notably, there has been an increase in the number of CIOs reporting to the president; an EDUCAUSE poll from 2019 found that only 29% of CIOs reported to the president (Brooks & O’Brien, 2019). This shift is evidence of the trend toward the CIO reporting to the president at institutions (Dlamini, 2013).

Table 4.1

CIO Reporting Levels

	President	CFO	Provost	COO	Other
N	138	111	43	28	20
%	40.6%	32.6%	12.6%	8.2%	5.9%

Table 4.2 delves into the reporting structure of CIOs, compared across the different Carnegie Classifications, to highlight if the institutional focus or research intensity influences the reporting relationship. The table reveals that reporting to the president is common across all institutions, indicating that institutional focus may not be critical for understanding the reporting relationship. Also notable is the relatively high number of CIOs reporting to provosts at

baccalaureate and very high research institutions. Is this configuration indicative of alignment with the mission of academics and research, or are other factors at play? Conversely, the relatively high number of CIOs reporting to the CFO at master's level institutions may indicate that colleges and universities are attempting to maintain costs.

Table 4.2

CIO Reporting Levels by Carnegie Classification

	President		CFO		Provost		COO		Other	
	N	%	N	%	N	%	N	%	N	%
Baccalaureate	26	18.8%	23	20.7%	10	**23.3%**	5	17.9%	2	10.0%
Masters	37	26.8%	**33**	**29.7%**	6	14.0%	6	21.4%	**10**	**50.0%**
Doctoral	12	8.7%	14	12.6%	5	11.6%	4	14.3%	1	5.0%
Doctoral (High Research)	30	21.7%	17	15.3%	6	14.0%	3	10.7%	3	15.0%
Doctoral (Very High Research)	33	23.9%	24	21.6%	**16**	**37.2%**	**10**	**35.7%**	4	20.0%
Total	138		111		43		28		20	

To whom the CIO reports is one of the aspects of the structure of IT at colleges, and the size and scope of their portfolio is another lens from which to examine the IT department, which I turn to next.

CIO Direct Reports

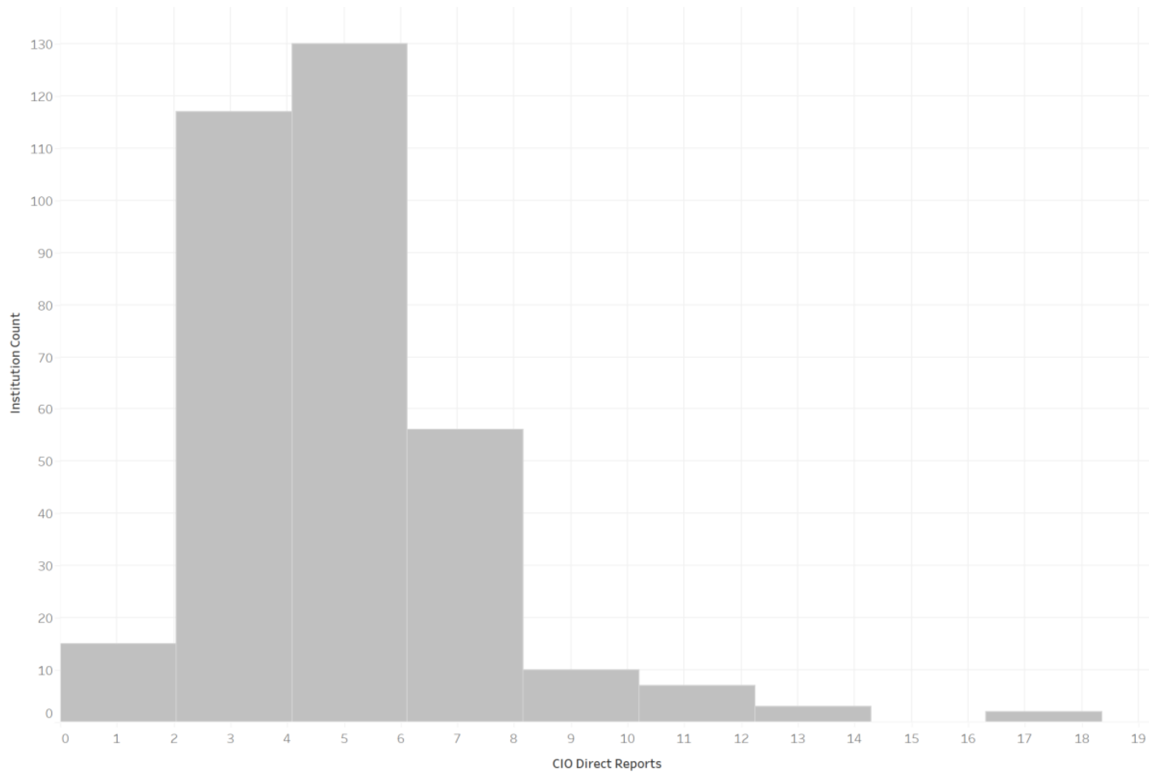
The CIO Portfolio concept indicates the IT department's scope and range of functions, and the first measure is the number of direct reports to the CIO. Each direct report oversees a function contributing to the IT department's scope of services. To illustrate, contrasting examples from the dataset include the University of Oklahoma and Eckerd College, which have 17 direct reports to the CIO. On the one hand, Oklahoma represented a large and diverse portfolio of services. For example, Oklahoma has a Research Computing function and functions needed for managing multiple campuses, thus indicating a more extensive scope. In contrast, Eckerd was a small and relatively flat organization with no clear management layer reporting to the CIO. Specifically, the staff directory provides no titles indicative of leadership beyond the CIO[9]. Additionally, the services listed on the Eckerd IT website highlight computer support for students, printing, labs, and email access, indicating a more compact and focused IT organization.

The study yields a wide range of results with as few as 2 to as many as 17 direct reports with a mean of 5.34 and a median of 5. Several factors could influence the size of direct reports. First, there is potential for mimetic isomorphism in organizational design where IT organizations in higher education look to other IT organizations to design their organization. Second, it could be due to the types of functions that are standard in higher education IT. For example, infrastructure, enterprise applications, support, and security create conditions for at least four direct reports. Third, the pattern could indicate organizational design principles at play. I expand on these possibilities further in Chapter 5. Figure 4.1 further illustrates this distribution, visually representing how CIO direct reports are spread across the population, though it highlights a more typical range of four to eight.

[9] https://directory.apps2.eckerd.edu/static/directory.pdf

Figure 4.1

CIO Direct Report Distribution



Specialty Functions

Another indicator of the CIO Portfolio is the functions represented in the direct reports to the CIO. Indeed, most institutions included (a) infrastructure to run networking and computing, though the teams could be separated, (b) applications to run enterprise software, (c) technical support in the form of a help desk, and (d) information security. As I described in the literature review, several potential ancillary functions in private industry include project management, support, information security, and vendor management (Peppard, 2018; Zammuto et al., 2007). In contrast, the expenditure domains used in higher education IT that closely align with what I term additional Specialty Functions are distinct, which is consistent with the distinct mission of colleges and universities relative to for-profit corporations. These specialty functions represent additions to the CIO's portfolio of responsibilities and the size and scope of IT. I briefly describe each specialty function below before looking at their occurrence across these institutions.

First, Project Management is a discipline built to manage and execute projects and can include training and certification like the Project Management Professional (PMP) certification. I classify project management as a Specialty Function here because it frequently appears as a separate function. However, it is also a source of variation when it is not a function of the IT department. Project management at colleges and universities can include implementing hardware and software to achieve a specific goal within a specific period. For example, an institution could assign a project manager to a project implementing a new electronic Student Information System (SIS).

Second, Academic Technology represents the tools and technology necessary for teaching and learning at institutions. For example, a Learning Management System (LMS) can be considered a teaching and learning technology, as are the software applications needed for labs and education. While not collected for this study, I anticipate that most institutions have some system for Teaching and Learning, though that could be the focus of future research. In other words, an Academic Technology function's absence does not mean an LMS's absence. Third, Research Computing manages computing and technologies for the research enterprise. This category frequently included teams necessary to operate specialty research hardware, such as high-performance computing, or the software tools necessary to conduct research.

Fourth, Analytics emerged as a potentially growing function in IT. Analytics includes building datasets, visualization tools, and infrastructure for data and analysis. For example, the growth of teaching and learning data has created the opportunity to measure learning outcomes and evaluate online programs (Martin et al., 2020).

Table 4.3 illustrates the presence of these functions, indicating a fair amount of variation across institutions. The table highlights the notable prevalence of Academic Technology (N = 143) and Project Management (N = 105). This finding suggests a significant emphasis on supporting software and systems for teaching and learning and the need for a robust infrastructure to manage and execute projects within IT departments. The use of Project Management closely aligns with the literature that highlights the additional functions of IT while also highlighting the distinctions of higher education in the form of Academic Technology and Research Computing.

Table 4.3

Specialty Functions

	Project Management	Academic Technology	Research Computing	Analytics
N	105	143	60	71
%	30.9%	42.1%	17.6%	20.9%

The Specialty Count, a measure of the number of distinct specialties present, provides additional insight into IT structures by measuring the diversity and breadth of an institution's IT department's responsibilities. It ranges from zero to four, with a higher number indicating a larger and more complex scope. Table 4.4 summarizes the distribution of specialty counts across the population. A striking finding is that approximately 70% of institutions have one specialty or less, potentially indicating that most IT departments are focused primarily on core functions.

Table 4.4

Specialty Counts

	0	1	2	3	4
N	99	136	74	22	9
%	29.1%	40.0%	21.8%	6.5%	2.6%

In this section, I have examined the dimensions of the top-level management of IT at colleges and universities. I have reported on the hierarchy and how the CIO's frequency of reporting to the president appears to be increasing compared to earlier reports. Further, I explored the number of direct reports, demonstrating a range of direct reports but a tendency towards three to six direct reports. Finally, I examined specialty functions that align closely with the EDUCAUSE spending domains, and results show that Academic Technology is most prevalent, indicating a desire to align teams with the university's academic mission. It is followed by Project Management, which indicates a desire to manage complex projects.

Further, I introduced the metric of specialty count as a measure that indicates the growth of IT responsibilities that corresponds with an increasing count. However, for the majority of universities, specialization was relatively limited. This descriptive analysis also laid the groundwork for the LPA, given that all the variables explored in this section are components of the LPA model I discussed in Chapter 3 and the findings I turn to now.

Four Class Model

The Latent Profile Analysis (LPA) yielded a four-class model based on staff size, number of direct reports, centralization level, and the sum of specialty counts. After testing several variable combinations, the four-class model was determined to be the best-fitting model. A complete discussion of model estimation, including models evaluated and how the four-class model was determined to be the best fitting was included in Chapter 3. This section will focus on the results. To that end, I define and describe each class's distinguishing characteristics while highlighting differences from other classes. The order in which the classes are discussed is not an indicator of hierarchy or rank, and the profiles are instead ordered from the largest to the smallest based on the count of institutions fitting the profile. Rather than number the classes, I added a descriptive name to each to highlight one or more distinguishing features relative to institution characteristics.

Class 1 – Diverse Centralized

The Diverse Centralized class in the four-class LPA model includes institutions where the IT department supports a diverse type of colleges and universities, and the department is smaller and more highly centralized than the other three classes, hence the name. High levels of centralization are a distinguishing characteristic, with 84% of institutions in this class (N =243) reporting 75% or higher centralization, with 21.4% indicating complete (100% centralization).

The Diverse Centralized institutions also tend to have fewer of the four identified specialty functions - (a) Project Management, (b) Academic Technology, (c) Research Computing, and (d) Analytics—with 36% showing no evident specialties, possibly indicating a streamlined and efficient approach to core IT functions for the institutions in this cluster.

Furthermore, the institutions in this class tend to have a smaller IT Staff Size, fewer CIO Direct Reports, and fewer Specialties than the other classes. An example institution from this class is Oklahoma Christian College, where the CIO reports to the president, has three direct reports, and has a staff size well below the mean. Conversely, Colorado College, where the CIO reports to the CFO, has four direct reports and a central IT staff closely aligning with the mean. Both institutions have smaller IT staff and a smaller number of direct reports when compared to the mean of 5.34

In addition, on average, this class's high centralization rate of 84.77% underscores a predominant focus on managing core IT functions like network operations, computing, and software maintenance. Appendix C contains a complete list of the colleges and universities in the Diverse Centralized class.

Table 4.5 summarizes the model variables and the four classes. There are five columns to the table, with the first describing the overall population and the subsequent columns describing each of the four classes. Each row corresponds to a variable that was included in the LPA models. The first row refers to Not Reporting to the President, which may initially seem counterintuitive. For example, 60.08% of the CIOs in the Diverse Centralized class do not report to the president. Another way to look at it is that approximately 40% of these CIOs report to the president. The second row is the indicator of a Highly Centralized[10] IT department. The third row is the IT Staff Size as reported to EDUCAUSE. The fourth row is the number of CIO Directs gathered from website data, and the fifth is the Specialty Count gathered from website data. The members of the Diverse Centralized class are highly centralized with smaller overall IT departments, and the CIOs have fewer direct reports and specialty functions compared to other classes. In other words, this class is focused on delivering core IT functions.

Table 4.5

Model Variables

		Overall	Diverse Centralized	Comprehensive Balanced	Elite Decentralized	Research Unicorns
		340	243	68	24	5
			71.47%	20.00%	7.06%	1.47%
Not Report President		58.82%	60.08%	48.53%	79.17%	40.00%
Highly Centralized		66.76%	84.77%	27.94%	8.33%	0%
IT Staff Size	Mean	100.25	45.37	163.78	348.87	709.78
	SD	(122)				
CIO Directs	Mean	5.34	4.87	6.05	7.54	7.6
	SD	(2)				
Specialty Count	Mean	1.14	0.87	1.73	1.83	2.2
	SD	(1)				

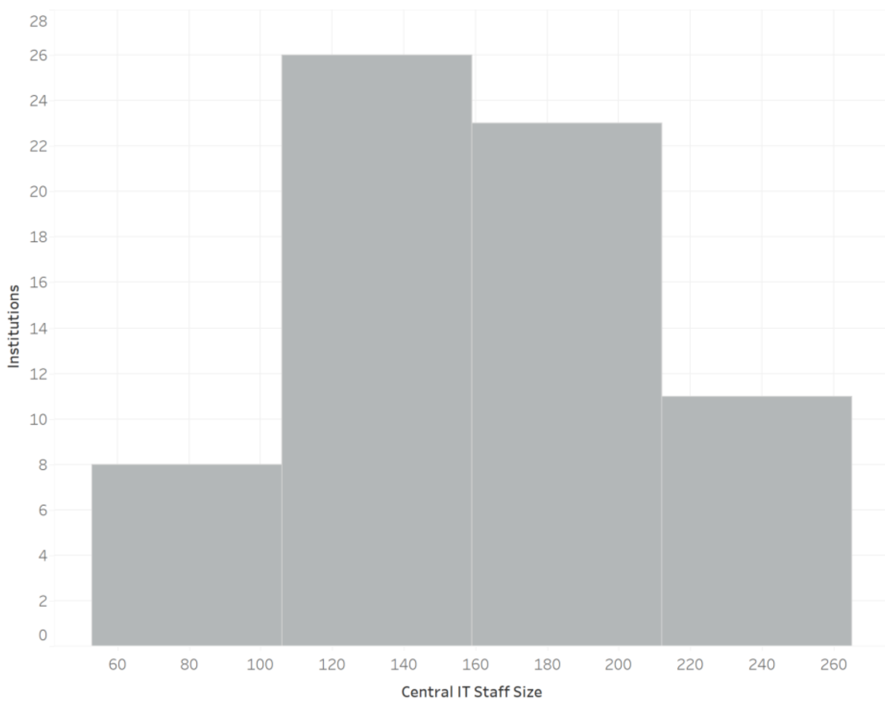
[10] Institutions with 75% or greater centralization in the EDUCAUSE Institutional Profile.

Class 2 – Comprehensive Balanced

The Comprehensive Balanced class represents institutions with larger IT departments with a less centralized structure than the Diverse Centralized class (Table 4.5). A key characteristic of this latent class is the larger Central IT Staff Size, with a mean of 163.78 FTE staff which is over 3.5 times larger than the average Diverse Centralized class staff size. This distinction is further illustrated in Figure 4.2, which shows that, unlike the right-skewed distribution of the Diverse Centralized class, the Comprehensive Balanced class aligns closer to a normal distribution with a range of sizes from less than 60 through 260.

Figure 4.2

Comprehensive Balanced Class: Central IT Staff Size Distribution



Centralization levels in the Comprehensive Balanced class are notably lower than in the Diverse Centralized class. Only 54% of these colleges and universities (N=37) fall within the 50-

75% centralization range, and only 28% are highly centralized, suggesting that these schools are less centralized and more distributed IT structures relative to the Diverse Centralized class. Examples of universities in this class include the University of Texas at Dallas, where the CIO reports to the president, oversees six direct reports, and manages a staff within 40 people of the mean. A second example is Stony Brook University, where the CIO reports to the CFO, has eight direct reports, and has a staff size like the mean.

Additionally, this class features a higher propensity for the CIO to report to the president again relative to the Diverse Centralized class, with 51% of institutions doing so. Further, the mean number of direct reports to the CIO was 6.05 compared to 4.9 in the Diverse Centralized class, reflecting more complex IT needs. The colleges and universities that are included in the Comprehensive Balanced class are listed in Appendix D.

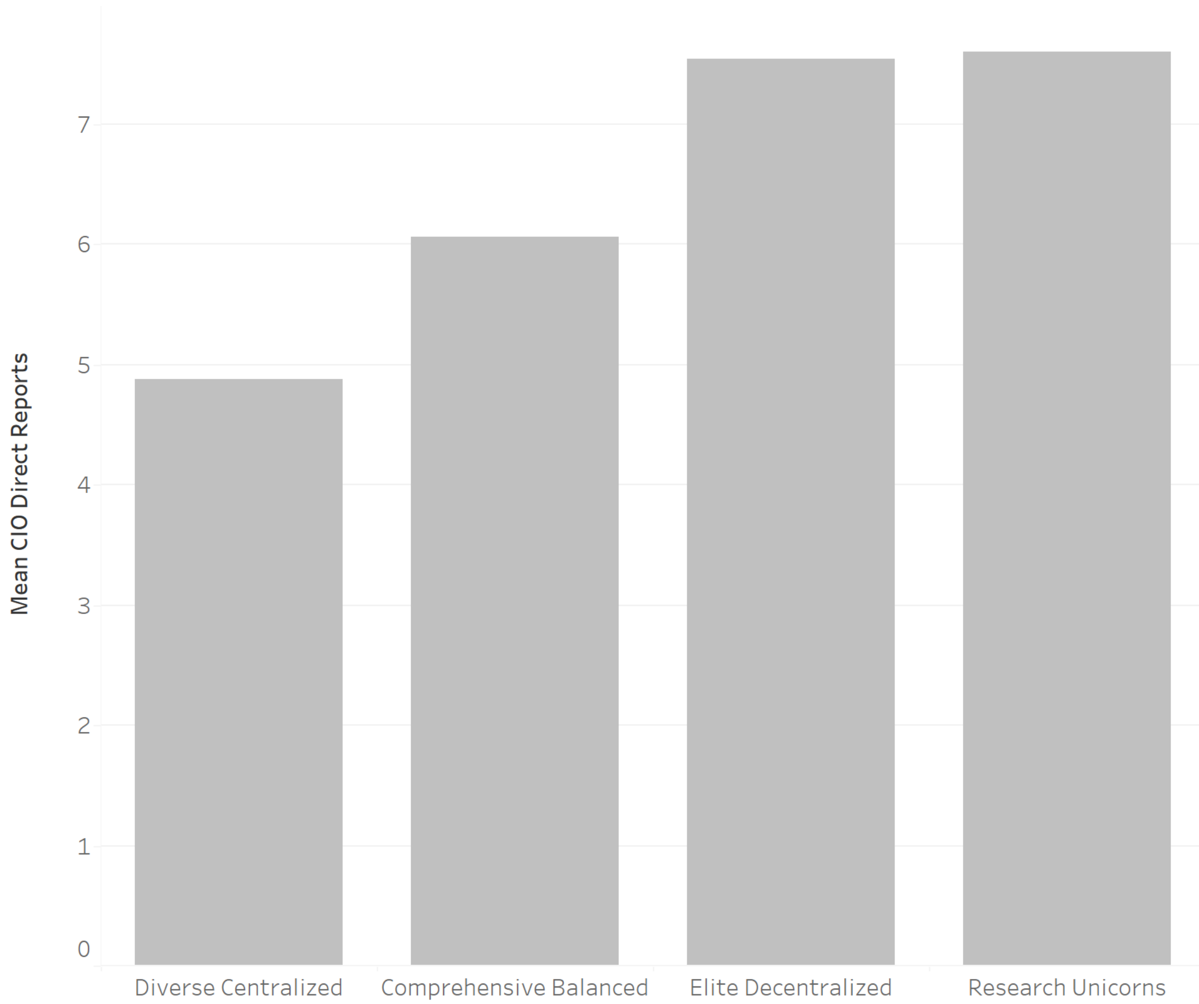
Class 3 – Elite Decentralized

A pronounced difference in centralization, specifically a decentralized IT structure, distinguishes the Elite Decentralized class. Half of the colleges and universities in this class (N = 24) report a 50% or less centralization level, suggesting a model favoring distributed decision-making, necessitating heightened coordination. For instance, Purdue University has a CIO reporting to the CFO, with eight direct reports and a staff size closely aligning with the mean. In contrast, the University of Illinois at Urbana reports a lower centralization, with the CIO reporting to the provost, managing four direct reports, and having a staff size smaller than the mean.

Further, the average staff size is 348.87, more than seven times the Central IT staff size in the Diverse Centralized class. The size difference indicates larger-scale IT needs and is likely representative of scaling needs for larger institutions. Second, there is a higher mean number of direct reports to the CIO, which is 7.5, approximately 1.5-person higher than the Comprehensive Balanced class. As illustrated in Figure 4.3, this increase closely matches the direct reports observed in the Research Unicorn class, indicating a blurred line between these two categories regarding direct reports. However, there is a distinct difference in the number of direct reports compared to the Diverse Centralized and Comprehensive Balanced classes, which is important because it indicates a greater scope and a more extensive IT department.

Figure 4.3

Number of Direct Report in Four Classes

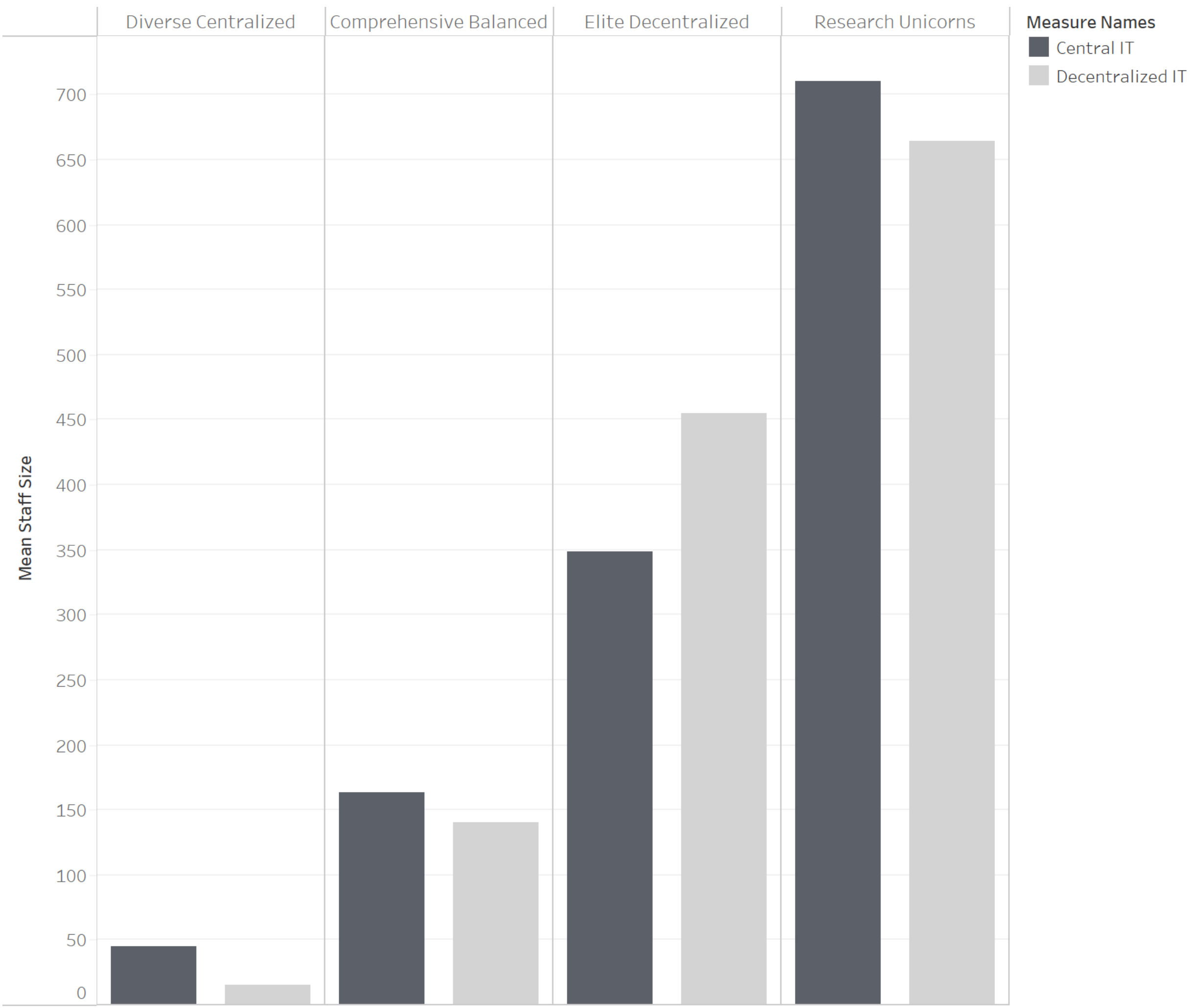


Furthermore, 57% of institutions in the Elite Decentralized class possess two or more specialty functions, indicating a more extensive and diverse CIO portfolio than the first two classes. This diversity in specialties also suggests a broader and more complex array of IT services and responsibilities in conjunction with the decentralized structure of these IT departments. Such a configuration may offer greater flexibility and specialization in addressing the diverse IT needs of large and multifaceted institutions.

A significant characteristic of the Elite Decentralized class is the significant size of the reported decentralized IT staff. Specifically, the mean Decentralized IT staff exceeds the mean Central IT staff size, which is a pattern dissimilar to all other classes, as demonstrated in Figure 4.4. The figure reveals that this class's average centralized IT staff size is approximately 350, and the decentralized staff exceeds this, averaging over 450. This change in distribution, relative to all other classes, may indicate a combination of more resources to purchase distributed IT or responses to specialized needs. The colleges and universities in the Elite Decentralized Class are listed in Appendix E.

Figure 4.4

Central and Decentralized IT Staff in Each Class



Class 4 – Research Unicorn

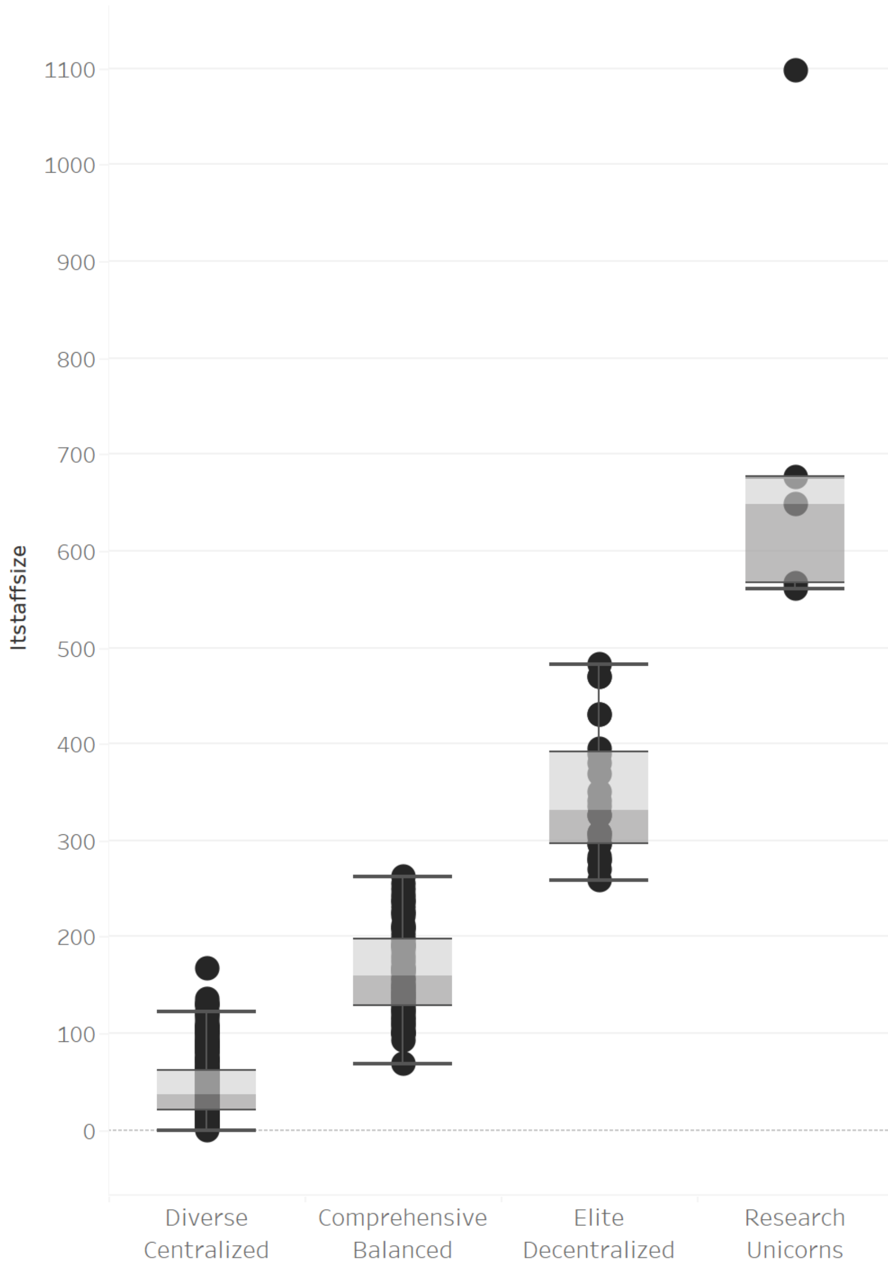
The last class represents both the largest centralized and decentralized IT staff. The five members of this class are Arizona State University, Indiana University Bloomington, Stanford University, Pennsylvania State University, and the University of Michigan-Ann Arbor. This class continues to highlight greater levels of decentralization, a pattern observed throughout all the classes. For instance, within the Research Unicorn class, three institutions report a 25-50% centralization level, and the remaining two fall in the 50-75% range, much lower than the other three classes.

Prominent members of this class are research unicorns like Stanford, where the CIO reports to the CFO, has eight direct reports, and manages a central IT staff below the mean of 709 for the class. Similarly, the University of Michigan at Ann Arbor has a CIO reporting to the president, with nine direct reports and a central IT staff size below the mean. An intriguing distinction in this class is a higher percentage of CIOs reporting to the president (60%), but the small sample makes interpretation challenging to interpret any further.

Only one member of the Research Unicorn class has a single specialty function, Stanford. In contrast, two institutions have three, and another two have two, suggesting they have a more diverse IT portfolio than the Diverse Centralized class. Another key difference is the remarkable increase in the mean Central IT Staff Size, which is 709, more than 15 times that of the Diverse Centralized class. Further, this class stands out with no mean overlap in staff size, indicating that it stands independently with significantly larger IT departments than all other institutions, as visualized in the boxplot in Figure 4.5. The size of the IT departments indicates significant IT investment and institutional technology needs.

Figure 4.5

Boxplot of Central IT Staff Size by Class

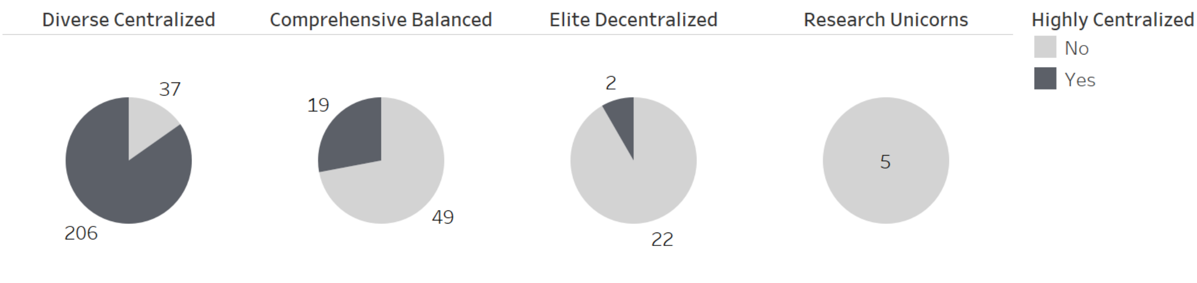


In summarizing the four classes, a pattern emerges: 'increasing.' Whether it is staff size, number of direct reports, or specialty count, there is a consistent increase across the classes.

Furthermore, the growth in the size of decentralized IT staff highlights the differences from the Diverse Centralized class. For example, Figure 4.6 underscores this point by contrasting the high centralization in the Diverse Centralized class with the markedly lower centralization levels in the Elite Decentralized and Research Unicorn classes.

Figure 4.6

Highly Centralized (>75%) by Class



I have explored the diverse organizational structures of IT departments across colleges and universities and have identified four distinct classes: (a) Diverse Centralized, (b) Comprehensive Balanced, (c) Elite Decentralized, and (d) Research Unicorn. Each class reveals unique patterns regarding CIO reporting structure, staff size, direct reports, specialties, and centralization levels. From the highly centralized and smaller-sized IT departments in the Diverse Centralized class to the expansive and decentralized Research Unicorn class, these categories underscore increasing size and complexity.

This study also reveals potential isomorphic features concerning IT sizing, structure, and placement at colleges and universities. For example, the large Diverse Centralized class demonstrates IT organizations focused on the core IT functions employing a centralized IT organization. A notable example is that 74.77% of CIOs who report to the CFO and 65% who report to the president oversee highly centralized IT organizations. In contrast, the other reporting structures are more evenly distributed. Such a pattern may indicate that institutions are adopting similar IT structures with perceived best practices, sectoral norms, or the results of an outside consulting engagement.

With this new understanding of how IT departments are organized at colleges and universities, I now turn to the contextual factors relating to the four-class model to address the second research question about factors that may shape IT in higher education institutions.

Contextual Factors of the Four-Class Profile

This section explores the characteristics distinguishing colleges and universities across the four identified classes. This encompasses a range of factors, including research focus, institutional control, urbanicity, institutional and IT expenditures, and overall institutional size. By examining these characteristics, I aim to explore the distinctions between each class, providing a more comprehensive understanding of the factors that influence IT department structures.

Table 4.6 summarizes the various contextual variables analyzed in this section. Again, there are five columns, one for the overall population and one for each class. The first two rows are the number (N) and percentage of the total population. The third row is the percentage of institutions in the population that are AAU members. For example, only .41% of institutions in the Diverse Centralized class are AAU members (N = 1). The fourth row is the percentage of the population classified as Very High Research. For example, 100% of the members of the Research Unicorn class are classified as Very High Research. The fifth row is the percentage of the population that is privately controlled. The next three rows relate to expenditures, institutional, central IT, and IT expenditures as a percentage of total expenditures. The final row is the Institutional FTE. In short, the table offers an overview of how each class aligns with these characteristics, allowing for a comparative analysis that highlights the various attributes of each class. Each characteristic will be addressed in turn, including (a) AAU Membership and Research Intensity, (b) Control, (c) Location, (d) Institutional and IT Expenditures, and (e) Institutional FTE.

Table 4.6

Class Characteristics

		Overall	Diverse Centralized	Comprehensive Balanced	Elite Decentralized	Research Unicorn
N		340	243	68	24	5
Population Percent			71.47%	20%	7.06%	1.47%
AAU Members		11%	0.41%	14.7%	88%	100%
Very High Research		26%	14%	68%	100%	100%
Percent Private		51%	64%	16%	25%	20%
Urban*		84%	79%	93%	100%	100%
Institutional Expenditures**	Mean	$700	$211	$1,140	$3,410	$5,430
	SD	(1330)				
Central IT Expenditures**	Mean	$20	$8	$33	$75	$157
	SD	(27)				
% IT Expenditures of Institutional		2.9%	3.8%	2.9%	2.2%	2.9%
Institutional FTE	Mean	12,279	6,288	22,648	35,312	51,789
	SD	(12,814)				

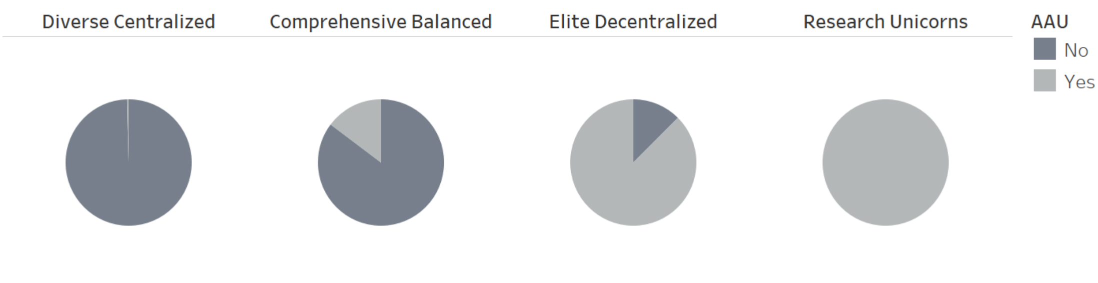
* IPEDS classification of Urban and Rural collapsed
** Millions

AAU Membership and Research Intensity

An examination of the American Association of Universities (AAU membership) reveals a clear pattern emerging among the classes: institutions not affiliated with the AAU predominately fall within the Diverse Centralized class[11]. Additionally, only 10 of the 68 institutions are AAU members within the Comprehensive Balanced class, as demonstrated in Figure 4.7. This contrasts sharply with the Elite Decentralized class, where 21 of 24 member institutions are AAUs, and the Research Unicorn class, where all five are AAU institutions. Conversely, the Comprehensive Balanced class has 10 AAU members, further reinforcing that the Comprehensive Balanced Class is a distinct class with fewer elite research universities. These findings suggest that it is not solely the level of research activity that influences IT department structures but rather a combination of factors associated with AAU membership that contribute to centralized and decentralized IT growth.

Figure 4.7

AAU Membership



The relationship between AAU membership and class membership appeared significant enough to explore further. Consequently, I ran a chi-square test between class membership and AAU membership, and the results suggest there is a relationship between class membership and AAU membership (x^2 = 214.7146, p<0.000). Remarkably, the LPA accurately predicted AAU institutions without that variable being present in the model, also reinforcing how LPA finds unobserved patterns in observed data. This finding continues to suggest that the various factors

[11] Brandeis University is the sole AAU member of the Diverse Centralized class.

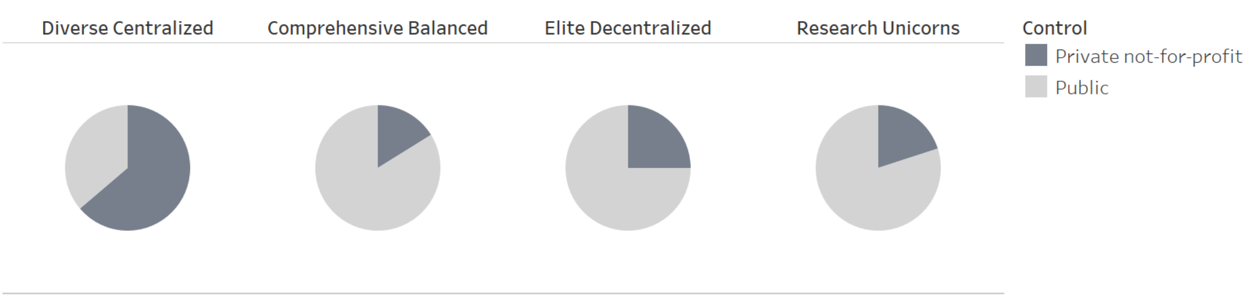
contributing to AAU membership –research intensity, funding models, or scale of operations – play significant roles in the size and structure of IT and the subsequent mix of centralized/decentralized IT resources. Past research has examined the qualities of CIOs at AAU institutions, finding that CIOs need diverse work experience, multi-dimensional personalities, and a higher education background (Dlamini, 2013). I address future research into AAU universities in the subsequent chapter's research recommendations.

Control

On average, approximately 51% of institutions in the total sample are private, but significant differences exist across the classes. As Figure 4.8 demonstrates, the Diverse Centralized class members are the majority private (64%), suggesting a possibility of private institutions favoring centralized IT services. Conversely, in the Comprehensive Balanced class, only 16% of the members are private.

Figure 4.8

Institutional Control



This finding may suggest that public institutions, with potentially different funding models and scales, are more likely to balance centralization and decentralization. Further, the high proportion of public institutions in the Large Centralized and Research Unicorn classes indicates that publicly funded institutions tend towards a higher level of decentralization.

Geographic Location and Institutional Setting

The influence of the geographic location of colleges and universities, particularly those in rural areas, presents two notable patterns in the analysis. First, rural institutions are situated solely in the Diverse Centralized and Comprehensive Balanced classes. While rural colleges and universities are a lower percentage of the overall population (16%, N = 55), they are most heavily concentrated in the Diverse Centralized Class (N = 50). Second, the population is mixed of public (N = 23) and private control (N = 27), whereas all schools (N = 5) are publicly controlled in the Comprehensive Balanced class.

The concentration of rural institutions in specific classes, particularly the Diverse Centralized class, could indicate resource limitations, less complex IT needs, or different strategic priorities in these settings. The five rural public universities in the Diverse Centralized institutions in this class are (a) Miami University in Oxford, Ohio; (b) Appalachian State University in St. Boone, North Carolina; (c) Sam Houston State University in Huntsville, Texas; (d) Montana State University in Bozeman, Montana; and (e) Ohio University in Athens, Ohio.

Another perspective to consider in this analysis is the region where an institution resides and how it may compare to class membership. Table 4.7 provides the overall percentage of institutions and the IPEDS geographic region in which they reside. The Diverse Centralized class closely aligns with the overall distribution of institutions, likely because of the large number of institutions in the class. Notable observations include the lower proportion of institutions in New England and Plains regions in the Comprehensive Balanced class. Similarly, the Far West is proportionally lower in the Elite Decentralized class, but the Great Lakes, Middle Eastern, and

Southeastern appear at a higher proportion than the average. Future analysis could investigate the higher ed IT departments in varying regions to study the potential effects of regional isomorphism. Another potential future study could also investigate institutions that are local or regional consortium members. For example, several Texas institutions are members of the Lonestar Education and Research Network (LEARN)[12]. Finally, future research could investigate potential isomorphism within accreditation areas, which was noted earlier as a time limitation to the present study.

Table 4.7

Regions by Class

	Overall	Diverse Centralized	Comprehensive Balanced	Elite Decentralized	Research Unicorn
Far West	11%	11%	13%	4%	20%
Great Lakes	16%	16%	15%	21%	40%
Mideast	18%	19%	15%	25%	20%
New England	9%	11%	3%	4%	
Plains	10%	13%	3%	8%	
Rockies	5%	5%	6%	4%	
Southeast	19%	17%	26%	25%	
Southwest	11%	9%	19%	8%	20%

Institutional and Proportional Central IT Expenditures

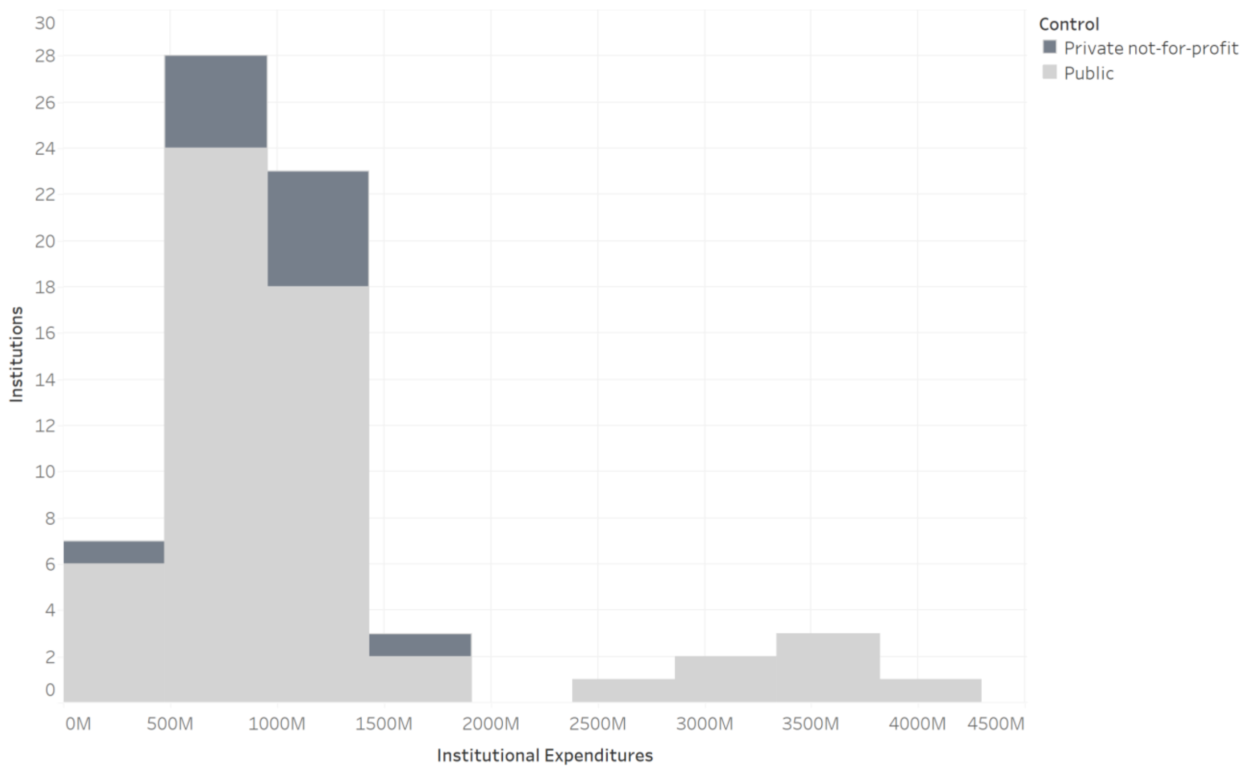
Institutional expenditure[13] consistently increases across the four classes, reflecting the growth of the scale and IT needs. An interesting difference is observed in the Comprehensive Balanced class, where the institutional expenditures show a bimodal pattern. As shown in Figure 4.9, the higher end of the expenditure distribution is exclusively public institutions. Institutions at the higher end of the expenditure distribution include the University of Colorado – Denver,

[12] https://www.tx-learn.org/members/index.php
[13] Includes costs for (a) instruction, (b) research, (c) public service, (d) academic support, (e) student services, (f) institutional support and scholarships and fellowships.

Stony Brook University, and the University of Kentucky. However, they are not the largest in terms of FTE size. The higher costs could indicate investment or other costs for these institutions.

Figure 4.9

Institutional Expenditures for the Comprehensive Balanced Class



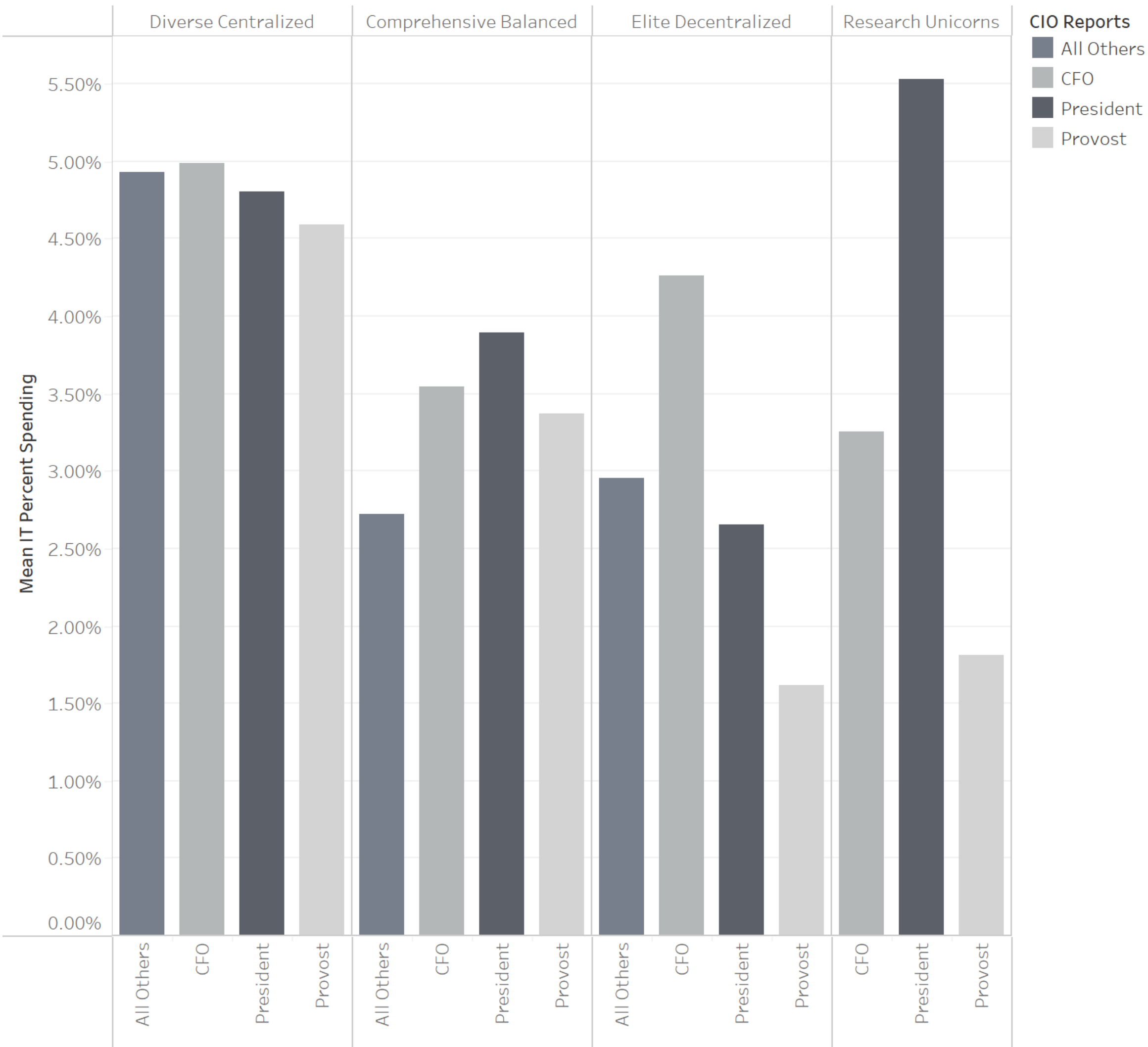
An analysis of centralized IT spending as a percentage of total institutional expenditure reveals interesting patterns in terms of IT costs relative to all costs. On average, institutions allocate 2.9% of total spending toward central IT. However, average IT expenditures in the Diverse Centralized class reveal nearly a whole percentage point higher (3.8%) of expenditures, potentially due to factors such as smaller scale or more increased institutional investment.

Alternatively, it could reflect heavy centralization, representing a more comprehensive total IT expenditure. In contrast, the Elite Decentralized class allocates a lower proportion of spending towards IT (2.2%), possibly due to economies of scale or higher costs hidden in larger decentralized staff. Interestingly, the Comprehensive Balanced and Research Unicorn both report a higher proportion of spending (2.9%), potentially reflecting increased investment in IT resources.

Combining spending percentages with the individual to whom the CIO Reports yields an interesting finding. Specifically, IT departments reporting to the provost demonstrate a lower overall percentage of spending. Figure 4.10 displays each class and to whom the CIO reports, where the provost is the light gray last bar in each class. For ease of reading, the chart combines COO, Not Found, and Other into ‘All Others’ for simplicity. Another observation is the outlier spending when reporting to the president in the Research Unicorn class. However, the lower population size in this class does not necessarily indicate a pattern that can be generalized.

Figure 4.10

Percent Central IT Spending per Class and CIO Reporting



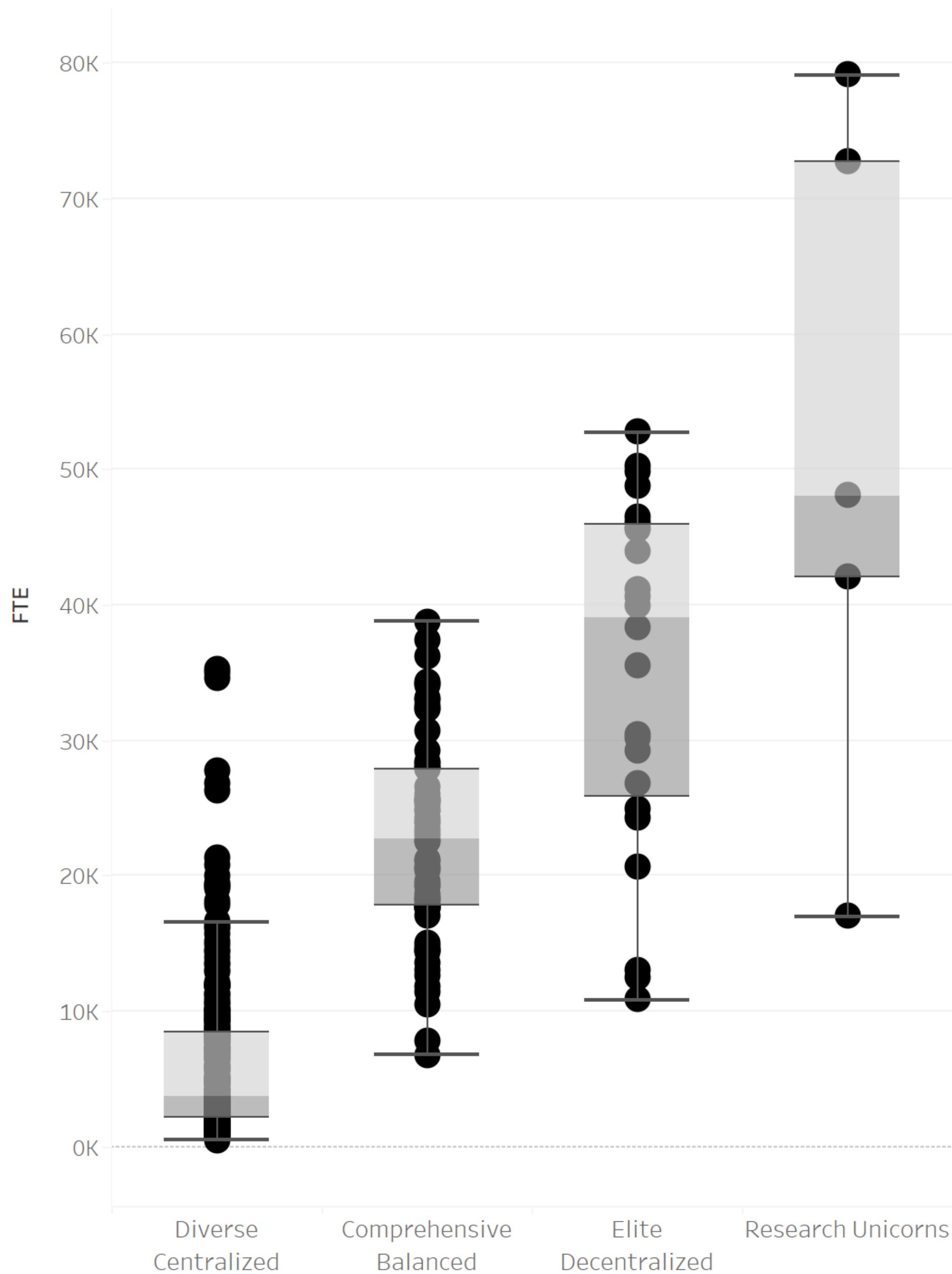
Further, the decentralization of IT in the Elite Decentralized and Research Unicorn classes poses significant implications for understanding the actual overall costs of IT. The dispersed staffing and spending across various departments potentially mask these institutions' total investment in technology resources. This lack of a complete picture of IT costs represents an avenue for future research where central IT spending can be more effectively combined with decentralized IT spending. Such an analysis could contribute significantly to the understanding of IT, particularly within members of the AAU. I address this and other future research directions more in Chapter 5.

Institutional FTE

The analysis of Institutional FTE across the four classes offers insights into how scale impacts the organization of IT departments in colleges and universities. The mean institutional FTE across all classes is 12,279; yet again, there are differences across all classes, as demonstrated in Figure 4.11. The Institutional FTE distinctions among the classes overlap more than in other measures, yet distinct differences remain. For example, the smaller size of Stanford, the lowest mark in the Research Unicorn class of Figure 4.11, could be placed in any of the other classes.

Figure 4.11

Institutional FTE Boxplot



In the Diverse Centralized class, the average FTE is 6,288, indicative of smaller student bodies. This smaller scale may align with the more centralized structures observed in this class, where a compact and centralized IT department can efficiently manage the campus' IT needs. There is a significant jump in the mean (22,648) when moving to the Comprehensive Balanced class, an increase to 35,312 for Elite Decentralized and 51,789 for the Research Unicorn, continuing to reinforce the increasing scale of each class.

The Central IT staff per 1,000 institutional FTE is a metric demonstrating a similar pattern compared to IT expenditures. The Research Unicorn class has the highest ratio, with 12.7 central IT staff for every 1,000 institutional FTEs. The high ratio and the high number of decentralized staff indicate a high investment in technology across the institutions and also warrant future study to understand the actual institutional investment in technology. Conversely, with its low levels of centralization, the Diverse Centralized class only reports 9.5 central IT FTE per 1,000 institutional FTE and suggests a lower overall IT investment across the institution. Moreover, the Comprehensive Balanced class, with 7.8 central IT staff per 1,000 institutional FTE, appears to benefit from economies of scale, balancing central IT with institutional size.

First, I explored the top-level management of IT departments to gain insight into the CIO reporting structure, direct reports, and specialty functions. Then, I explored the results of the four-class LPA model. Finally, I explored the contextual factors to better understand the populations in the four classes. Next, I summarize all the significant findings.

Summary of Findings

In this Comprehensive Balanced analysis, I have explored the organizational structures of 340 IT departments across higher education institutions, diving into the factors that may influence the shape of these structures. This LPA study reveals four distinct classes of IT departments: (a) Diverse Centralized, (b) Comprehensive Balanced, (c) Elite Decentralized, and (d) Research Unicorn. These classes represent unique patterns, including CIO reporting structure, number of direct reports, staff size, and centralization levels, ranging from highly centralized and relatively small IT departments to expansive and large IT departments with more extensive decentralization.

One key observation is the recognition of IT's strategic importance, as evidenced by the growing trend of CIOs reporting directly to the president, surpassing alternate reporting options. This is a departure from the figures in a 2019 EDUCAUSE poll indicating a shift in higher education IT. Additionally, the findings reveal that staff size and specialty functions grow in conjunction with the department, underscoring the relationship between department size, resource availability, and operational complexity.

Another observation is the higher likelihood of a highly centralized IT organization when the CIO reports to the CFO or president compared to the other reporting structures. What is unexplored in this study is the length of time the reporting relationship has existed at institutions. In other words, this finding could be a sign of isomorphism or path dependence.

Another observation is that rural institutions favor more centralized IT, potentially reflecting their unique technological needs, funding models, or strategic priorities. This finding may suggest that IT institutions have specialized needs and models differing from urban institutions.

The most striking finding emerges from the observations that AAU member institutions typically have larger IT departments and more decentralized IT structures. This pattern could be a function of the number of federal research awards, the flexibility of more resources, strategically placing IT nearer to researchers, or another factor. Regardless, more resources, larger colleges, and AAU membership fuel higher levels of decentralization and larger central IT staff sizes. It is a notable finding because the overall institutional investment in IT is not fully captured. Future research could consider a more holistic examination of IT in AAU institutions.

Overall, these findings provide a more nuanced picture of how various factors, including institutional type, institutional focus, institutional location, and research orientation, appear to shape the placement, size, and resources of IT at colleges and universities.

Chapter 5: Conclusion

This study sought to answer two research questions about Information Technology (IT) at colleges and universities. First, how is the top-level management organized in higher education institutions? Specifically, this means to whom the CIO reports and how the top level of the CIO's organization is structured regarding the size and functions served. Second, what university factors are associated with variations in the structure of IT departments? Both questions were investigated using a quantitative method that aligned with the conceptual model first introduced in the second chapter on page 16.

The conceptual model theorizes two dimensions that influence the structure of IT at colleges and universities: IT and higher education factors, respectively. The IT factors are the centralization level, the leadership of IT, and the functions that drove the LPA model that ultimately yielded the four-class model. The higher education factors are leadership, university type, isomorphic pressures, and other characteristics. These were explored through contextual analysis of the classes' membership.

The chapter is organized into four sections: (a) findings, (b) implications, (c) policy recommendations, (e) recommendations for future research, and (d) conclusions. First, the findings section reviews the methodology and connects the conceptual model to the resulting analysis. Second, I highlight the study's broader implications by exploring the IT department at colleges, reporting and resources, discussing centralization, and exploring the role of isomorphism. Third, I provide recommendations for policy and practice for elite institutions, clarify IT costs, examine centralization, the CIO reporting relationship, and specialty functions. Fourth, I recommend several avenues for future research based on the weaknesses outlined in Chapter 3 on page 103. I offer recommendations to generalize the findings better, expand on

EDUCAUSE data usage, gather better clarity on decentralized IT, study elite institutions, augment website data gathering, and continue to refine the role of specialties. Finally, I offer concluding thoughts on this study where we revisit Sophie, first introduced in Chapter 1 on page 2.

Discussion of the Findings

This is a quantitative study of 340 public and private not-for-profit four-year institutions participating in the EDUCAUSE Core Data Survey (CDS) in 2022. Further, the dataset was augmented with an original dataset collected from university websites, including reporting information of the CIO and the technology functions represented by the direct reports to the CIO. The dataset also includes AAU membership and IPEDS data for further contextual analysis.

The analytic method was a Latent Profile Analysis (LPA); this technique has been used in higher education for several analyses where researchers sought to find unobserved trends given an observed set of variables (Barringer & Jaquette, 2018; Rosinger et al., 2016; Taylor & Cantwell, 2018; Weerts et al., 2014). Additionally, LPA has been used as a technique that combines a combination of continuous and categorical variables to classify patterns amongst a population (Rosinger et al., 2016; Spurk et al., 2020; Weerts et al., 2014). The LPA model successfully yielded a four-class model, presented in detail in Chapter 4, that demonstrated differences and patterns in university and IT factors. In the previous chapter, I detailed each of the classes, and here, I discuss the broader characteristics of each class and its relation to the conceptual model and the related literature.

Diverse Centralized

The Diverse Centralized class's name highlights the population's distinguishing features: institutions with diverse missions and highly centralized IT structures. The class population is the largest compared to the other three classes (N = 243, 71.47%).

The CIO most frequently reports to the president (40%), and over 75% report to the president or the CFO. This class has the fewest specialty functions, with only .87 on average[14], indicating an emphasis on core IT needs that are most critical for smaller campuses of the colleges and universities in this profile. Notably, approximately 85% of these colleges and universities are highly centralized[15]. In this class, most specifically, we can gain a more precise picture of the total cost of IT because of the data reported to EDUCAUSE of centralized IT expenditures.

The entire population of baccalaureate colleges and universities are members of this class, as are most master's colleges and universities. Additionally, most rural institutions from the sample reside in this class. This class is not as research intensive as the subsequent classes – only twelve institutions are classified as Doctoral – Very High Research (R1), and only one member is elite when using AAU membership as a proxy. These findings suggest that institutions with less focus on research favor a more streamlined approach focused on delivering core IT functions.

The class's consistency of CIO reporting structures aligns with the literature supporting normative isomorphism, where institutions follow norms and best practices when designing reporting structures (DiMaggio & Powell, 1983). Further, this finding is consistent with research

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[14] The specialty functions are Academic Technology, Analytics, Project Management, and Research Computing
[15] When centralized IT is defined as 75% or greater in the EDUCAUSE CDS. These include the responses of 75-99% and 100% centralized.

outside of higher education, where the CIO generally reports to the president or the CFO (Banker et al., 2011; Chun & Mooney, 2009).

Comprehensive Balanced

The Comprehensive Balanced class is the second largest class (N = 68, 20% of the sample) and is distinguished by its combination of centralization levels, larger size, and population of large comprehensive universities. A notable pattern in this class is the proportionally higher number of CIOs reporting to the provost (N = 15, 22%) compared to the other classes. The design choice of having the CIO report to the provost may suggest a preference to align the IT department more closely with institutions' academic and research missions. However, the class is also consistent in that the CIOs report to the president or CFO most frequently, which is consistent with the literature.

Another IT structural difference of this class relative to the first is the higher number of direct reports, the number of central IT staff, and the higher average number of specialty functions, suggesting the larger scale and scope of the IT department when compared to the Diverse Centralized class. This class represents the most balanced approach mixture of centralized and decentralized IT of all four classes, suggesting a greater tolerance towards a more distributed IT organization. Greater decentralization rates create a murkier picture of total IT costs because the decentralized IT staff are distributed to the units where the EDUCAUSE data becomes more elusive than centralized expenditures. Specifically, respondents to the EDUCAUSE survey do not report decentralized IT expenditures consistently compared to the centralized data.

The predominance of research-focused institutions (R1 and R2[16]) in this class and that the majority are public (84%) colleges and universities suggest that institutional characteristics such as research focus and public status may influence IT structuring decisions. In addition, the relatively low percentage of AAU (14%) members indicates that elite status is not a determinant of structures in these institutions. In fact, these structures are most common at non-elite universities.

Elite Decentralized

Scale and research are the distinguishing characteristics of the Elite Decentralized class. The IT department is more expansive, as are member institutions' central IT FTE counts. The pattern of CIOs reporting to the president (33%) and CFO (29%) most frequently remains constant, yet the total percentage is lower when compared to the Diverse Centralized class[17]. The distinction here is the higher proportion of CIOs reporting to the COO (17%) compared to the other classes.

The centralized IT departments of universities in this profile have more specialty functions, with over 58% offering two or more specialties and 87.5% offering at least one specialty. In addition, more specialties also mean more direct reports to the CIO (7.5% on average in this class), and both together highlight the more extensive scope for the centralized IT department of the universities in this class. A striking finding is the flipped proportion of decentralized IT FTE to centralized IT – the average size of the decentralized IT staff (454) is larger than the centralized IT staff (349) (from Figure 4.4, page 120). In other words, these institutions tolerate heavy levels of decentralization. Additionally, average centralized IT expenditures as a proportion of total expenditures are the lowest (3.1%) compared to the other

[16] Doctoral – High Research
[17] 75% of CIOs report to president or CFO in Diverse Focus and 62% report to president or CFO in Average Mixed.

classes. However, the low expenditure does not indicate a lower total IT cost, given the large number of decentralized IT staff not accounted for in centralized IT expenditures. Consequently, the total cost of IT is challenging to estimate at these institutions.

AAU membership is a distinguishing characteristic of the schools in this class (21 of 24), as is being a public institution (75%). Notably, all private institutions in this class are members of the AAU and tend to have a lower student FTE than the public institutions in this class. Thus, size does not necessarily influence the size, scope, and centralization level of IT at colleges and universities.

Research Unicorn

The Research Unicorn class is the smallest, comprising only five members: Arizona State University, Indiana University Bloomington, Stanford University, Pennsylvania State University, and the University of Michigan-Ann Arbor.

The CIO reports to the president in three of the five institutions, with one of the remaining reporting to the provost and the other reporting to the CFO. These institutions tend to have more specialties than in the Diverse Centralized or Comprehensive Balanced classes, further suggesting that the scope and scale of IT is more expansive in the universities in this class relative to those two classes. Further, the class is characterized by an average of 12.7 central IT staff per 1,000 institutional FTE, whereas the other classes have 9.5 or fewer central IT staff per 1,000 FTE. However, this FTE count per 1,000 FTE does not include the decentralized IT staff, and these institutions report large, decentralized IT staff. However, as observed in the Elite Decentralized class, the average decentralized IT staff does not exceed the average central IT staff size. Again, the decentralized staff is not accounted for in the centralized IT expenditures; thus, the total cost of IT is not captured.

Arizona State University and Indiana University are the two institutions that look like outliers in this class relative to Stanford, Penn State, and Michigan. I argue that their inclusion in this class suggests they exhibit some mimetic isomorphism in the IT departments' size, scope, and offerings compared to the other three research unicorns. On the other hand, Arizona State University has invested in online education, and the technology organization could reflect the need to support online education.

The four classes demonstrate that the majority of CIOs report to the president or CFO, though those are not the sole configurations as highlighted by the provost and COO reporting in the Comprehensive Balanced and Elite Decentralized classes, respectively. The majority (66%) of institutions are highly centralized, and the majority of highly centralized institutions are members of the Diverse Centralized class. I now turn to the broader implications of this study to discuss the findings at a broader level.

Implications

In highlighting the implications of these findings for schools, higher education IT organizations, and the IT industry at large, this study is different from the broader IT industry research that often emphasizes the relationship between IT and firm performance (Cragg et al., 2002; Rockart et al., 1996; Rockart & Morton, 1984; Smaltz et al., 2006). In contrast, this study focuses on the patterns of IT department configuration and deliberately avoids any causal associations between IT and institutional performance. An alternative lens to revenues is the resources expended where I argue that Information Technology is not an insignificant cost at colleges and universities. For example, the mean centralized IT expenditures per student FTE are $1,842; some sample institutions exceed $5,000 per student. Moreover, the mean IT expenditures as a proportion of institutional expenditures[18] is 4.4% across the sample. Therefore, this study is relevant in providing a broader understanding of the patterns that influence the size and costs of IT.

The implications are presented through several lenses that align closely with the conceptual model: (a) the IT department, (b) reporting and resources, (c) centralization vs. decentralization, and (d) isomorphism. First, I examine IT at the colleges and universities in the study, as well as the varied patterns and configurations, and provide an overview of the configuration patterns at colleges and universities. Next, the discussion turns to the interplay between reporting structures and resources, where I review and expand on the literature that discusses the influence of reporting relationships on IT resource allocation. Third, the analysis shifts to the centralization versus decentralization paradigm, where scholars have argued for various configurations. Finally, I address potential isomorphic factors that may influence IT department configurations. Each of these dimensions sheds additional light on the patterns of the IT department at colleges and universities.

The IT Department at Colleges and Universities

There is no singular configuration for the IT department at colleges and universities, yet this study yields some insights that could have implications for colleges and universities more generally. First, the standard IT functions of networking, computing, software applications, security, and support are prevalent across the institutions in the sample. There is some variation in the placement of the security organization compared to the other three, yet security is present at nearly all institutions, indicating the importance of protecting information assets at colleges

[18] Includes costs for (a) instruction, (b) research, (c) public service, (d) academic support, (e) student services, (f) institutional support and scholarships and fellowships.

and universities. The near universality of these functions across the IT units of colleges and universities studied here suggests some isomorphic patterns at play.

Second, the number of specialty functions appears to increase with institution size and resources, as evidenced by the pattern differences in the four-class model, where we observe larger staff sizes in conjunction with additional specialties. A note of caution regarding specialty functions: it is essential to realize that the absence of a specialty function does not imply that it is not offered at an institution. It simply means that the function is not represented at the top management layer of the IT department. Academic Technology is the most frequently identified specialty function across the institutions studied. This finding underscores the critical role of supporting the educational objectives of colleges and universities and further highlights the unique needs of higher education. The IT department’s leader is the organization's apex and deploys resources to execute the projects and activities that support the institutional mission.

Reporting and Resources

From a reporting perspective, CIOs in the sample tend to report to the president or CFO, yet these configurations are not the sole reporting structures. For instance, 43 CIOs in the study report to the provost, and another 28 report to the COO. The pattern diverges from scant higher education leadership literature that suggests the CIO reports to the president (Carpenter-Hubin & Snover, 2017; Schuh et al., 2017). What this study did reveal is evidence suggesting that the CIO reporting to the president becoming a more frequent occurrence in this sample when compared to older EDUCAUSE reports, perhaps due to the perceived strategic value of IT or due to isomorphic factors (Brooks & O’Brien, 2019; Dlamini, 2013).

The literature suggests a distinction between reporting relationships and the focus of the IT organization. For example, Banker et al. (2011) concluded that the CFO is the most appropriate reporting relationship for firms seeking cost leadership, and the president was favored for strategic differentiation. However, colleges and universities do not appear to support Banker's findings, where the percentage of IT expenditures is similar when reporting to the president and CFO (4.51 and 4.69, respectively).

Interestingly, the proportion of Central IT expenditures to institutional expenditures is markedly lower when the CIO reports to the provost (3.8%) compared to the mean (4.5%). This finding could suggest a more cost-conscious IT approach when the IT department is part of the academic organization, or it could be a function of the lack of formal authority afforded to the provost (Mech, 1997). On the other hand, the spending differential could reflect the realities when IT is placed outside of the administrative bureaucracy (Baldridge et al., 1991; Birnbaum, 1991; Birnbaum & Eckel, 2005). This study does demonstrate that IT expenditures vary based on the CIO's reporting relationship. Next, I examine the patterns of centralization and decentralization across colleges and universities.

Centralization vs. Decentralization

The sample analysis indicates a preference for highly centralized IT organizations among private institutions, with 147 of the 173 private institutions centralized at 75% or greater. In contrast, around half of the public institutions (80 out of 167) exhibit a similar level of centralization, suggesting that public institutions tolerate decentralization more than private institutions. Overall, 66% of the institutions in the sample are identified as highly centralized, indicating a general preference for centralized structures. However, decentralized models are also present and not solely determined by the size of the institution or its research intensity.

The study observed a pattern among AAU institutions in the sample with a mixture of centralized and decentralized configurations, as demonstrated in the Elite Decentralized and

Research Unicorn classes. This pattern suggests a flexible approach to IT organization, with these universities incorporating varied configurations to meet their needs. A case in point is the University of South Florida, classified within the Elite Decentralized category, highlighting the concentration of federally funded research within AAU members—accounting for 63% of the total funding, or approximately $28.8 billion (Meketa, 2023).

The literature of the 1980s and 1990s suggests that innovative uses of technology belong with the individuals responsible for revenue and should not be the responsibility of a single IT organization (Blanton et al., 1992; Brown & Magill, 1994; DeSanctis & Jackson, 1994; Zmud, 1984). Compatibility complications and duplicative systems compelled researchers to change the discussion of how IT would be deployed to decision rights and authority. Indeed, a recent study in higher education found that heterogeneous, decentralized IT systems are more susceptible to cybersecurity incidents (Liu et al., 2020). The present study found that over 33% of the institutions in the sample are 50% decentralized or more, thus highlighting that the debate is not over for higher education.

The theorists recognized that the driving force behind the debate was the authority to decide the activities of the IT organization (Evaristo et al., 2005; Peppard, 2018). For example, how does the central IT organization support an innovative online project, a research grant, or system upgrades? To resolve this question, researchers turned towards governance models to resolve the decision rights and prioritization mechanisms for IT (Bharadwaj, 2000; Bianchi & Sousa, 2016; Coltman et al., 2015; Sambamurthy & Zmud, 2000; Smaltz et al., 2006). They theorize councils, steering committees, and standards to prioritize IT activities and standardize hardware and software. In other words, the greater the decentralization, the greater the need for the mechanisms to ensure the systems and activities interoperate.

In detail, we have examined the IT department, its leadership, and the centralization and decentralization patterns at colleges and universities. Armed with the patterns and configurations, I now discuss the role of isomorphic factors in IT departments at colleges and universities.

The Role of Isomorphism

There appears to be evidence of isomorphism that plays into the structure of IT at colleges and universities, though we cannot be sure because of two factors. First, this study did not examine IT at two different time points, which would offer an opportunity to assess changes over time. Second, this study did not investigate qualitative data sources that could provide additional data for CIO and institutional choices. For example, imagine interviews directly investigating departmental changes and the reasoning behind those choices.

In chapter 2, on page 52, I highlighted three isomorphism types: coercive, mimetic, and normative. Coercive isomorphism arises from the influence of external organizations, such as state governments, influencing public universities. Mimetic isomorphism occurs when institutions imitate the models and practices of institutions perceived as successful. Normative isomorphism arises when professional organizations or networks develop common standards and practices, leading to uniformity across different entities. However, mimetic isomorphism in the context of the theories presented here refers more to universities and their mimicking of institutions they deem more prestigious and not units such as IT.

I argue that there could still be mimetic factors at play. For example, imagine an ambitious CIO who observes another university rapidly advancing in research awards, and they note the presence of a research computing office in central IT. The CIO could make a budgetary case to build up research computing skillsets, thus demonstrating mimetic isomorphism by seeking to mimic successful practices.

In contrast, EDUCAUSE could be evidence of normative isomorphism because it provides guidance, best practices, and research to IT organizations in higher education. For example, there is an annual EDUCAUSE conference with sessions dedicated to all IT activities, including technical, process, data, organization management, and overall best practices. Further, its membership comprises IT departments and IT professionals demonstrating professionalization of the field (DiMaggio & Powell, 1983). Then again, the normative factors could be the larger IT field and not directly related to IT in colleges and universities except for specialty functions.

This study demonstrated that the private institutions in the sample favor centralized IT. In contrast, the relatively even split of public institutions' centralization levels could suggest coercive isomorphism. For example, the uncertainty of government funding could create conditions where IT resources are secured at the local level to ensure needs are met. Similarly, departments in decentralized institutions could perceive that their needs are not being adequately met and adopt structures that are more responsive to local needs. Finally, compliance needs mandated by governmental entities could drive decentralized structures.

The Role of Path Dependency

Path dependency, like isomorphism, is challenging to assess without examining the IT department at two time points. However, it could be in play across several dimensions of this study. First, I have noted that there appears to be evidence of CIOs reporting to presidents more frequently in the past. Perhaps the original state of the reporting relationship was that CIOs reported to CFOs, thus creating a condition where the default option was reporting to the CFO.

Second, I described how IT must react to aging systems requiring significant institutional investment. In these cases, there could be changes to IT to respond to the significant investment, thus making changes because of path dependency. Third, path dependency may play into centralization and decentralization at colleges and universities. Imagine a pendulum that swings between centralization and decentralization. For example, a university deliberately tries to centralize services at one point, though the institutional memory may be short, and decentralized resources begin to appear after several years.

The conceptual model hypothesized that both IT and university characteristics would influence the structure of IT at colleges and universities, and it appears that the results support the model. For example, we see that there is variation between private and public universities in the sample, whereby private universities favor centralization. Further, I observe distinct differences in the centralization levels of AAU member institutions. Thus, the structure of IT at colleges and universities reflects not only their needs and environment but could also be influenced by isomorphic or path-dependent factors. With this information at hand, the following section outlines recommendations for policy and practice guided by the literature and the study results.

Recommendations for Policy and Practice

IT is a component of all higher education institutions, whether geared towards efficient operations or strategic differentiation. Several findings from this study offer recommendations for policy and practice across three populations: (a) the institutions included in the study, (b) higher education IT at colleges and universities more generally, and (c) the field of IT. Table 5.1 summarizes recommendations by highlighting the significant findings and providing paired recommendations for each population discussed below. I provide a detailed explanation of each in the sections after the table.

Table 5.1

Summary of Recommendations

Major Finding	Recommendation	Population
The most successful and elite institutions are more heavily decentralized IT structures.	Aspiring institutions should study the most elite institutions to fully understand the decentralized needs of prominent and highly successful institutions.	Higher Education IT
	Aspiring institutions should avoid the urge to mimic the decentralized structures before understanding the factors influencing decentralization.	Higher Education IT
The total cost of IT is hard to measure for decentralized IT organizations.	Highly decentralized institutions should undertake an exercise to understand the total cost of IT.	IT Field
	Highly decentralized institutions should analyze the activities provided by the decentralized units compared to centralized units.	IT Field
	Highly decentralized colleges and universities should consider consolidation efforts.	Higher Education IT

Major Finding	Recommendation	Population
Centralization is the most prevalent model for colleges and universities.	Universities should consider centralizing to reduce exposure to cybersecurity issues by creating conditions for a more homogenous IT environment.	Higher Education IT
	Universities should consider centralization to respond to uncertainty and disruptions like the COVID-19 pandemic.	IT Field
	AAU institutions should critically examine the decentralization levels and the benefits.	Sample Institutions
CIOs report to different individuals, mostly the president, but are responsible for central IT at institutions regardless of the reporting structure.	Presidents should consider placing the CIO on the cabinet, even if not a direct report.	Higher Education IT
	CIOs should learn mechanisms to exert influence when they do not report to the president.	Higher Education IT

Major Finding	Recommendation	Population
Not all universities employ specialty functions.	Universities should examine the needs of Academic Technology and ensure it is adequately managed.	Higher Education IT
	Universities without Project Management should consider its relative value in completing IT projects.	Higher Education IT
	Institutions aspiring towards increased research could consider implementing a Research Computing functional team.	Higher Education IT

Elite Institutions

This study revealed that elite institutions exhibit two distinct patterns of IT configuration: prominently large centralized and decentralized IT departments. This finding suggests that the relatively large decentralization does not diminish the needs of the centralized IT department. IT departments at institutions aspiring to achieve elite status should conduct in-depth analyses of elite universities within the sample to determine operational needs and strategic priorities. In this way, aspiring institutions can better understand the needs that drive decentralized IT. Institutions aspiring to elevate their status should evaluate the benefits and challenges of adopting decentralized IT structures to fully understand the operational efficiencies, costs, and effectiveness of meeting institutional needs. Aspiring centralized organizations should study Brandeis University to ascertain the IT factors that allow it to belong to the Diverse Centralized class because it is a unique AAU institution.

Elite institutions should contemplate the value of a centralization or consolidation effort to control costs and centralize operations. To be sure, this is not simple because of the sheer scale of the task. For example, the mean decentralized IT count in the Elite Decentralized class is 450 staff members. Each position must be inventoried, skill assessed, placed into the consolidated organization, and moved funding. In addition, ensuring smooth service during the transition would be crucial to success and perceived success. Indeed, such an endeavor would require a highly skilled and collaborative CIO and institutional will to complete the task. The institutional will would require a CIO with the authority to act, which would mean reporting to the president.

These findings do not broadly apply to all IT organizations outside of higher education and are likely a phenomenon unique to academia that does not translate to other organizations. Another side effect of decentralization for this study is the lack of precise costs for decentralized IT.

Unclear Costs

The investigation into IT expenditures across the institutions revealed that the costs of decentralized IT are not easily calculated due to their underrepresentation in the EDUCAUSE dataset. The obscurity creates an unclear picture of the total costs of IT, especially for heavily decentralized organizations. Controlling IT costs is a challenge especially as duplicative software and systems create unnecessary redundancy.

Reduction of duplicative software requires intense focus and authority to decide what software to keep and what to remove. Furthermore, efforts like this require teams to collaborate and various skill sets depending on the action. For example, consolidating two email systems requires administrators of both systems to work together, as well as potential network changes, training, and support during migration to the single email platform. Therefore, it is one thing to consolidate costs and another entirely different to execute the consolidation. However, it is equally costly to maintain redundant systems, and realizing the value of consolidation can result in a positive return on investment.

All institutions should review their IT expenditure reporting practices, focusing on collecting and aggregating decentralized IT costs. Such an effort requires a collaborative institutional undertaking whereby departments share expenditure data to account for costs fully. Further, the higher education IT community, including organizations like EDUCAUSE, should consider promoting guidelines and mechanisms for reporting decentralized IT expenditures. At the broader level, all organizations build mechanisms to collect and aggregate all IT costs to better understand the total costs of IT.

Utility of Centralization?

Recent research, including studies by Liu et al. (2020) and observations of institutions like Case Western Reserve[19], underscores that higher levels of centralization can lead to reduced exposure to cybersecurity breaches (Case Western Reserve, 2016). Similarly, Park et al. (2023) concluded that centralized organizations are better equipped to respond to uncertainty like COVID-19. Consequently, institutions, particularly those with decentralized IT, should regularly review their cybersecurity policies and incident response plans. Further, incorporating centralized control elements like IT governance, where feasible, can better prepare institutions to manage cybersecurity threats and streamline responses to emergencies. AAU institutions in the sample are among the top research institutions in the country and are most certainly topics of bad actors, including nation-states.

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[19] Case Western Reserve began a centralization effort in 2016, citing cybersecurity threats as a partial reason for centralization.

Consequently, these institutions should ensure that valuable research is protected. All institutions should explore IT governance and mechanisms to unify choices, activities, and software and hardware acquisitions. Researchers offer various IT governance mechanisms for appropriate resource management and decision-making that better align with institutional strategy and protect institutional assets (Bianchi & Sousa, 2016). In other words, if an institution accepts decentralization as the norm, it should employ IT governance.

CIO Reporting

This study revealed no one-size-fits-all reporting relationship for CIOs in higher education, nor is there a singular optimal configuration. It is recommended that college presidents reevaluate the positioning of the CIO within the organizational hierarchy, or minimally, as a member of the president's cabinet. Membership acknowledges the strategic importance of IT but also ensures IT considerations are incorporated into institutional planning and decision-making.

Institutions considering significant IT changes such as consolidation, migration of the Enterprise Resource Planning (ERP) systems, or modernization should strongly consider where the CIO reports. For example, a CIO needs the authority and cabinet backing to execute significant organizational change.

Within the broader context of higher education IT, EDUCAUSE should continue highlighting the critical issue of CIO reporting relationships and advocate for presidential reporting. Further, EDUCAUSE should continue to offer frameworks and best practices to assist CIOs with gaining a broad understanding of institutional needs.

Role of Specialty Functions

This study underscores the importance of specialty functions within university IT departments and can support the institution's mission. Institutions should thoughtfully analyze their mission and operational needs to determine the relevance of specialty functions to their given context. Further, the broader higher education sector, with help from EDUCAUSE, could continue to advocate for specialty functions that align with specific institutional missions. On a more general level, all institutions should consider the integral role of project management in successfully executing IT strategy. Establishing the dedicated specialty function of Project Management can facilitate better coordination of resources.

Recommendations for Future Research

There are two drivers for future research based on the outcome of this study. First, I highlighted six limitations in Chapter 3 on page 103 that serve as the basis of avenues for future research. Here, I collapse two limitations related to EDUCAUSE data reliability because the research suggestions are similar and intertwined. Moreover, while acknowledged, the limitation concerning IPEDS data has been excluded from this section as it pertains more to the study's contextual rather than IT-specific factors. The second set of recommendations are unique findings from the study that could serve as the basis for future research. Consequently, Table 4.2 is organized with a limitation or a finding in the first column paired with one more suggestion for future research in the second column. The sections following the table provide details about each limitation or finding.

Table 5.2

Recommendations for Future Research

Limitation/Finding	Future Research
Patterns and configurations do not measure outcomes.	Study the impacts of various IT configurations by attempting to build determine and analyze how they relate to outcomes.
Isomorphism and path dependence do not directly indicate the current state of IT departments at universities.	Qualitatively examine IT at sample institutions.
The EDUCAUSE 2022 CDS survey is opt-in and overrepresents doctoral institutions.	Broaden data sources through direct surveys of institutions.
	Address the selection bias by creating a representative sample.
Human error could be present in EDUCAUSE data, or the data could be estimated.	Broaden data sources through direct surveys of institutions.
	Conduct a longitudinal analysis using five years of EDUCAUSE data.
	Utilize a smaller and more focused sample.
	Conduct similar analysis and weight responses considered to be “loose estimates.”

Limitation/Finding	Future Research
The EDUCAUSE dataset on decentralized IT is incomplete.	Broaden data sources through direct surveys of institutions.
	Perform collaborative data gathering with researchers and EDUCAUSE.
	Conduct a case study and a comparative analysis.
AAU institutions employ a distinctive IT configuration	Perform a case study of an AAU institution.
	Survey AAU CIOs and leaders.
Website data	Gather organizational charts through direct institutional outreach and perform a document analysis.
	Broaden data sources through direct surveys of CIOs.
There are two prevalent specialties: Project Management and Academic Technology.	Broaden data sources through direct surveys of institutions.
	Conduct a longitudinal analysis of websites or organizational charts.

Measure IT Outcomes

This study was focused on understanding the structures of IT departments and therefore did not examine any outcomes; thus, we do not know if any classes create different outcomes. Further, we do not know if specific outcomes are influenced by CIO reporting, centralization level, or even specialty functions. Future research that looks at outcome measures would expand on this work.

However, the question would then become what should the outcomes be? Liu et al. (2020) and Park et al. (2023) both conducted studies that included a dependent variable that was an outcome. In the case of Liu et al. (2020), cybersecurity incidents are the dependent variable measuring the outcome of cybersecurity breaches, and institutions would desire the lowest possible number. On the other hand, Park et al. (2023) used RateMyProfessor scores as the dependent variable, where higher professor scores were the desired outcome. However, neither of these are a great fit for the focus here on IT structures. Neither are enrollment, sponsored research, or graduation rates, which while common outcomes measures in higher ed, they are directly attributable to the IT department and could be explained by other factors. Future research could focus on measuring multiple IT departments in various configurations.

First, future research could examine IT directly, including satisfaction among the various constituencies, and could be benchmarked across several institutions. For example, a joint survey could be used across several institutions with various IT configurations. Second, IT can be measured in terms of efficiency in work produced or completed. For example, IT help desks regularly measure the number of help tickets opened and closed. Researchers could measure the "throughput" of tickets at various institutions in various configurations. Care would be needed on the researcher's part to ensure that team processes for opening and closing tickets are similar across studied institutions. Alternatively, IT could be measured in terms of projects completed, assuming similar mechanisms for opening, running, and closing projects. Third, IT departments could be measured in terms of their responsiveness to the organization. For example, multiple institutional players at colleges and universities could answer surveys about the IT department, and the data could be paired again with the CDS dataset to examine the outcomes of different configurations. The direct measures listed here work well for the central IT department; other mechanisms are needed for a decentralized IT department.

First, the decentralized IT departments could be similarly measured through satisfaction surveys. Researchers could survey multiple schools with decentralized IT, though the complexity may lie in identifying exactly where and whom to survey because the population may not be readily apparent. Therefore, future researchers would need to determine the samples before a study begins. Further, future researchers could study the services offered by the decentralized IT departments. In other words, they could examine what needs are being met by the departments to determine the outcomes desired by decentralized IT resources.

Theories of IT Configuration

This study examines IT at a point in time, which does not offer data on changes to IT configuration over time. Therefore, ascribing theories such as isomorphism or path dependence is challenging. Future studies could examine IT at different points in time and thus address the extent to which path dependency and ismorphism are evident in greater detail. .

One method to accomplish this is to use website data collection and an examination of the internet's archive, the Wayback Machine, which offers historical website views[20]. Using internet sources would allow a similar examination to the present study.

Building on the wayback concept presented above, the entire present study could be recreated using historical EDUCAUSE data, website data augmented with Wayback Machine information, the AAU membership list using the date members were added, and IPEDS from the specific years.

[20] https://archive.org/web/

Recreating aspects of the current study would allow us to see the movement of IT departments, either CIO reporting, additional specialty functions, and expenditure changes, creating conditions to analyze IT with theories better.

Overrepresentation of Doctoral Institutions

Doctoral institutions were overrepresented in this study compared to the overall proportion of doctoral institutions in the United States, which restricts the generalizability of the results. Thus, future studies could use a similar approach with a more representative sample to allow for broader generalization of the findings.

One method to accomplish this would be to gather more baccalaureate and master institutional data through direct surveys focused on the model variables from the EDUCAUSE dataset: IT Staff Size and Centralization Level. With the additional data, a more representative population sample could be obtained, and the same model ran again.

Alternatively, the same sample could be used, and the overrepresentation could be addressed by removing doctoral institutions, thus creating a representative sample using the proportions of colleges and universities in the US. However, caution is needed to address the AAU population when removing doctoral institutions from the sample. For example, it would be ineffective to remove all AAU institutions, and it would be equally ineffective to leave them all in the sample.

In sum, enhancing the sample allows for greater generalization of future studies. Next, I focus on the potential for error in the EDUCAUSE dataset that can be addressed in future research.

EDUCAUSE Data Reliability

I noted several potential reliability limitations, including human error, in entering data and the potential for respondents' answers to lack precision. For example, central FTE, budgets, and decentralized IT each have a subsequent question asking for the response's precision, including accuracy, loose estimate, and unable to estimate. Both human error and estimation answers create potential variability in the response accuracy that could create uncertainty in the present study's analysis. Thus, I offer several avenues that could build upon this study and account for reliability issues.

First, the same study could be performed with enhanced data-gathering mechanisms to augment the dataset. For example, a survey of the sample to confirm the EDUCAUSE CDS responses could ensure that the data entered was accurate. The instrument could be designed to provide a CIO or respondent with the answers submitted to the CDS to simplify the response. By doing so, future researchers could triangulate the answers from multiple sources (Singleton & Straits, 2005).

A second approach is conducting a longitudinal analysis of EDUCAUSE CDS data, which is robust for multiple reasons. First, future researchers could include additional cases into the dataset by adding institutions that responded at different times in the study period. Second, a longitudinal study could allow for more analysis of potential isomorphic forces by examining changes over time.

A third approach is conducting an analysis using a smaller, more focused sample. In this approach, the researcher purposefully defines the sample based on the criteria that all respondents' answers are "accurate." A weakness of this method is the likely exclusion of decentralized IT data from the sample, which would impact any analysis of decentralized IT.

A final approach to the EDUCAUSE data would be to weigh responses based on the reported accuracy. For example, “loose estimates” would be weighted lower than “accurate,” thus allowing the same analysis with a more critical examination of the responses. The weighting method could also allow additional variables to be added using weighting.

The EDUCAUSE dataset is extensive and rich, and future researchers could find mechanisms to employ it for IT studies at colleges and universities similar to Park et al. (2023) and Liu et al. (2020), where the dependent variables are resilience and cybersecurity incidents, respectively. However, a weakness of the dataset is the completeness of the decentralized IT data.

Decentralized IT Data

EDUCAUSE has acknowledged that the data on decentralized IT is elusive, and this study has yielded crucial findings on the patterns driving decentralized IT (Lang, 2016). Thus, this study provides insight into decentralized IT, but we know it needs further refinement because of the sample population and the potential issues noted in the EDUCAUSE dataset. Further, the only variables included in the study were the centralization level and contextual analysis of decentralized IT staff. The results restrict our understanding of decentralization and the factors that contribute to it. Therefore, we lack clarity on the size, cost, and activities of IT, contributing to an incomplete picture of the total cost of IT at colleges and universities.

One method to overcome the limitations is deep and collaborative research focused on decentralized IT between EDUCAUSE, researchers, and institutions. Such a focus could pair survey instruments and document analysis. For example, researchers could target surveys to known decentralized institutions to gather more precise data on IT in decentralized units. A document analysis of budgetary data at public institutions could augment surveys and potentially create a more refined picture of IT expenditures and staff sizes at decentralized institutions. A weakness of this method is that it does not help to answer questions about the factors that may contribute to decentralization.

Qualitative research is ideal when researchers attempt to understand the meaning of a specific phenomenon (Holley & Harris, 2019). Thus, case studies or comparative analyses of the known decentralized institutions could paint a more robust picture of the factors influencing decentralization. Further, researchers could examine different institution types, such as the University of Michigan and Arizona State University, to understand better the mechanics of decentralization and the patterns of elite institutions.

This study highlights two important facts. First, decentralization is present in 33% of the sample, highlighting that it is an accepted practice. Second, elite universities demonstrate tolerance of decentralization in the sample.

Elite Institutions

This study has yielded patterns of IT configuration at the most successful and elite institutions that warrant additional study. Like the previous recommendation, a greater understanding of the elite phenomena warrants qualitative examination. Future researchers could employ case studies or surveys of AAU leaders to clarify decentralized IT factors better. For example, Holley and Harris (2017) studied a single urban research institution better to understand the relationship between the city and the institution. They found that institutions prioritized knowledge creation at large instead of knowledge that may improve the quality of life for city residents. Like this study, Holley and Harris utilized website data to augment their study.

Website Data

This study relied on organizational reporting data gathered from institutional websites, including the presidential site, the IT website, cabinet members' websites, publicly available organizational charts, and people directories. Website data gathering has become more common among higher education researchers in recent years, though it also is only as accurate as the most recent update (Barringer & Pryor, 2022; Barringer, Taylor, et al., 2022; Leahey et al., 2019; Morphew & Hartley, 2006). Future researchers could confirm the findings of this study by utilizing organizational charts obtained by institutions or gathered similarly to this study. Indeed, organization charts offered the most easily interpreted reporting structure. Alternatively, organizational charts or reporting could be gathered through institutional surveys of CIOs and institutional leaders. In sum, the website data for this study was crucial to understanding reporting relationships and the specialty functions and can provide several avenues for future research.

Specialties

Park et al. (2023) employed the EDUCAUSE CDS expenditure domains: (a) Administration and Management of IT, (b) Enterprise Information Systems (IT)/Infrastructure, (c) Communications Infrastructure, (d) IT Support Services, (e) Educational Technology, (f) Information Security, and (g) Research Computing. This study found that IT structures align closely with expenditure domains, with exceptions. First, the Administration and Management domain includes the Project Management specialty. Second, there was not an expenditure domain for analytics. Therefore, future researchers could better align the specialty functions with the patterns discovered within this study. Researchers could refine the analysis using more variables within the rich EDUCAUSE dataset. For example, the CDS instrument includes several questions on staffing size based on the domains that could be used in future research. Further, EDUCAUSE could include specific questions about the specialty functions outlined in this study. Future researchers could similarly use the dataset to confirm the core IT functions and ensure they align with the expenditure domains.

Alternatively, researchers could survey institutional CIOs to gather additional information on specialty functions. Indeed, expanding research to a CIO survey instrument could add to the understanding of the patterns and structures of IT departments. It would be the most direct method for future researchers because it could incorporate future research directions from all the above. Thus, future researchers could select topics of interest based on a combination of findings from this study.

Conclusion

This study has quantitatively examined the patterns and structures of IT at colleges and universities through several datasets and novel data collection and was carefully designed to enhance our understanding of the similarities and differences in institutional approaches.

While no direct hypotheses were indicated initially, I had several hunches that turned out to be false. First, I did not anticipate the levels of decentralization discovered at certain institution types, particularly the members of the AAU. In fact, I tended to agree with the literature review that the centralization debate ended in the early 2000s. Thus, this finding has been surprising and eye-opening. Second, I did not know which specialty functions IT would offer at higher rates. Specifically, I expected Project Management to be the predominant specialty function primarily because of normative isomorphic pressures that suggest project management helps IT projects to succeed at a higher rate. Third, I was surprised by the homogeneity of the core IT functions at colleges and universities. This homogeneity suggests that colleges and universities converge around a core set of IT functions essential for their operations and educational delivery despite varying sizes, missions, and resources.

With our expanded knowledge of the patterns and structures of IT, let us return to our example student, Sophie, first introduced in the first chapter on page 2. Sophie woke up and interacted with the IT systems in the following ways: first, she connected wirelessly to the university network, a function provided by an infrastructure or networking team; second, she logged onto a Zoom appointment with an advisor, a function provided by the team that manages software applications; third she logs into the LMS, a top-level function we see in some IT teams and not in others. Finally, she swipes her card at the dining hall into a software application provided by the applications team. Sophie's interactions with technologies demonstrate how deeply embedded these functions are in today's modern university.

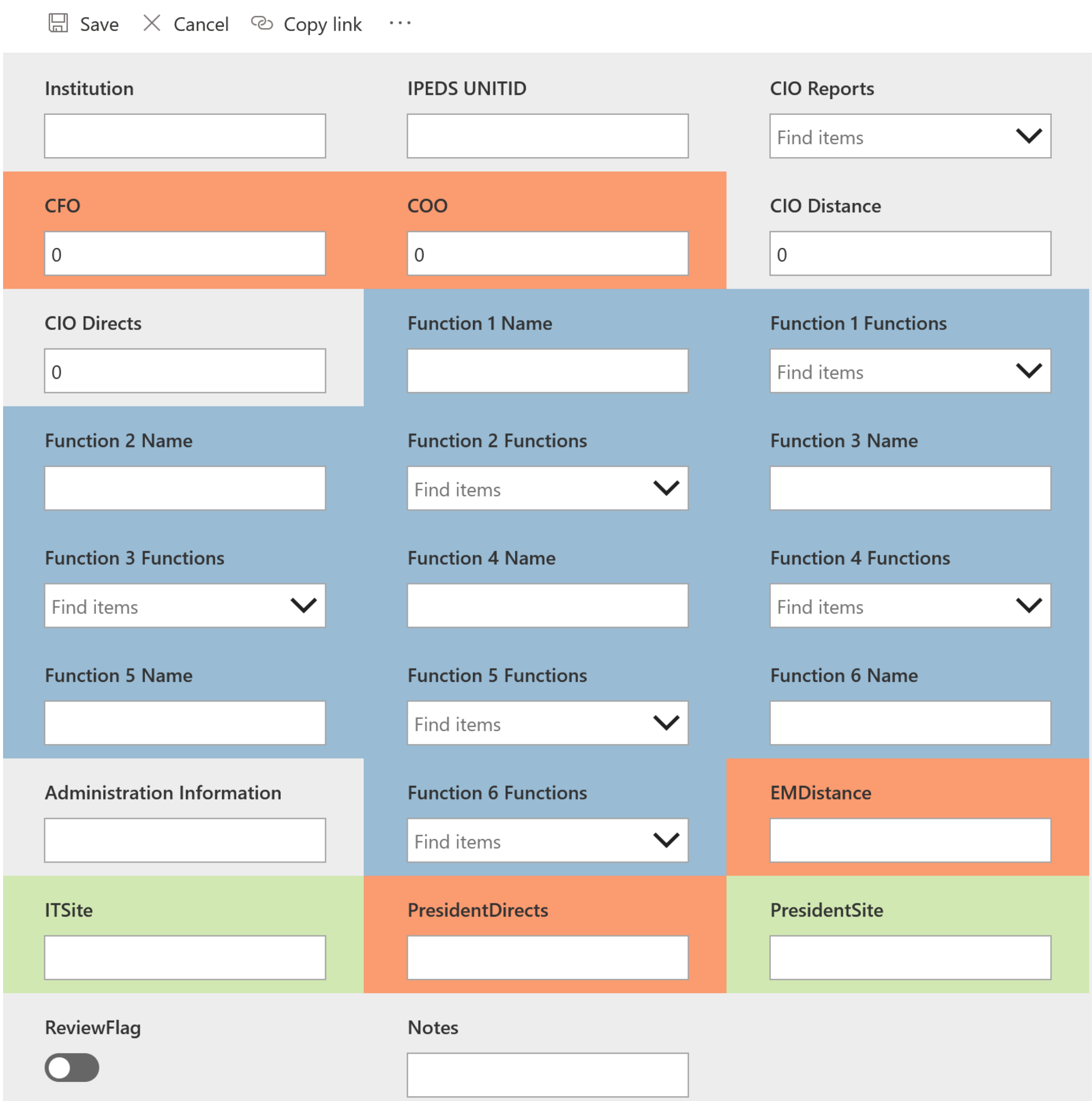
The technological world we see today was incubated through partnerships between the federal government, universities, and private industry between the 1940s and 1970s. Indeed, university researchers played a substantial and crucial role in shaping today's modern internet; first introduced as ARPANET, they connected the Stanford Research Institute with the University of California at Los Angeles[21] in 1969[22]. Don Pederson built the world's first microprocessor fabrication plant at the University of California at Berkeley after the invention of the first integrated circuit at Texas Instruments in 1958[23], setting the stage for chips like the Intel and NVIDIA chips capable of processing billions of instructions per second. In many ways, researchers at today's elite universities set the stage for the modern computing age, which we may soon call the Artificial Intelligence Age.

[21] AAU membership in 1974
[22] https://ethw.org/Milestones:Inception_of_the_ARPANET,_1969
[23] https://engineering.berkeley.edu/don-pederson-creator-of-spice/

This study demonstrates that the modern IT department at colleges and universities supports a wide array of functions for the bifurcated academic enterprise. It further shows that institutions tailor their focus based on their unique needs, histories, missions, values, and pursuits. Undoubtedly, the IT department will continue to evolve as we enter the subsequent eras of computing.

Appendices

Appendix A – SharePoint Online Data Collection Form


Save Cancel Copy link ...

Institution
IPEDS UNITID
CIO Reports
Find items
CFO
0
COO
0
CIO Distance
0
CIO Directs
0
Function 1 Name
Function 1 Functions
Find items
Function 2 Name
Function 2 Functions
Find items
Function 3 Name
Function 3 Functions
Find items
Function 4 Name
Function 4 Functions
Find items
Function 5 Name
Function 5 Functions
Find items
Function 6 Name
Administration Information
Function 6 Functions
Find items
EMDistance
ITSite
PresidentDirects
PresidentSite
ReviewFlag
Notes

Appendix B – Specialty Function Code List

Applications
Infrastructure
Security
Support
Project Management
Data and Analytics
Vendor Management
Academic Technology
Web
Operations
Administration
Quality Assurance
Media and/or Classrooms
Library Related
Partnerships
Training/Communications
Research Computing
Healthcare IT
Enterprise Architecture
Advancement Specific
Business Process/Transformation
Networking
Multi-Campus Leadership
Identity and/or ID Cards
Strategic
Cloud
Compliance
Registrar

Appendix C – Members of Diverse Centralized Class

Abilene Christian University
Albright College
Alma College
Amherst College
Angelo State University
Arcadia University
Asbury University
Augsburg University
Augustana University
Ball State University
Barnard College
Barry University
Bay Path University
Baylor University
Bellarmine University
Beloit College
Berry College
Bethany Lutheran College
Boise State University
Bradley University
Brandeis University
Bridgewater State University
Bryn Mawr College
Bucknell University
Buena Vista University
California Institute of the Arts
California Polytechnic State University, San Luis Obispo
California State Polytechnic University, Pomona
California State University, Long Beach
California State University, Northridge
California State University, San Marcos
Calvin University
Campbell University
Carroll College
Carthage College
Central College
Central Connecticut State University
Central Michigan University
Chapman University
Charleston Southern University
Chatham University
Christopher Newport University
Claremont McKenna College
Clark University
Clarkson University
Coker University
Colby College
Colgate University
College of Charleston
College of Saint Benedict/Saint John's University
Colorado Christian University
Colorado College
Columbia College
Concordia College
Connecticut College
Daemen University
Denison University
DePaul University
Dickinson College
Dominican University
Drake University
Duquesne University
Earlham College
Eastern Michigan University
Eastern New Mexico University
Eastern Washington University
Eckerd College
Elizabethtown College
Elmira College
Elon University
Emerson College
Flagler College
Florida Gulf Coast University
Florida Polytechnic University
Florida Southern College
Fort Hays State University

Framingham State University
Franciscan University of Steubenville
Georgia College & State University
Gonzaga University
Grand Valley State University
Grinnell College
Gustavus Adolphus College
Hamilton College
Hamline University
Hanover College
Harvey Mudd College
Hobart and William Smith Colleges
Holy Cross College
Illinois Wesleyan University
Indiana State University
James Madison University
John Brown University
Lafayette College
Lake Forest College
LeTourneau University
Lewis & Clark College
Lewis University
Lourdes University
Loyola Marymount University
Loyola University Chicago
Loyola University Maryland
Lycoming College
Madonna University
Manhattanville College
Marist College
Marquette University
Marshall University
Marymount University
Marywood University
Mercy College
Meredith College
Messiah University
Metropolitan College of New York
Metropolitan State University of Denver
Michigan Technological University
Middle Tennessee State University
Midwestern State University
Montana State University-Billings
Montclair State University
Mount Holyoke College
Murray State University
Nazareth College of Rochester
New Jersey Institute of Technology
Nichols College
North Carolina A&T State University
Northern State University
Norwich University
Oakland University
Oberlin College
Oklahoma Christian University
Pace University
Pacific Lutheran University
Pacific University
Parker University
Pennsylvania Western University
Pitzer College
Pomona College
Quinnipiac University
Reed College
Rensselaer Polytechnic Institute
Rhodes College
Rollins College
Saint Louis University
Saint Mary's College
Saint Michael's College
Saint Peter's University
Samford University
Santa Clara University
Scripps College
Seattle Pacific University
Seton Hall University

Seton Hill University
Sewanee: The University of the South
Siena College
Simmons University
Southeastern Louisiana University
Southern Illinois University at Carbondale
Southern Illinois University Edwardsville
Southwest Minnesota State University
Southwestern University
Springfield College
St. Cloud State University
St. Edward's University
St. Lawrence University
St. Mary's University
St. Norbert College
St. Olaf College
Suffolk University
Tarleton State University
Texas A&M University-Corpus Christi
Texas Lutheran University
The Catholic University of America
The College of New Jersey
The College of William & Mary
The University of Memphis
The University of South Dakota
Trinity College
Truman State University
Union College
Union University
University of Alabama at Huntsville
University of Arkansas, Little Rock
University of Central Missouri
University of Colorado Colorado Springs
University of Dayton
University of Houston-Clear Lake
University of Houston-Downtown
University of Indianapolis
University of La Verne
University of Mary Hardin-Baylor
University of Maryland, Baltimore County
University of Massachusetts Amherst
University of Michigan-Dearborn
University of Michigan-Flint
University of Minnesota-Crookston
University of Minnesota-Duluth
University of Missouri-Kansas City
University of Missouri-St Louis
University of Montana
University of North Carolina at Greensboro
University of North Georgia
University of North Texas
University of Northern Iowa
University of Northwestern, St. Paul
University of Rhode Island
University of Richmond
University of San Francisco
University of Southern Mississippi
University of St. Thomas
University of Texas at Tyler
University of Texas of the Permian Basin
University of the Incarnate Word
University of Vermont
University of West Florida
University of Wisconsin-Green Bay
University of Wisconsin-Stout
University of Wyoming
Utah Tech University
Vassar College
Viterbo University
Wake Forest University
Wartburg College
Washington & Jefferson College
Washington College
Washington State University
Wayne State College
Weber State University

Wellesley College
Wesleyan University
West Chester University of Pennsylvania
West Texas A&M University
Western Carolina University
Western Washington University
Wheaton College
Whitman College
Whitworth University
William Paterson University of New Jersey
Williams College
Winona State University
Winston-Salem State University
Worcester Polytechnic Institute
Yeshiva University

Appendix D – Members of the Comprehensive Balanced Class

American University	The University of Tennessee
Appalachian State University	Towson University
Auburn University	University of Alabama
Augusta University	University of Alabama at Birmingham
Boston College	University of Arkansas
California State University, Sacramento	University of California, Santa Barbara
Carnegie Mellon University	University of California, Santa Cruz
Case Western Reserve University	University of Cincinnati
Clemson University	University of Colorado Boulder
Florida Atlantic University	University of Colorado Denver
Fordham University	University of Connecticut
Georgetown University	University of Delaware
Illinois State University	University of Georgia
Kansas State University	University of Houston
Kent State University	University of Illinois Chicago
Lehigh University	University of Kansas
Louisiana State University	University of Kentucky
Miami University	University of Louisville
Montana State University	University of Nevada, Las Vegas
New Mexico State University	University of New Mexico
Northern Arizona University	University of North Carolina, Wilmington
Northern Illinois University	University of Oklahoma
Ohio University	University of Oregon
Oregon State University	University of South Carolina
Portland State University	University of Texas at Arlington
Sam Houston State University	University of Texas at Dallas
San Diego State University	University of Texas at San Antonio
San Francisco State University	University of Texas Rio Grande Valley
Southern Methodist University	University of Wisconsin-Milwaukee
Stony Brook University	Utah Valley University
Syracuse University	Vanderbilt University
Texas State University	Virginia Commonwealth University
Texas Tech University	Wayne State University
The George Washington University	West Virginia University

Appendix E – Members of the Elite Decentralized Class

Florida State University
Georgia Institute of Technology
Michigan State University
New York University
Northwestern University
Purdue University
Rutgers, The State University of New Jersey
The University of Arizona
The University of Iowa
Tufts University
University of Florida
University of Illinois at Urbana-Champaign
University of Maryland
University of Minnesota
University of Notre Dame
University of Pennsylvania
University of Pittsburgh
University of Rochester
University of South Florida
University of Texas at Austin
University of Utah
University of Virginia
University of Washington
Virginia Tech

Appendix F – Members of the Research Unicorn Class

Arizona State University
Indiana University Bloomington
Stanford University
The Pennsylvania State University
University of Michigan-Ann Arbor

Appendix G – SMU Institutional Administrator and EDUCAUSE Approval of CDS Usage

I think it will need to be herridge@mail.smu.edu. Thank you.

From: Parke George (she/her) <pgeorge@educause.edu>
Sent: Tuesday, August 16, 2022 3:44 PM
To: Herridge, Curt <herridge@mail.smu.edu>
Subject: Re: Dissertation Question

[EXTERNAL SENDER]
Thanks for the information. You have two profiles which I'll need to merge.

Herridge Curt	1	Southern Methodist University	herridge@mail.smu.edu	60749655	6425 Boaz Street - PO Box 296	Dallas, TX 75275-0001
Herridge Curt	1	Southern Methodist University	herridge@smu.edu	60209244	PO Box 750262	Dallas, TX 75275-0262

Could you please let me know which email and address is preferable?

From: "Herridge, Curt" <herridge@mail.smu.edu>
Date: Tuesday, August 16, 2022 at 2:41 PM
To: "Parke George (she/her)" <pgeorge@educause.edu>, "Hites, Michael" <hites@mail.smu.edu>
Subject: RE: Dissertation Question

Hi Parke – thank you for your help. I do have an Educause profile with either herridge@mail.smu.edu or herridge@smu.edu and I am an authorized user of the CDS data already. I'm copying Michael Hites who is already aware that I will be using the CDS data for a dissertation.

From: Parke George (she/her) <pgeorge@educause.edu>
Sent: Tuesday, August 16, 2022 3:28 PM
To: Herridge, Curt <herridge@mail.smu.edu>
Subject: Re: Dissertation Question

[EXTERNAL SENDER]
Hi Curt,
Thanks for reaching out. You will need to get permission from Michael Hites- the EDUCAUSE contact in order to access the CDS data. Please have him email me directly or info@educause.edu. His email is hites@smu.edu

Once he has authorized you, you'll need to submit a profile. I have attached instructions regarding how to create a profile.

Best,

Parke George Member Relations Specialist

EDUCAUSE
Uncommon Thinking for the Common Good
4845 East Pearl Circle, Suite 118 PMB 43761 Boulder, CO 80301-6112
direct: 303.939-0325| main: 303.449.4430 | educause.edu

From: "Herridge, Curt" <herridge@mail.smu.edu>
Date: Tuesday, August 16, 2022 at 6:36 AM
To: General <General@educause.onmicrosoft.com>
Subject: Dissertation Question

Greetings – I am an IT leader and a doctoral student at SMU. I am just now in the dissertation planning stage of my program and would like to check into the feasibility of using some components of the CDS dataset. I wanted to check in with you before going down too far in my planning.

Thank you so much for your attention.

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