

# FACTORS THAT INFLUENCE ICT INFRASTRUCTURE IN HIGHER EDUCATION: A CASE STUDY

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**Abstract.** *This article analyses essential factors that can affect the Information and Communication Technology (ICT) infrastructure in higher education. There is a general lack of research on providing the general criteria for infrastructure that could be used as guidelines for education institutions. Higher schools usually develop their own infrastructure based on experts' advice or delegate this task to the private IT companies. The article aims to investigate how users' demands influence higher education ICT infrastructure. Therefore, the university-wide students' demands that affect not only their academic performance but also particular activities are epitomized in the paper. As a case study, the ICT infrastructure of Kaunas University of Technology (KUT) was investigated in order to determine how university e-services fulfil the students' demands. The research showed that some KUT e-services comply with specific students' demands, while the others are universal and widely applicable. On closer inspection, it was inferred that not all demands are supported by e-services in the university as only the general information about a particular service is provided.*

**Keywords:** *e-services, ICT, students' demands, influence factors*

## Introduction

Universities are noticed not only as teaching institutions but also as organizations that create a new intelligence and support the social demands (Numprasertchai & Poovarawan, 2006). What essential factors do influence the ICT infrastructure of higher education?

One of the main factors over the last decades determining the essential changes in educational environment of higher education institutions is the growing needs among the learners (Sileikiene, 2009). This is especially peculiar

for the adult learning because they must combine their studies with work, intensive community activity, responsibilities for the family and other activities.

The second factor can be regarded as the education price (Sileikiene, 2009). Education is expensive that requires great capital investments and high qualification of the education suppliers. Education should be viewed in the same way as any other services that have their own prices, market, users, and suppliers, and that should be organized only when it is expected to cover the expenses and to get the profit.

The third factor influencing the main changes while forming the higher education institution environment over the last decades is a rapid development of new learning technologies (Potter, 2013), (Mickus & Vidziunas, 2009), (Pukelyte, 2010), (Zhang, Yang, Chang, & Chang, 2016). It is obvious that the introduction of recent technologies requires the preparation of advanced education environments and methods in line with these technologies. The development of ICT and the occurrence of innovative technologies increasingly influence the infrastructure of higher schools. Even though higher schools pay special attention to the involvement of ICT solutions in the education process, the study of the literature sources shows that there is no unique methodology of a coverage of study demands by ICT.

Combination of the three factors (demands, costs and new ICT technologies) might define a competition process between higher education institutions. This article pays attention to the first and the third factors. As there is a lack of scientific literature that present generalised criteria for ICT infrastructure concerning the demands of users, this article contributes to fill this gap. The paper extends the content of our earlier published research (Miseviciene, Sutiene, Ambraziene, & Makackas, 2018).

*Research aim.* Investigate how users' demands influence the ICT infrastructure of higher education.

*Research tasks:*

- Overview the main study models and estimate their technological aspects.
- Generalize students' demands that affect not only their academic performance but also particular activities.
- Investigate ICT infrastructure provided by KUT and research how it fulfils the students' demands.

*Research methods* include: Research methods include analysis of scientific literature and publications, legal acts and other documents of KUT, and workshops' information with KUT student organization representatives and administrative staff.

The article is structured in the following way. First section reviews scientific literature on main study models and estimates their technological aspects. Second section evaluates university-wide students' demands. The last section presents a list of e-services provided in KUT and explores at how these services fulfil the students' demands.

### **Literature review of study models**

Educational infrastructure depends on the study model. Literature sources (Mickus & Vidziunas, 2009) disclose main study models, such as the traditional full-time education, distance learning and their combination.

So far, the traditional full-time education form with the expanded possibilities of ICT solutions in the educational institutions prevails in Lithuania. The traditional full-time education is based on the explanation of the material proposed by the lecturer. Information technologies have only the additional service functions in the kind of such studies. Computer tasks, e-books for individual studies or internet sources, and consultation via e-mail are mostly used during such lectures. The individual study material is typically presented in the institution's intranet system ("Web CT", "Moodle", "Blackboard", etc.).

Distance learning is the learning when the lecturer (or the person who presents the study material) is not in the same place with the student. Learner support is designed to study individually or in groups, when the students and the lecturer work in distance and/or different times, and the collaboration and cooperation as well as the study materials are delivered using information and communication technologies. Such studies are based on the newest ICT solutions, when the students can study at their work place or at home using the computer connected with the Internet. In addition, such students can co-operate with the lecturer and their colleagues via e-mail and interactive discussion sites. Distance learning study form is more oriented to the working people. Distance learning is attractive because it gives the learners the possibility to study individually when and where they want to study. Present level and variety of ICT gives many different distance learning possibilities starting from correspondence to virtual classes. Another advantage of such distance learning is the maximum adaptation to the individual needs, i.e., it enables students to study at their own discretion in the chosen communication circle and environment. Besides, the distance learning minimizes the tension of social inequality and stimulates cultural integration processes. Distance studies infrastructure includes the network infrastructure, the computing infrastructure, the system and application software, the Internet Service Provider, the bandwidth, the policy framework and the security infrastructure (Mickus & Vidziunas, 2009).

The combined infrastructure of full-time learning and distance learning is often used alongside with the traditional learning. This infrastructure gives the learners the same advantages and privileges that a traditional on-campus learner has always received. Many new learning models appear because of this reason. One of them is virtual learning environment (VLE). The standard VLE covers the means for the presentation of the learning material, the tools for the communication of the registered actors in the interactive environment, the tools for student collaboration and co-operation, and activities in the virtual environment (Kaklauskas & Kaklauskiene, 2011). However, the virtual learning environment can be directed to the administration of specific courses.

Combined methods with virtual courses or virtual means are often proposed in the learning study program (Al-Shehri, 2004), (Kalagiakos & Karampelas, 2011), (Akhavan & Arefi, 2014). These means provide the principles of ICT application presenting the individual material for the studies in virtual environment, ensuring constant study progress or academic record control, maintaining friendly relations with the students and developing of group work skills.

### **University-wide students' demands**

There is a general absence of scientific research that would provide general principles of infrastructure used as guidelines for educational institutions. Higher schools usually develop their own ICT infrastructures based on experts' advice or delegate this task to private IT companies.

Many scientific literatures only evaluate costs and benefits of the use of ICT. Some authors (David & Abreu, 2014) focus in advocating the importance of the recent developments on ICT in education, particularly in higher education. Other authors discuss the general development trends of ICT in education (Zhang et al., 2016).

This paper contributes by structuring the principles of ICT infrastructure in line with students' demands. Literature sources on definition of students' demands are also quite limited. Many authors define the demands of students through '*a spectrum of activities organizing and management of students support*' (Simpson, 2013). The author divides academic and non-academic demands. Other authors distinguish only academic needs. For example, researches (Potter, 2013), (Mickus & Vidziunas, 2009), (Pukelyte, 2010) characterize students' demands through communication or information and learning issues. Authors (El Mhouthi, Erradi, & Nasseh, 2018) illustrates the needs through learning process as organization of contents, resources, delivery of training courses, documentation, and administration tasks.

In order to better fulfil users' interests in the learning process, the characterization of participants involved in this process is necessary. In the Figure 1, we highlighted the possible participants that interact through the environment of the study process.

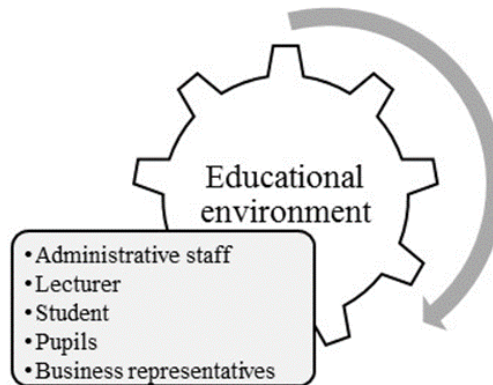


Figure 1 Main participants interacting in the educational environment

There are main participants groups: administrators, lecturers, students, business representatives, and pupils. Every higher school may have other additional users that have their own role in the process. Students are the main group that participate in the study organization process themselves and use the modern education facilities. Lecturer is the person who communicates with students satisfying the demands of such students. Administrative staff accomplishes admission, graduation, financial aid, documentation of student and faculty members' records. Pupils are also interested in later studies of higher schools. Business representatives propose students positions for practice during their studies.

The article generalizes only students' demands more widely. Figure 2 exemplifies the possible student's demands in the main groups like studies, finance, library, leisure, IT services, career-planning, documents, academic help support, study process quality assessment, and so on.

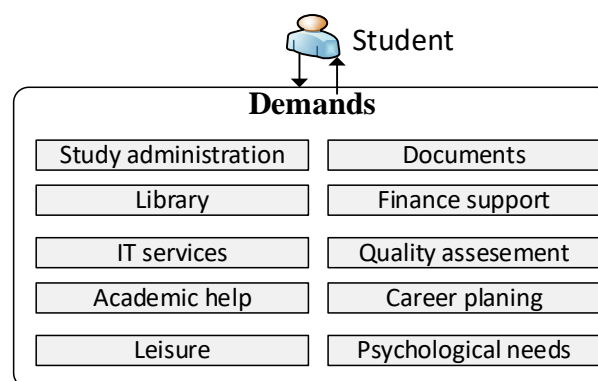


Figure 2 Groups of general student's demands

Table 1 characterizes the group's activities.

*Table 1 Demands groups characteristics*

<b>Demand groups</b>	<b>Activities</b>
Study administration	Registration, termination or interruption of studies. Graduation from the University. Individual study plans. Mirror studies. Knowledge evaluation. Rotation. Appeals. Academic Certificates. Course Schedule. Course materials. Academic environment. Lectures. Technical support.
Library	Books ordering. E-resources. Scientific publications database.
Finance support	The tuition fee and compensation. Financial Aid. Study loans. Scholarships. Incentive scholarships. Social support.
IT services	E-mail. Printing and copying. Software for self-study. Wireless network. Private network. Social network. Web services.
Physiological needs	Psychological and spiritual help. Accommodation, dormitories. Health services. Catering services.
Documents	Documents procedure descriptions, rules, regulations. Faculty address, contacts. Faculty data. FAQ. Events, news.
Leisure	Sport activities. Student organizations. Art societies. Trade union.
Career planning	Practice organization. Exchange programs. Internships. Support for students' international activity. Scientific research. Non-formal education. Part-time jobs.
Quality assessment	Academic ethics questions. Application of penalties. Surveys.
Academic help supports	Mentorship program: career mentor, research mentor, tutor. Academic assistance: academic advisor.

### **Investigation of ICT infrastructure: a case study**

KUT is running e-services on infrastructure (Figure 3). The infrastructure allows safely and efficiently administer services via Web, in computer classes and for self-working at home. The e-services are combined in categories due to their functionality: Information systems, E-communication tools, Virtual learning environment, Website, Help system, Network services and other services.

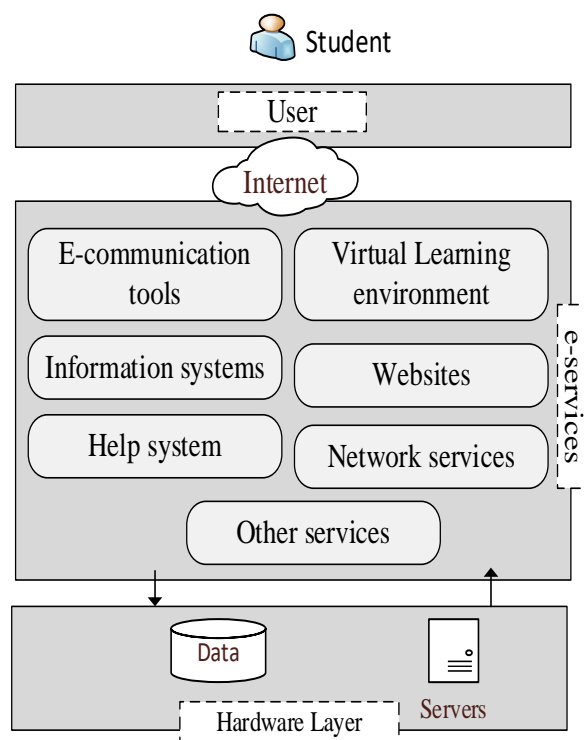


Figure 3 Scheme of e-services provided by KUT

Table 2 more deeply characterise the services.

Table 2 E-services characteristics

<b>Information Systems</b>
E-identity Management System (IMS) deals with identifying users in a system and controlling their access to resources and services within university.
Academic Information System (AIS) provides registration for classes, making of individual plans, documenting assessment scores, building schedules, maintenance of student data, reporting of surveys, handling of mentoring program and so on.
Document Management System (DMS) allows monitoring, managing, searching and storing documents.
Library Information System (LIS) provides support a search in university libraries and access to subscribed scientific databases.
<b>E-communication Tools</b>
E-mail for students' platforms Microsoft Office 365, MS Exchange Online service
MS Office 365It is a cloud-based service that is designed to provide access to Office 365 tools.
<b>Virtual Learning Environment</b>
E-learning system (MOODLE) interactive online learning environment including forums, quiz, wiki, workshop, assignment, wiki activities
Video lectures and conference service (VIDEO) access of video lectures and conferences through student / lecturer work places and mobile devices.

Computerized Testing System (CTS) provides capabilities to check students' knowledge on a specific field using interactive web-based system.
<b>Websites</b>
University website and Department websites branches out into many sections designated to departments, institutions, centres that, in many cases, have their own websites.
<b>Help System</b>
Incident registration and management system (Help desk) system is used to manage support queries from university personnel and students, to register IT, DMS and telephony incidents.
<b>Network Services</b>
Virtual Private Network (VPN) is a network service which allows university personnel and students to securely connect to the University network.
Wireless network (Wi-Fi) wireless networks can be used by KUT community, as well as by students from educational institutions participating in the Edu roam project.
<b>Other Services</b>
Self-service to register for access to IT systems and services (SELF). University has implemented an identity management and single sign-on solution for university IT services. All employees and students are provided with University IT user credentials.
Copying / Printing / Scanning services (CPS) are multifunctional self-service devices for copying, printing and scanning that have been installed in the university.

Table 3 presents interaction between student demands and e-services provided by KUT. The demands are intersected with e-services.

Table 3 Interaction between students' demands and e-services

E-services Students' demands	IMS	AIS	DMS	LIS	E-mail	MS Office	Moodle	VIDEO	CTS	Website	Help desk	VPN	WiFi	SELF	CPS
Studies	A	A	A		I	A	A	A	A	I	A	A	A	A	A
Finance	A	A	A		I					I					
Library	A			A	I					I		A	A		
Leisure										I					
IT services	A				I					I	A	A	A	A	A
Career planning			A		I					I					
Documents	A	A	A		I					I		A			
Academic help	A	A								I	A				
Quality assessment	A	A	A		I				A	I					
Other services	A				I	A				I		A		A	A

A – e-service, which is used to accomplish the demand; I – e-service only informs about possibility to achieve the demand.

Taken together, the table provides important insights into the necessity of certain e-service. Closer investigation of this table shows (displayed in Figure 4) that some of e-services comply with specific students' demands (alike LIS service), while the others are universal ones and widely applicable (related to university Websites, e-mails or IMS).



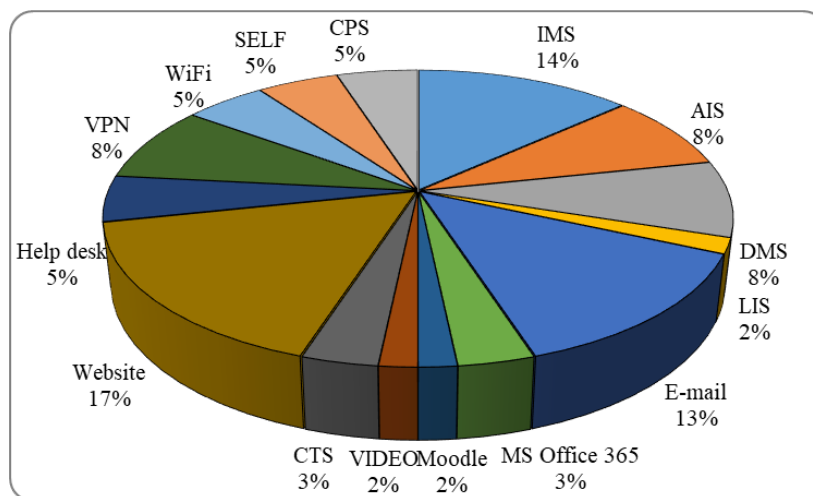


Figure 4 Usage of e-services fulfilling students' demands

It is apparent from the Figure 5 that the study demands, being as one of the main functions in the university, is supported by most the e-services, in contrast to Leisure service, for which only information can be found.

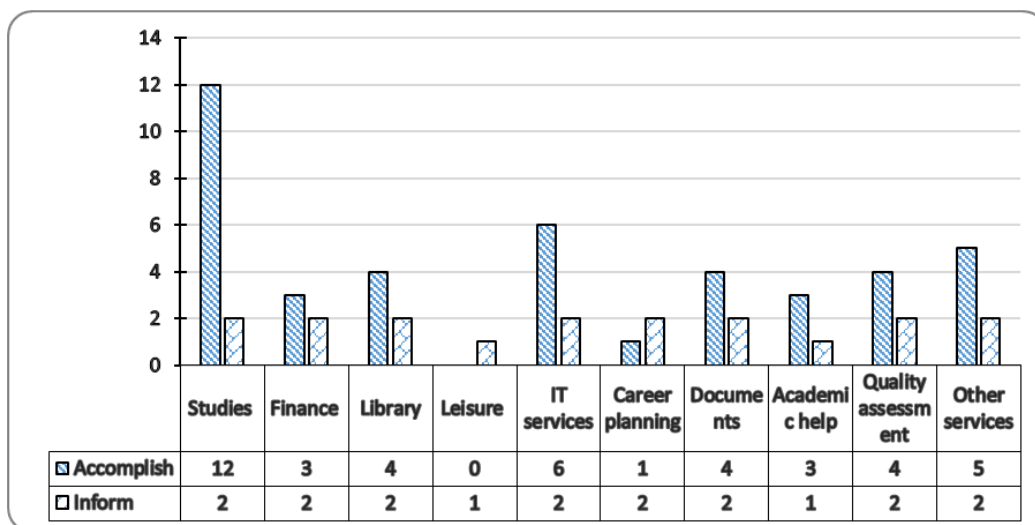


Figure 5 Amount of e-services fulfilling students' demands

### Conclusions

Education institutions have different understanding how to ensure the effective provision of university-wide support. The institutions usually develop their own ICT infrastructures employing their own specialists or delegate this task to private IT companies. There is a general lack of scientific publications that would present general criteria for ICT infrastructure.

This paper focused on the developing of general criteria based on students' demands that include not only their academic performance but also particular activities. Closer investigation how these students' demands are fulfilled by KUT e-services concluded that some of e-services comply with specific students' demands while the others are universal ones and widespread. Furthermore, not all demands are supported by most of the e-services, so only information can be found.

The research results could be used as guidelines for education institutions to design or upgrade their ICT infrastructure.

### Summary

The main challenge for higher education in the nearest future is the global competitiveness. Thus, traditional universities must adapt educational infrastructures in response with the global requirements.

Higher schools usually develop their own infrastructure based on experts' advice or delegate this task to the private IT companies. This article analyses essential factors that can affect the change of educational infrastructure. As there is a lack of researches on providing the general criteria for infrastructure that could be used as guidelines for education institutions, the article aims to investigate how users' demands influence the ICT infrastructure in higher education. The article is structured in the following way. First section reviews the scientific literature on main study models and estimates their technological aspects. Second section proposes the university-wide students' demands that can affect not only their academic performance but also particular activities. The last section presents a list of e-services provided in KUT and explores at how these services fulfil the students' demands. Research methods include analysis of scientific literature, publications, legal acts and other documents of KUT and workshops' information with KUT student organization representatives and administrative staff.

Investigation results conclude that some of e-services comply with specific students' demands while the others are universal ones and widespread. Furthermore, not all demands are supported by most of the e-services, so only information can be found.

The research results could be used as guidelines for education institutions to design or upgrade their ICT infrastructure.

### References

- Akhavan, P., & Arefi, M. (2014). Developing a Conceptual Framework for Evaluation of E-Content of Virtual Courses: E-Learning Center of an Iranian University Case Study. *Interdisciplinary Journal of E-Learning and Learning Objects*, 53-73.

- Al-Shehri, M. (2004). A virtual university: A proposed model. *Library and information Science*, 1-21.
- David, F., & Abreu, R. (2014). Information technology in education: Recent developments in higher education. *In Information Systems and Technologies*, 1-6.
- El Mhouti, A., Erradi, M., & Nasseh, A. (2018). Using cloud computing services in e-learning process: Benefits and challenges. *Education and Information Technologies*, 893-909.
- Kaklauskas, L., & Kaklauskienė, D. (2011). Analysis of Usage of Virtual Teaching/Learning Environment Tools for Teaching Mathematics (in Lithuanian). *Teacher Education*, 18-32.
- Kalagiakos, P., & Karampelas, P. (2011). Cloud computing learning. *Application of Information and Communication Technologies (AICT), 2011 5th International Conference* (pp. 1-4). IEEE.
- Mickus, A., & Vidziunas, A. (2009). Implementation of Information Communication Technologies and Distance Learning Methods in Traditional. *Acta Paedagogica Vilnensia*, 21-28.
- Miseviciene, R., Sutiene, K., Ambraziene, D., & Makackas, D. (2018). Enhancing University Competitiveness through ICT Infrastructure: the Case of Kaunas University of Technology. *Baltic Journal of Modern Computing*, 137-145.
- Numprasertchai, S., & Poovarawan, Y. (2006). Enhancing university competitiveness through ict based knowledge management system. *Management of Innovation and Technology* (pp. 417-421). IEEE.
- Potter, J. (2013). Beyond access: Student perspectives on support service needs in distance learning. *Canadian Journal of University Continuing Education*, 59-82.
- Pukelyte, R. (2010). Quality Assessment of University Studies as a Service: Dimensions and Criteria. *Quality of Higher Education*, 155-175.
- Sileikiene, I. (2009). *Computer learning systems (in Lithuanian)*. Retrieved from Computer learning systems: [http://gama.vtu.lt/KMS/KMS\\_teorija.doc](http://gama.vtu.lt/KMS/KMS_teorija.doc)
- Simpson, O. (2013). *Supporting students in online open and distance learning*. London: Routledge.
- Wächter, B. (2004). The Bologna Process: developments and prospects. *European Journal of Education*, 39.3, 265-273.
- Zhang, J., Yang, J., Chang, M., & Chang, T. (2016). Towards a Critical Understanding to the Best Practices of ICT in K-12 Education in Global Context. *ICT in education in global context*, 1-17.