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KEY DETERMINANTS OF SUPPORT SERVICES DEMAND IN INSTRUCTIONAL TECHNOLOGY MANAGEMENT

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ABSTRACT

This paper investigates the key determinants of the demand for instructional technology support services. To provide insight to the technology managers for better resource planning, we first study key categories of technology support services to predict the frequency of service demand. To this end, we apply an autocorrelated error corrected time-series regression model of support services demand on the various support services. Our research results show the existence of key determinants positively impacting the support services' demand. Results from this research also confirm that service demand for onsite support service is time dependent and as expected exhibit seasonality. These results match the scheduling dynamics of an academic calendar and illustrate how policymakers can use key determinants of demand to focus attention to high-demand and high-frequency service categories. Understanding the analytics of these key determinants prove advantageous when identifying new best practices for technology managers preparing a policy design to establish efficient technology operations.

Keywords: instructional technology, technology management, time-series regression, support services demand, end-user support

INTRODUCTION

Technologies are essential resources for any organization and stipulate significant investment in installation, maintenance/improvement, and user support services. The value of technology and the importance of an interconnected instructional technology system in an educational organization is undeniable, because of the enhancements technology provides to instruction. Students, instructors, staff, and administrators cannot image doing instruction without audio/visual technologies and internet connectivity on a regular basis. In a typical USA university classroom for example, the instructional technologies are so prevalent they are no longer viewed as an accessory, but as both an instructional necessity and as an avenue administrators could use to facilitate instructional innovation [36]. In that effort, the sophistication of technology has escalated from chalkboards and charts to digital projection systems and online lecture capture with live streaming video. Significant technological changes to these learning environments necessitated similar changes in the monitoring and support practices that assure infrequent interruptions to the technology operations. Integration of additional instructional technologies to university's larger information technology (IT) systems has also been an area of focus. However, understanding the dynamics of the support services dedicated to these technologies after integration has been neglected by research. This enquiry informs how technology innovations interrelate to technology support services demand and answers the call to broaden the scope of our understanding of instructional technology systems development [19] and sustainability [33].

There are many studies [6, 15, 16] regarding information technology (often referred to as IT) in a broad business office setting. Maintenance, through support service operations of instructional technology systems are similar to those found in these settings. Specifically, educational institutions monitor issues in the integrated IT systems using customary incident and maintenance management techniques of IT support service management [23]. In general, instructional technology is more disposed to frequent incident and maintenance requests as it is often a technology originally designed to be employed in business office settings modified and adapted for the use in classrooms. Instructional technologies are similar in form, but operationally function differently than its original design. Additionally, instructional technologies in classrooms are used by a various instructors within each day, on different days of the week, from semester to semester. Moreover, instructional technology support services demand surges from low to high at different times of the year. Due to these reasons, the understanding of the support service routines used with traditional applications are different from similar technology adapted for use in unique contexts, such as instructional technology. In the adapted use scenario, it is a complex process for managers to profile the support services demand in instructional technology. Accordingly, broader information technology literature, which itself lacks quantifiable data on the impact of IT support service management [23], does not generalize to instructional technology. Issues of an elevated disparity in frequency of service demand and types of services required for support systems are expected with instructional technology. Unfortunately, not much attention has been directed towards the investigation of identifying the factors responsible for support services demand in instructional technology operations. This lack of attention arises from the lack of data availability and deficiency in quantitative methodology [21]. Salah, Maciá-Fernández, Díaz-Verdejo, & Sánchez-Casado [28]'s research related to the reduction of redundancy in the incident ticket system surmised the data unavailability might be partly due to information confidentiality for competitive purposes. Alshibly, Chiong, & Bao [2], similarly observed, in their study of an electronic document management system, that most of the research studies were descriptive in nature and quantitatively oriented examinations in future research were warranted. Therefore, in the same spirit as Wrycza, Marcinkowski, & Gajda [35], a more methodical scientific study to identify the key determinants of support services demand for efficient operations of instructional technology management is imperative. Such a challenge begins by modeling key determinants of technology support services demand.

Making a contribution to advance the understanding of operational links between key service categories and support services demand are the motivational force behind this research study. This research will empirically explore and identify key factors impacting the support services demand in instructional technology management. Thus, this paper is about revealing the dynamics of instructional technology services demand through analytics to create a service demand model and recommend some guidelines for support planning. The frequency of support services associated with instructional technologies via incident management represents this research's effort to understand the demands associated with the longitudinal upkeep and incidental services dedicated to the classroom technology support. Analytics from this study will also identify time depended service demand patterns and discuss implications for the instructional technology governance mechanisms, such as the frequency of service requirements universities might anticipate and strive to align instructional technology installation with university classroom strategies to improve the operational system.

In our analysis, we have found evidence of demand for service request is highly seasonal and is a significant indicator of changes in demand. Also, the result obtained suggests the existence of high frequency demand for onsite support. Finally, this investigation provides evidence of an integrated relationship between the service categories that are time dependent, and suggests practical implementation process to improve operational efficiency, as well as some recommendations for future research projects. This paper is organized as follows: the next section presents the literature review on instructional and related technologies. These are followed by sections describing the data, research methodology, and results from the data analysis. The final section presents concluding remarks on the value of the research, meaningful implementations for practitioners, and areas for future research to improve operational efficiency.

BACKGROUND AND LITERATURE REVIEW

The literature on the integration of instructional technology in the university classrooms has focused on faculty adoption [18], faculty use [32], and success of students' technology-enhanced learning [20]. To a lesser degree researchers have focused on the process used by universities to select technology for the long term and faculty adoption of technology, a common research area, is one of the barriers associated with the efficient integration of instructional technologies [26]. Ironically, the amount and frequency of technological support provided by staff can be a hallmark of inconsistent system operation. Sufficient support is required to attain satisfactory functionality across a university's classroom technologies and failing to do so significantly hinders the faculty's usage and adoption of a technology for use during instruction. Additional interest in this area is important [19] and it should be an identifiable dimension in Vanderlinde and van Barakk [34]'s model of technology planning in schools. Large scale enterprises, like universities, must holistically view instructional technology's place in its technological system, because a holistic view ensures each functional unit can operate in harmony [29]. Because there is a risk of productivity paradox where initial improvements promised by instructional technology do not actually result in more effective instruction, the examination of intervening variables like inconsistent operation is needed [10]. Determining the frequency to which systems once adopted are maintained and the frequency to which technology support staffs are called into a classroom for routine and/or emergency support may be associated with successes, which may also broaden the understanding of technology adoption and its performance. This area might seem intuitive as technology companies provide predictions for the frequency of upkeep, but the landscape of universities creates complicated technology integrations because the technology is often different from one department to another to suit the pedogological demands of the different departments. Thus, complexity increases because academic departments have traditionally sought systems specific to their needs while centralized IT departments have been tasked to integrate these systems as if they were part of a large-scale standardized technology deployment [29]. In brief, the ways universities are organized make it difficult for viewing systems support demands in a holistic way, and innovations are not typically designed to cross the boundaries from one academic department to another, or between the IT, academic staff, policy makers and administrators [5]. In addition, hardware and/or technology systems frequently require unexpected on-site modification once adopted to attain successful operation in a learning space.

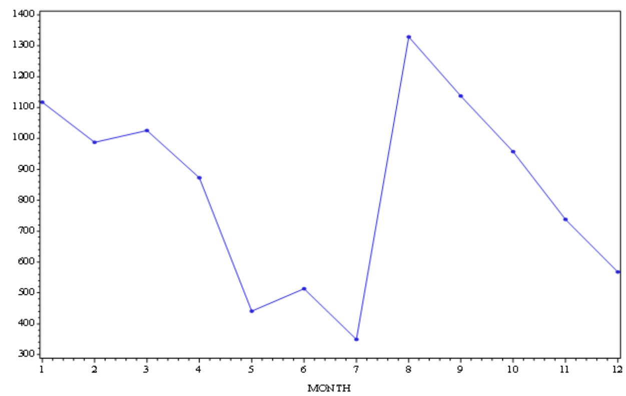

Figure 1: Frequency of Support Services Demand by Month

However, the question has grown from, 'if the university invests in a technological resource will it enhance education?' to, if installed, when and how often will the university's staff be called upon to service the technology and what are the key determinants of those service calls. Initially, integration of technology in the classroom was spurred by evidence that the technology did enhance student learning [17]. In addition, business schools [11, 14] found the infrastructure of updated technology aided in the attraction and retention of quality faculty. Resource constraints require technology managers to contemplate the opportunity of technological gains with respect to the cost of implementation. Resource problems are specifically salient to state institutions in the United States as state funding has continued to decrease [4]. At the same time accrediting organizations have indicated programs expecting to maintain accreditation must meet the technology of needs of both students and faculty [1]. In a survey of business school deans, it was found that multimedia classrooms, internet for instruction, distance learning, and internet for research were perceived as important drivers of meeting student expectations [16]. A similar phenomenon occurs at the institutional level as those universities pursuing national accreditation felt more pressure to increase instructor use of professional technologies. Examples have included accounting faculty being pressured to demonstrate Excel's usefulness in the classroom, while law faculty has been pressured to demonstrate the usefulness of Lexis-Nexis [27].

Regardless of the institution or institution type, most made access to the internet, a large primary display system, and other multimedia technologies a classroom necessity. Yet, little information is available related to the frequency to which these technologies must be supported or maintained to meet university and faculty requirements, both scheduled and ad hoc. Evidence suggests that technology must work effectively in the classroom for faculty to actually use it; faculty tended not to use technology that did not work well the first time, or proved to be unreliable in its use and functionality, or resulted in negative student evaluations [25, 26]. The negativity emanating from technology failures in the classroom indicate that the support for classroom technology has to appear seamless to the end users and may require maintenance competencies equivalent to resolving issues before they occur, as they occur, and emergency service immediately upon request to minimize failure anomalies with technology systems.

While the users of technology are often identified as a major barrier to the adoption and use of instructional technology [8, 26], we propose the frequency to which a university's staff must dedicate support services to these technologies may also be a barrier. As technology is adapted into the classroom, some equipment, even the basic equipment such as overhead projectors, likely require frequent service from support staff. It is also unclear what the relationship has been for the frequency of use and the frequency of service (planned and unplanned). Therefore, improved understanding on the long-term support associated with the integration of instructional technology would help determine if additional benefits could be achieved if more informed collaboration occurred between technology experts, university administrators, and teaching personnel as the adoption of technology evolves over time [3]. Continued expansion and adoption of instructional technologies will surely raise more questions that cannot be effectively evaluated with an intuitive evaluation of technology. Quantifiable identification of service patterns and key determinants should help technology managers synthesize operational histories while planning implementation and more appropriately plan initiatives for adoption more strategically.

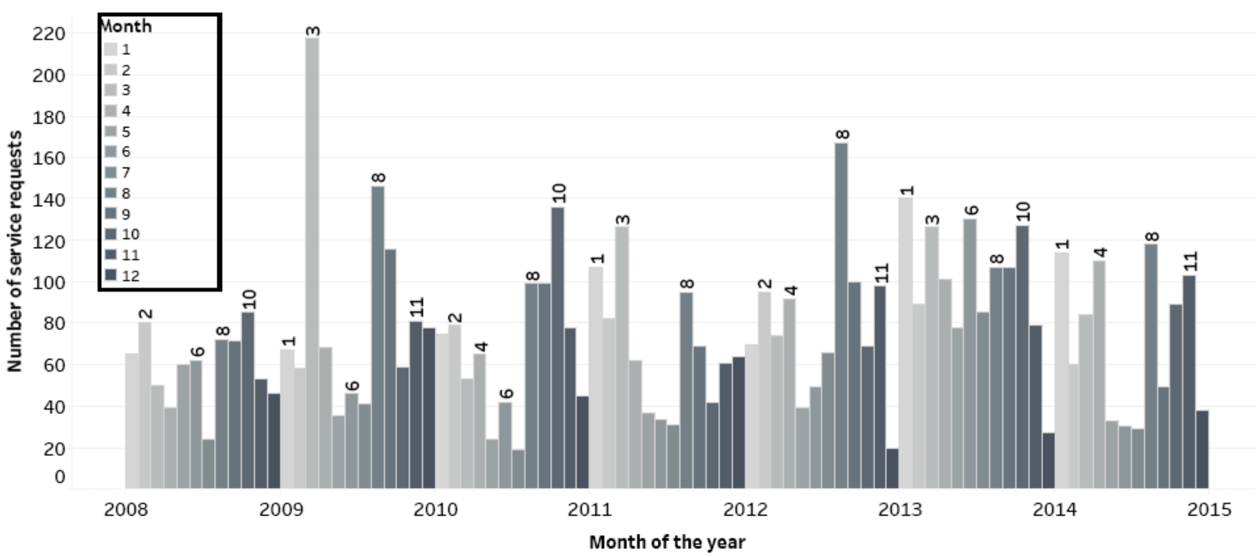

Figure 2: Monthly service demand over the years

DATA AND RESEARCH METHODOLOGY

The data were extracted from the university's enterprise-wide incident management software's archival database. The data used for this research is related to the classroom instructional technology department who oversees the maintenance and support of all the classroom technologies of the university.

Data and Variable Descriptions

This is a monthly time series data beginning January 2008 and ending December 2014 reflecting various factors related to instructional technology support service demand. The type and availability of routinely collected incident report, as well as upkeep related data on instructional technology, determined the study period. The frequency of service provided was selected as a measure for technology support services demand, since the frequency of service request can be used as a criterion in understanding the dynamics of technology usage [13, 24, 25, 26, 31].

The various types of service categories as factors in our analysis are defined as follows: "Demonstration" is to demonstrate how to use the equipment or technology in person by support personnel to a user. "Equip Install" is to install equipment that delivers a function previously not present in the classroom, such as installing a student response system in a classroom that did not have one before, and is differentiated from "Equip Replace" which is to replace equipment with another that performs the same function but may be of different make or model, such as replacing an aging model of system controls with an upgraded version. "Equip Service" refers to performing routine upkeep on equipment, for example cleaning air filters on data projectors, installing updates on classroom computers, etc., in accordance with manufacturer recommendations to prolong the equipment's useful lifespan. "Lamp Change" refers to changing light source lamps, most often in data projectors but can also include transparency projectors and slide projectors. "Onsite Support" is to respond to a request for assistance in regards to the technology, where a staff technician is dispatched to resolve the service request on-site. The service category "Other" is a catch-all for services that do not fall into a service category that is explicitly offered or are a part of the normal departmental service catalogs, such as assisting in the removal of equipment, desks, and furniture from rooms in preparation of a building renovation. "Phone Support" refers to service requests that were successfully resolved over the phone by a staff member, for example talking an instructor through the process of resolving a simple, known computer issue. "Repair Class" is to repair malfunctioning or damaged equipment on-site. "Repair Shop" is to repair malfunctioning or damaged equipment in the shop as opposed to repair in the classroom, for example, transparency projectors that require extensive time and disassembly to repair and cannot be easily performed in the classroom.

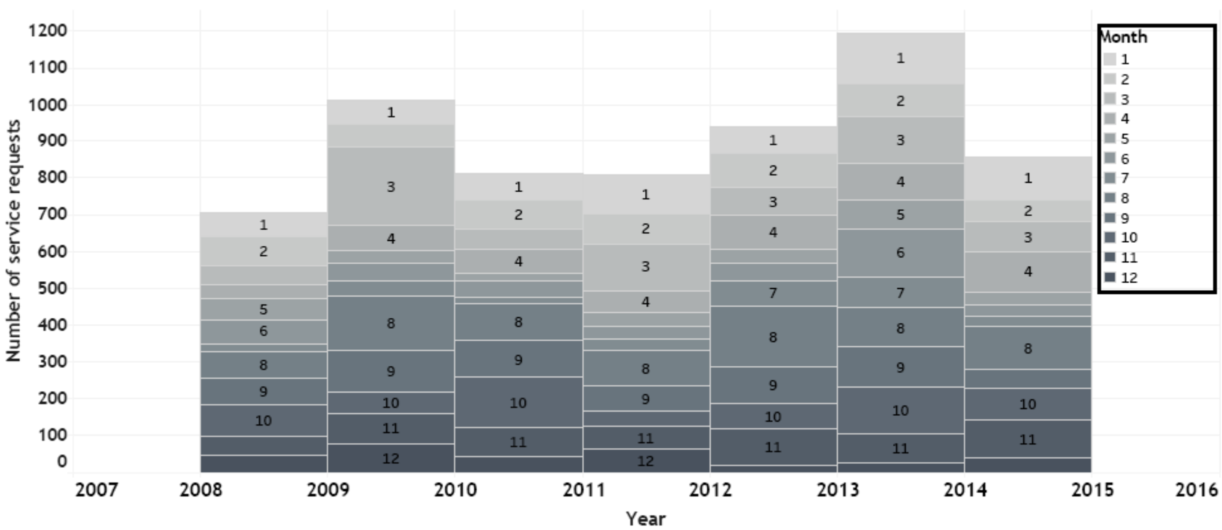

Figure 3: Yearly service demand divided into months

Statistical Analysis

As shown in Figure 1, the frequency of support services demand has a unique pattern of seasonal behavior. The highest demand for service request occurs in August which is the beginning of the academic year and followed by September. In a like manner, January, February, and March also show a high demand with July being the lowest in most years. This can be clearly observed in Figure 2. Thus, in a single year substantial variability can be observed in support services demand (see, Figure 3). In addition, Figure 3 also shows some variations in number of service demand between the years. However, the knowledge of this seasonality, even though expected, provides the opportunity to make the operations/scheduling more efficient and accurate. Smoothing of support services demand may be possible by moving some of the regular maintenance work to November and December, and large scale equipment or software installation projects during May-July. In fact, this was done in the year 2013, as it is observed from the equally divided slots in the graph (see, Figure 3). Distributions of technology support service categories demand are reported in Table 1. We observe that onsite support has the highest average frequency of service demand followed by equipment category. By applying the "Pareto Principle", administrators and policy makers' priority should be to focus on these key categories to develop efficient operations.

Table 1: Summary Statistics of support service demand by categories

Service Category	N	Average	Median	Std Dev	Minimum	Maximum
Demonstration	64	6.0938	4.0	5.887	1	30
Equip Install	82	13.512	12.5	10.593	1	59
Equip Replace	44	5.205	4.5	5.2588	1	32
Equip Service	84	33.964	25.0	27.684	1	135
Lamp Change	78	5.487	4.0	4.595	1	22
Onsite Support	84	35.060	33.5	22.974	2	106
Other	39	1.5641	1.0	0.852	1	4
Phone Support	70	4.471	2.0	5.370	1	32
Repair Class	81	13.556	11.0	9.801	1	45
Repair Shop	35	2.714	2.0	2.283	1	12
Software	72	7.153	4.0	10.123	1	81

Note: N represent the number of months where at least 1 service request was received. Mean, minimum, and maximum represent per month values.

To perform statistical analysis, we employ two separate tools. First, we use all possible correlations including lagged effect (results not reported) in our analysis to examine the direction of the association and whether the relevant factors exhibit any long memory, a term used to refer to long-term statistical dependence in time series data. Second, we use time-series regressions to examine the magnitude and significance of service demand for various service categories over time and to observe any seasonal dependency. Specifically, we regress the number of service requests on the various support service categories after controlling for seasonality and corrected for autocorrelation. Results indicate an increase in demand for onsite support service corresponds to elevated malfunction rates of instructional technologies and thus lowering the ability of instructors' use during their instruction process. Therefore, a careful synthesis of different types of service requests and identifying high frequency requests will facilitate to implement an efficient operational process.

In an attempt to better disentangle the effects of frequency of service requests and its expanding or contracting behavior, the regression model includes months as control variables measuring the seasonal effect. Additionally, Durbin-Watson statistic of ordinary least squares (OLS) estimates indicated the presence of autocorrelation, which affects statistical inference. Durbin-Watson statistic is not valid for error processes other than the first order process (see [12]). Thus, we evaluated the autocorrelation function (ACF) and partial autocorrelation function (PACF) of the ordinary least squares regression residuals using SAS procedure PROC ARIMA (see SAS/ETS User's Guide). This allowed the observance of the degree of autocorrelation and the identification of the order of the residual model that sufficiently described the autocorrelation. After evaluating the ACF and PACF, the residual model is identified as the following autoregressive model (see [7]):

$$\left(1-\phi_8 B^8-\phi_9 B^9\right)\nu_t=\varepsilon_t \qquad (1)$$

We have used maximum likelihood estimation method instead of two step generalized least squares to estimate the model. Maximum likelihood estimation is preferable over two step generalized least squares, because of its capability to estimate both regression and autoregressive parameters simultaneously. Moreover, maximum likelihood estimation accounts for the determinant of the covariance matrix in the likelihood function. Further discussion on different estimation methods and the likelihood functions can be found in [9]. Likelihood function of the regression model with autocorrelated errors can be expressed as follows:

$$L(\beta,\theta,\sigma^2)=-\frac{n}{2}\ln(\sigma^2)-\frac{1}{2}\ln|\Omega|-\frac{(Y-X\beta)'\Omega^{-1}(Y-X\beta)}{2\sigma^2} \qquad (2)$$

where,

Y- vector of the response variable,

X – matrix of independent variables,

β – vector of regression parameters,

θ – vector of autoregressive parameters,

n – the number of observations,

σ^2 – error variance,

Ω – covariance matrix of autocorrelated errors.

Table 2: Generalized regression results of support service demand (After corrected for autocorrelation)

Variables	DF	Parameter Estimates	Standard Error	t Value	Pr > |t|
Intercept	1	-0.7225	1.1348	-0.64	0.5245
Onsite Support &August	1	24.1807	5.3359	4.53	<.0001
Onsite Support &January	1	12.3589	5.3385	2.32	0.0209
Equip Service	1	28.4655	1.6050	17.74	<.0001
Onsite Support	1	27.7162	1.7126	16.18	<.0001
Equip Install	1	9.1979	1.5949	5.77	<.0001
Equip Replace	1	9.1008	1.6022	5.68	<.0001
AUG	1	10.3074	1.8946	5.44	<.0001
SEP	1	9.9373	1.9037	5.22	<.0001
OCT	1	7.0040	1.9075	3.67	0.0003
NOV	1	3.7325	1.8563	2.01	0.0447
JAN	1	8.2723	1.9414	4.26	<.0001
FEB	1	8.0135	1.9434	4.12	<.0001
MAR	1	8.5231	1.9235	4.43	<.0001
APR	1	6.5263	1.8413	3.54	0.0004
R-Square	0.5075				

Note: The regression residuals model is identified as, $\left(1-\phi_8 B^8-\phi_9 B^9\right)\nu_t=\varepsilon_t$ and the estimated first and second order autoregressive (AR) parameters from SAS are, $\left(1-\underset{(-5.00)^{***}}{0.2095}B^8-\underset{(-2.09)^{**}}{0.1098}B^9\right)\nu_t=\varepsilon_t$.

Autoregressive parameter's t-statistics are reported in parentheses. They are significant at the one (***) and five (**) percent level of significance respectively.

DATA ANALYSIS AND EMPIRICAL RESULTS

We report the results of statistical analysis investigating the association between the frequency of support service demand and various service factors applying time-series regression (see, Table 2). The estimated regression model is statistically significant with a high R-squared of 50.75%. After controlling for seasonal effect, strong positive associations are observed with various types of service categories that are highly statistically significant. We applied forward, backward, and mixed stepwise methods to select the key factors in the regression model using significance level as a criterion to add variables into the model or delete variables from the model. Moreover, the model resulting from stepwise selection provided the same conclusion that key service categories are the significant factors in impacting the support services demand. The larger magnitude in service demand is concentrated in two types of service categories, namely onsite support and equipment service. For example, onsite support request is 27 more and the number of equipment service requirement is 28 more per month, which is much higher compared to other types of support services demand in instructional technology systems. Furthermore, increase in additional service demand for onsite support request increases by 24 in August and 12 in January – an uneven demand scenario compared to typical business-process IT systems – with highly significant p-value. This interaction effect between the onsite support and seasonality indicates that demand for onsite support rises at the start of each semester with highest demand at the beginning of the academic year and therefore, demand for onsite support is time dependent. This result is valuable to the technology managers as to allocate resources efficiently and timely to be evenly distributed during the planning and scheduling periods.

Onsite Support and Equipment Service are identified as the two strongest key determinants of support services demand. Frequency of service demand for onsite support is higher on average, but the demand for service request for onsite support is also time dependent, specifically the demand increases during the first few weeks at the beginning of the semester and then slowly stabilizes. Therefore, it may be beneficial to explore this key factor further in the future research to identify the specific source of support service request to differentiate the resource allocation need. Demand for onsite support service and equipment upkeep service have a direct impact on the service demand, as indicated by the positive coefficient. More specifically, one can assert that the chance of an onsite support service request and the need for equipment upkeep service will be higher compared to other categories of service demand in instructional technology. In addition, results indicate that the demand for both of these high frequency service requests is highest at the beginning of the semester and then slowly diminishes. This creates a unique structure of support services demand for academic calendar-centric instructional technology systems as compared to typical, yearly calendar-centric IT systems, since IT systems may not have such an uneven yet predictable service demand. Thus, this research provides opportunity for technology managers to understand the underlying demand pattern dynamics and to improve the operational process by separating equipment upkeep service schedule to different months than onsite support service requirements. Specifically, we suggest May-July may be a better timing for preventative maintenance and upkeep, since onsite support is on-demand support service in real time and cannot be postponed. Additionally, frequency of service request does not seem to affect all support service categories equally. Thus, our analysis reveals that there are differences in various categories of support services demand and identified the key determinants for instructional technology support service structure.

CONCLUDING REMARKS

This study is aimed at the specific segment of information technology dedicated to investigating the key determinants of support services demand in instructional technology. The result of this research provides evidence of the differential effect of various factors on the support services demand. Research also provides additional evidence suggesting support services demand in instructional technology display long memory. In addition, support services demand for the instructional technology is time dependent. These results, while important, are not entirely unexpected given the scheduling dynamics of academic calendar and change of classrooms and instructors in each academic year. Thus, understanding the seasonality characteristics of service demand's behavior makes it possible to identify the upper and lower bound, enabling technology managers in instructional technology manage with greater accuracy. Therefore, by highlighting the key determinants in our model for support services demand, administrators and technology managers may find our results beneficial in instructional technology operations.

In addition, the time-series regression model resulted from our analysis may also be useful in the prediction of service demand and should be the core analytics used by technology managers. Use of this study's model advances planning schedule beyond those created using basic descriptive statistics only. Considering the higher demand for onsite support service and equipment service that separated them from other technology support service categories illustrates how administrative policy makers can benefit from using the key results of this study for optimum scheduling and resource allocation in their technology program. Thus, our research, providing evidence of key service categories, has a higher impact on technology support programs, subsequently requiring more administrative and staff attention, and consequently proper alignment of resources in those areas. These results add another dimension to the debate concerning the effect of observable and unobservable factors on the instructional activity in educational institutions. Additional research analysis may be required in regards to the linkage between observable and unobservable factors that are liable for efficient use of instructional technologies in the classrooms. Future research could determine whether the higher demand for onsite support service requirement related to equipment/system service requests are time dependent. Additional research might incorporate these key factors with the technology acceptance model [35], which tend to be more strongly influenced by technology characteristics than non-students [30].

In practical terms, university administrators and technology managers can regard this study as an important guide, in their effort to support the continued service of instructional technology. Administrators and technology managers are usually quite accustomed to showing their willingness to support users of technology in need. Yet, unless priority is given to safeguard the efficiency and effectiveness of the technology operations after implementation, this support is eventually perceived as disingenuous and costly [22]. The challenges faced by technology policy makers continue to include quantifiable resolution using empirical evidence to make an enhanced operational strategy. This research study could provide a strong argument to convince administrators and technology managers to engage in proactive incident management through the adoption of quantitative methodology.

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