



INTERNATIONAL
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Digitalisation and digital transformation in academic libraries in Greece

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SCHOOL OF SCIENCE & TECHNOLOGY

A thesis submitted for the degree of

Master of Science (MSc) in E-Business and Digital Marketing

JANUARY 2023

THESSALONIKI – GREECE



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Abstract

With the digital era going through a notable transition the last couple of years, and the focus being on the internet use via mobiles and the emergence of social media, communication has been crucially affected. Digitalisation and digital transformation have become widely known as terms, and have interfered in the way organisations handle their processes, network, and overall culture. Additionally, the volume of data availability and the appearance of new technologies push the organisations to adapt their strategies in a more holistic point of view and proceed with at least the digitalisation of all possible areas. Such a huge change in the organisation's core processes implies that work distribution and HR would also be affected, as it would require the employees to acquire a new set of skills to support this change, as well as to interact more effectively under the new working conditions, setting digitalisation as a prerequisite to proceed with the digital transformation of an organisation.

This study aims to identify which emerging technologies academic libraries in Greece are familiar with, and how these technologies have impacted the library services. Additionally, it aims to recognize the levels of awareness and readiness for digital transformation in academic libraries, and the barriers according to academic librarians' opinion.

Chrysanthi Chatzopoulou

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INTRODUCTION

With the digital era going through a notable transition the last couple of years, and the focus being on the internet use via mobiles and the emergence of social media, communication has been crucially affected. Smart devices and technology are an evolutionary process, and they affect both individuals and organisations as they are an integral component of our everyday lives. This rapidly evolving landscape of the previously unimaginable possibilities has been enabled by the highly automated processes originated by digitalisation, and consequently heading towards a more digital mindset and culture of the individuals, organisations, and societies.

Digitalisation is the process of using technology to enhance, streamline, and improve procedures and operations of an organisation. The process itself aims to create new activities within an organisation, or improve the current ones, by the implementation of digital technologies and exploiting the data that derives from the organisational processes [Tomte et al., 2019; and Gkrimpizi & Peristeras, 2022]. Digitalisation advantages have been identified in information distribution and flow, which in turn leads to simplifying administrative processes, and the creation of systems that can be easily shared and modified to apply in multiple organisational levels. This process has been proven of high value for educational institutions, including academic libraries, as it has enabled new methods for identifying plagiarism, enriching learning resources, and creating new collaboration and communication possibilities [Tomte et al., 2018; and Khalid et al., 2018].

Digital transformation has become widely known in the last years, though its history goes back further to what we can think. Despite the term itself being a relatively new concept, digital transformation as defined today can be first spotted in the late 1970s, where companies started using computer-aided programs to affect their processes [Magenest, 2022]. The definition of digital transformation has started being developed around the late 1990s, and it is currently formed as the concept that encloses the use of digital technologies to create new processes, or the integration of digital technologies to reform all the existing processes of a business, resulting to enhanced customer experience, and affecting the existence of a business as a whole: its operation, its culture, its network, the impact on the society, etc. [Schallmo et al., 2017; The Enterprises Project, 2016; and Salesforce, 2020].

In a more recent point of view, digital transformation is defined as the capability of having access to digital methods, communication, and innovation, that allow to an organization universally combine digital assets and resources, as well as the consideration of digital networks to create new products or services (or to modernize the existing ones), offering the chance to create added value to their products and retain competitive advantage in the market [Badescu, 2021; and Annareli, 2021]. Hence, digital transformation concept does not actually revolve around adopting technologies, rather than using them as an impact multiplier for an organisation to adapt its culture and its mentality to reproduce their effectiveness to a maximum level. To achievement of this, changes must occur in culture, individuals, procedures, and strategies of an organisation, while technology is used as the means to achieve the organisational change. In other words, the elements for organisational change are consistent, though the relative significance varies, as digital transformation is considered a sociocultural phenomenon [Gkrimpizi & Peristeras, 2022; and Saarikko & Westergren; 2020].

Diving into the differences of digitisation, digitalisation and digital transformation, Gkrimpizi & Peristeras have made a very precise distinction of the terms to help delimit each phase in the evolution of an organisation:

- Digitisation is the technical process where analog data and processes are converted into a machine-readable format (e.g., paper forms to web forms).
- Digitalisation is a socio-technical process where the use of digital technologies, data, and inter-connections result in new activities, or in changes in the existing activities of an organisation.
- Digital transformation on the other hand, is a socio-cultural process. It refers to the cultural change of an organisation, including all its processes and operations, via the intelligent integration of digital technologies, processes and competencies across all operational levels of the organisation. Its major focus is to transform the mindset and culture of the organisation, to ensure that technology is deployed to maximise the impact of the organisation [Gkrimpizi & Peristeras, 2022].

The technological advances of the last decades have caused massive changes in the organizational operations, though these advances have been particularly developed further the last three years. In light of the recent global evolvments and with the pressure that the COVID-19 pandemic has caused in the organizational setup, it was essential that all organizations improved their digital skills in order for their services not to be supplant by more modern ones. For most of

the organizations, transferring their operation to the digital environment, including their communication and operational processes, has been a survival issue and not an option [Badescu, 2021]. In order for the organisations to ensure that information and digital technologies can positively affect various organisational elements, there are several options of digitalisation and digital transformation means the organisations can exploit. A 2017 study mentions as such technologies the use of social media, IoT (Internet of Things), mobile apps and technologies, cloud computing, and big data analytics [Morakanyane et al., 2017; and Fitzgerald et al., 2013]. Further research from Loonam [2018] classifies those technologies that can empower a business/organisation during the digital transformation journey in three main categories: a) the virtualization systems, such as cloud computing, b) the mobility systems, such as social media, IoT, and mobile use, and c) the embedded analytic systems, such as big data.

The tendency to enrich the organisation's operations and transform the way the organisation operates as an entity by creating additional value and enhancing the experience of all their stakeholders, is also closely related to the organisational business models. According to Berman [2012] and Morakanyane [2017], there are three main potentials of digital transformation: the development of new business models, the extension of the operational procedures, and upgrading customers' experience. Hence, the transformation process may be organisational focused, and customer focused. As further analyzed by Westerman et al. [2014; 2015], the business model remodeling can be developed according to five main goals:

- a. Reinventing the entire industry – successful examples in this category would be the Airbnb effect on the hotel market, or the Uber to the way the taxi transport used to work.
- b. Creating substitutes for products and/or services – such as the electrical cars from Tesla,
- c. The creation of new businesses via the growth of new products/services – such as Google, that started as an online search service and currently offers multiple products,
- d. Redesigning value delivery models, where businesses can change their operations and have a more direct relationship with their customers by removing the intermediates – as Apple has done by making their systems and products available directly to the customers; and
- e. Reconsidering their value propositions.

According to Loonam [2017] though, despite the fact that 90% of businesses in the UK and the US have set digital transformation as a high priority task, the implementation of large-scale ICT initiatives has had a poor rate of success in organisations, at least up to that date. Moving on

to the next years evolutions, research shows that transformation within organisations starts from the information processes, and then passes to business processes and business models [Machado et al., 2019; and Sanchez-Gonzalez et al., 2019]. Additionally, the volume of data availability and the appearance of new technologies push the organisations to adapt their strategies in a more holistic point of view and proceed with at least the digitalisation of all possible areas [Jedynak et al., 2021]. Such a huge change in the organisation's core processes implies that work distribution and HR would also be affected, as it would require the employees to acquire a new set of skills to support this change, as well as to interact more effectively under the new working conditions, setting digitalisation as a prerequisite to proceed with the digital transformation of an organisation [Jedynak et al., 2021; and Ostmeier, 2022].

LITERATURE REVIEW

The appearance of computers has undoubtable impacted organisations, as since their emergence in the 1950s opportunities for improving internal operations have arisen. Through the years, computers have become an essential part of all operations in an organisation, gradually affecting all functions of the organisation, such as efficiency, end products, service, access to information, working time and accuracy, transparency, etc.

In relation to libraries as organisations, Saharkhiz et al. [2016] claims that there have been two periods in the age of computers: the first one refers to the wave of automation in library processes (digitalisation), and the second one to the digitization of libraries. During the first phase (late 1970s and 1980s) Online Computer Library Center – OCLC was created, and it was a great technological breakthrough, as it was the first system entirely dedicated to the main operation of libraries; borrowing books, and the first attempt for a unique library catalogue across many libraries. Hence, all borrowing-related operations were affected: cataloguing, circulation, periodicals, search, control, and the borrowing process itself [OCLC, 2022]. The second period of computers in libraries, digitization, is more complex and still developing, as technological evolutions are changing more and more rapidly as time passes by. This phase includes the content of libraries being digitized, stored, and being accessible to the library users via computer systems [Saharkhiz et al., 2016]. Research done through the last decade already suggested that for the future technological advances, as the trends are evolving and affect the political, social, and market

backgrounds, academic libraries should focus on the use of various media, by exploiting the visual infrastructure advances (such as projectors, VR, and virtual displays) [Silverstone, 2012].

The technological disruptions have naturally affected both the services and workflows of academic libraries, and the role of librarians. Federer [2013] noticed that the traditional library services were dedicated in delivering the end product, which in case of academic libraries could be summarized as the literature for research, while the process to deliver this product has been affected due to the information overload. Hence, librarians should evolve their role to positively affect the overall process during which researchers identify data, to create a more valuable research output. According to Favaro & Hoadley [2014], academic libraries always used to operate as warehouses of information, though the behavior of their users has been radically reshaped, and so should the dissemination of information and the search processes promoted by the library professionals. The availability of information on the web creates the need for more instant retrieval of information, rapid acculturation to new fields, online collaboration during the research process, and knowledge building and dissemination activities. To this scope, the Association of College and Research Libraries (ACRL) released the Framework for Information Literacy for Higher Education report in 2015, expressing the need for in depth reconsideration of the information literacy practices used by academic libraries, and the integration of new methods of information flows [ACRL; 2015].

As a result, it could be stated that the academic libraries scope and operation has been totally reshaped though the digitalisation process, changing their products while being affected by other industries (e.g., the publishing industry with the appearance of e-books and the disruption of open access in the research publishing field), reforming their services and the means for delivering them accordingly, and leading to the emerge of new specialties within their scope (such as research informationists, resource librarians, digital librarians, digital curators and research data managers, and teaching librarians/information literacy specialists) [Favaro & Hoadley, 2014; Federer, 2013; and Cox & Corral; 2013].

Emerging technologies that reformed academic libraries

Technological advances present great significance in all industries in the last decades literature. In many businesses, new technologies even lead to the emergence of new professional practice

models and roles. Although technology can be utilized in various sectors and for different purposes, it frequently aims to support managerial values, such as efficiency and the elimination of costs. In case of libraries, artificial intelligence (AI), cloud computing, Internet of Things (IoT), and Big Data are the technologies that brought massive changes and have played an essential role to digitalisation and digital transformation not only of their physical spaces, but also effecting fundamentally their internal operations and processes, the services, the products they offer to the end user and of course, librarians themselves.

Artificial Intelligence

AI was founded as an academic discipline in 1956. In contrast to the natural intelligence exhibited by humans and animals, AI is intelligence demonstrated by machines. Any system that senses its environment and takes actions to maximize its chances of attaining its goals is considered an intelligent agent, and AI is the study of those intelligent agents [Wikipedia, 2022]. Since its inception, AI research has experimented with a wide range of methodologies, including brain simulation in a wide range of topics, modeling human behavior in problem-solving, formal logic, extensive knowledge databases, and even animal behavior imitation. At its beginning, mathematical-statistical machine learning (which is an offshoot of AI) has been used to solve demanding problems in industries and academia, leading to highly successful results [Clark, 2015; and McCorduck, 2004].

To efficiently describe the use of AI, it could be stated that it is generally used to leverage machines and computers so that they mimic the problem-solving and decision-making skills of the human mind [IBM, 2020]. According to McCarthy [2004], AI “is the science and engineering of making intelligent machines, especially intelligent computer programs. It is related to the similar task of using computers to understand human intelligence, but AI does not have to confine itself to methods that are biologically observable”.

Currently there are several types of AI. According to Gartner [2018], their analysts identify “six core interconnected AI technologies”, and these are listed as business analytics and data science, natural language processing, speech recognition and text to speech, machine learning – deep learning and neural networks, machine reasoning – decision making and algorithms, and computer vision – robots and sensors. Some common examples of AI applications are the advanced

search engines such as Google, that include advanced algorithms for ranking pages and identifying user behavior patterns, the recommendation systems used by YouTube, Netflix, etc., the understanding human speech systems such as Alexa and Siri, chatbots that deal with directional queries, automated decision-making used in strategic games such as online chess or backgammon, and the self-driving cars of Tesla, and so on [Daley, 2022].

When it comes to the integration of AI systems in libraries, research results are relatively low. Most of the documentation on what developments have occurred in terms of AI use in academic libraries comes from internal networks, such as blogs or union meetings. Most of the official library associations such as IFLA (International Federation of Library Associations), ALA (American Library Association) and CFLA (Canadian Federation of Library Associations) have recognized the importance of AI integration in library services, especially for libraries involved in research. More specifically, the IFLA 2022 Trend Report highlights important benefits from AI in libraries, such as connections to the semantic web and search, chatbots and personal assistants, improvements to the cloud-based computing, neutral networks, and more [IFLA, 2022].

It is widely known though that libraries have shown big resistance to change, especially when it comes to integration of digital technologies where librarians are considering this a threatening change that will replace their jobs [Wheatley & Hervieux, 2019; and Nakhoda & Tajik, 2017]. Particularly, Wheatley & Hervieux [2019] performed a study where they scanned 27 academic libraries in the US and Canada, to identify the inclusion of AI in their services. Surprisingly, none of the university libraries included in the study mentioned AI in their strategic plans, although all of them had some level of interaction with AI. The most prominent example of AI was course offerings or hub centers for staff and the users, but only 18.5% of the libraries offered programming related to AI and only one out of the 27 libraries had created a specialized guide on AI [Wheatley & Hervieux, 2019].

According to other studies, the fear of substitution is quite normal in academic libraries, as some parts of the profession are at high risk: library assistants have a risk of 95% amenable to automation and library technicians of 99%. The role of librarian though, is perceived to have a risk of only 65% [Cox, 2022; and Frey & Osborne; 2017]. The benefits of AI though should surpass this fear, as there are studies that oppose to this opinion claiming that the wave of automation will radically change all industries, though there will be time to adjust and new areas of application to

rehumanize work will not lead to actual substitution of professions [Willcocks, 2020; Cox, 2021; and GPAI; 2020].

The OCLC report *Responsible Operations* examines how machine learning and AI might affect librarianship and offers suggestions for directing responsible adoption of these technologies. Apart from the technical infrastructure strategies, metadata creation, and related venues, it is analyzed that libraries should gradually integrate data and programming literacy, as they are crucial for contemporary students [OCLC, 2019].

As technological innovations are successfully adopted only when their intended benefits are clear, Cox [2022] has made a clear presentation of how AI can benefit academic library services. Some of the integrations discussed are already implemented by some libraries, though others still remain unrealizable. These integrations include web and mobile search advances in the library catalogues, advanced library systems and search interfaces, knowledge discovery (such as licensing AI products, offering targeted collections of data, and supporting AI communities), AI assistants (such as voice assistance, chatbots, and conversational agents), advanced user management that includes learning and library analytics and sentiment analysis, robotic automation processes for the back end systems, and smart libraries with the use of sensor data, internet of things (IoT), and even extra dimensions of the library [Cox, 2021; Cox, 2022].

Most of the currently developed AI systems that are used by academic libraries are related to tasks related to the management of users, budget, collection development, information literacy, circulation, etc. The use of these systems is focused on enhancing user experience with automated performance of tasks, e.g., the ready reference systems (EndNote) or information retrieval systems. There are though further opportunities to be explored for informational researchers, including digital libraries, multimedia systems, and e-commerce [Vijayakumar & Sheshadri, 2019]. Librarians have developed a variety of skills to organize information and make it accessible from anywhere, and libraries can confirm the application of tools that correspond to the new generation researchers' requirements. With AI libraries have the chance to emphasize and redirect the attention of researchers [Jacknis, 2017; and Whitehair, 2016]. AI can lead to faster and more accurate information retrieval, which will be followed by learning more about the searchers' behavior. Additionally, it can enhance search by recognizing metadata issues, examining how content was indexed, and making sure it was discoverable. Recommendation systems can get better, pattern recognition in the researchers' behavior can lead to highly personalized results, and

chatbots can help researchers engage in the learning experience with technology. Not to mention that these capabilities can also expand in the marketing of academic libraries for deep insights [Cox et al., 2019; Cox, 2022].

Cloud computing

Cloud computing is the term that encloses the delivery of services via the internet, the disposal of computer resources and systems upon request, especially computing power and data storage, without immediate operational administration by the user [Investopedia, 2022; Wikipedia, 2022]. In cloud computing, information and services are housed in massively scalable data centers that are accessible online from any connected device, utilizing these resources' capacities and making them available as a single resource that can be altered to meet the user's needs. The foundation of cloud computing is the creation of a number of virtual servers on the huge resource pool that is accessible and their provision to the customers [Kumar, 2017]. The National Institute of Standards and Technology defines cloud computing as “a model for enabling ubiquitous, convenient, on-demand network access to a shared pool of configurable computing resources (e.g., networks, servers, storage, applications, and services) that can be rapidly provisioned and released with minimal management effort or service provider interaction” [NIST, 2011].

Cloud computing has four main types: private clouds, public clouds, hybrid clouds, and multclouds; and three types of services: Software as a Service (SaaS), Platform as a Service (PaaS), and Infrastructure as a Service (IaaS). The variations between the type of clouds are mainly identified by location and ownership:

- Public clouds are not owned by the end user, and are usually created by IT infrastructure. Good examples of public clouds are the Google Cloud, Microsoft Azure, and IBM Cloud.
- Private clouds are described as cloud environments that are only used by one end user or group, and which typically operate behind the firewall of that user/group.
- Hybrid clouds can be defined by the combination of several IT environments to a single one, through the use of LANs, WANs, VPNs, APIs.
- Multclouds are a type of cloud that consists of many cloud services from various public and private cloud vendors.

In terms of services, the three types can be distinguished by defining what one rents. With IaaS you can rent infrastructure, such as servers and virtual machines, networks, storage, and operating systems. PaaS refers to the supply of an on-demand environment for software development, testing, delivery, and management. The goal of PaaS is to free developers from having to set up or manage the servers, storage, networks, and databases required for development in order to swiftly create online or mobile apps. Finally, SaaS is a technique for offering software applications over the Internet, on demand, and often via subscription. SaaS applications are hosted and managed by cloud service providers, who also take care of any maintenance tasks like software upgrades and security patches. Users often use a web browser on their phone, tablet, or PC to connect to the application through the Internet [Microsoft, 2022].

As cloud computing services have matured and become more prevalent, they are the latest technology trend in library science offering a wide range of new technologies and tools, and achieving enhancement and economy of all library functions. With the help of cloud computing technologies, especially those targeting end users, librarians with varied levels of technology proficiency can now access and use tools and services that would otherwise be out of their reach [Kumar, 2017; and Tritt & Kendrick, 2014]. When focused to the benefits of cloud computing to organisations, there are several aspects that declare that it can lead to improvements in accessibility and efficiency to deliver computing services on demand, e.g., digital archiving, library instructions, scholarly communication, academic publishing, etc. [Tritt & Kendrick, 2014; and Breeding, 2013]. Further benefits that are highlighted from the implementation of cloud computing in academic libraries include backup, restoration, flexibility, movability, increased storage, innovation, and shared resources. Additionally, research on the field supports that it is cost saving, user centric, promoted openness and transparency, and helps encourage creativity and collaboration as it provides access from anywhere, thus leading to enhancing library operations as they do not have to confront with technological problems, and focusing on their mission and services for better user experience [Kumar, 2017; and Sivankalai, 2021].

Cloud computing has various applications in library services, with the existence of digital libraries and institutional repositories, unified library catalogues, search of scholarly content, and building communities being the most common among them. Generally, SaaS technologies are considered to be the most applicable among academic libraries, with emphasis given on Google Docs, Dropbox and Evernote. Such services are deemed to provide a powerful alternative for

libraries that may not have the budget or appropriately trained staff to implement further computing services [Luo, 2013; and Swaminathan, 2020].

Some examples of major integrations of cloud computing in the library services are OCLC, ExLibris, Scrib, and Encore. OCLC provides Information Library Systems (ILS) on cloud environment, hence leading to circulation, acquisitions, cataloguing and search being performed via cloud, enabling quick application processing and data collection across server clusters, and also includes WorldCat records, which is the largest bibliographic database, and hence allowing big data applications among libraries. ExLibris controls a huge market share within academic libraries, and includes cloud based ILS such as Sierra, Polaris, and Alma, and allows all members of its community to operate with their higher-end cloud platform enabling openness, agility and flexibility. Scrib is a cloud based service that provides access to over one million e-books and audiobooks, periodicals, and other resources. Finally, Encore is a feature that aids users in conducting related searches for items by providing a cloud-based tag on library subject headings and user-generated tags [Benedetti et al., 2020; Gosavi et al., 2012; Kumar, 2017; and Sivankalai, 2021]. Further examples of SaaS and PaaS that are worth mentioning are the LibGuides, EBSCO Discovery Service, and Citation Management software, which are widely used among researchers. Finally, IaaS mostly refers to the space and time that library users can purchase to use external servers for electronic storage, such as in institutional repositories or archives. This infrastructure also enables the open-source software for running repositories, such as D-Space, Digital Commons, Eprints, etc. [Mavodza, 2012].

Internet of Things

IoT was first spotted as a term in 1999 by Kevin Ashton, who defined it as “a system where the Internet is connected to the real world via ubiquitous sensors”. According to this concept, in order to count and track products without requiring the involvement of human labor, Radio-Frequency Identification (RFID) tags can be used in business supply chains while being connected to the Internet [Ashton, 2009]. The concept is also spotted under the term “Internet of Objects”, and refers to a wireless network between objects that can generate and exchange data, as well as communicate with each other without any human intervention. These objects can be RFID devices, laser scanners, infrared sensors, or any other device. While embedded with sensors and chips via

cloud computing and harvesting technologies, these objects can behave as they “think” or “feel”, and take decisions based on their communication [Liu & Sheng, 2011; Gupta & Singh, 2018; Pujar & Satyanarayana, 2015; and Bindu, 2021]. According to Sheeja & Mathew [2019], these things acquire identities during this process, they have physical attributes and virtual personalities while incorporated to the network [Sheeja & Mathew, 2019].

As libraries continue to integrate cutting-edge technologies for better and expanded service delivery, they become smarter every day. Therefore, there is a close relationship between new library services and technological development. The use of IoT in academic libraries has posed a constructive challenge to the status quo in terms of disruptive innovation. According to Hoy [2017], IoT technologies are ideally suited to benefit libraries. Many of these items can be included into the library's physical environment, and librarians can serve as local specialists to help their clients comprehend and use these new technologies. These technologies can help add value to academic library services and enrich the experience of users, not only by improving and securing the physical spaces of libraries, but also improving services such as track and trace materials, self-checkouts, distribution of information, and of course marketing and promotion [Gupta & Singh, 2018; and Igbinoia & Okuonghae, 2021].

Since internet is currently at its second life (the so-called Internet Plus), it can be integrated with other businesses via characteristics that include platforms, information and communication technologies, cloud computing, mobile internet and big data. Libraries are already familiar with the use of RFID, which accomplishes a similar task of interacting with machines, tags and updates the library management system with entries of books issued to a user. Since their collections also include books, journals, CDs/DVDs, theses, and many other physical items, IoT can be really helpful in disguise for resolving certain enduring issues with libraries, including lost items and their utilization [Nag & Nikam, 2016]. Additionally, spaces can be improved with the use of intelligent systems for augmenting security or sustainability of buildings, e.g., smart fire systems or adjusting temperature and light technologies [Nie, 2017; & OCLC, 2015].

Two great examples of IoT implementation in libraries have been presented by IFLA, were opportunities such as payments, ticketing and events organizing, inventory control, space configuration, accessibility and resource availability were also highlighted. The first example is of the Russian State Library for Young Adults (RSLYA), where a concept similar to the smart houses has been implemented. With the use of modern technologies, they have added equipment such as

TV-sets, screens, electrically sustainable curtains, and other devices that could be managed remotely, with infrared remote control or radio frequencies via their specially designed/custom made app. Only restriction for anyone to manage these devices, the internet access. Further library equipment mentioned by these examples and with the mentioning of The Mansueto Library at the University of Chicago, refers to “smart bookshelves” with RFID technologies that allow the best possible management control. These bookshelves have many antennas that allow to librarians easily locate the exact position of lost or misplaced items in the collection, easier and faster checkout and returns via automatic sorters for each department, allowing strict control over the collection. The Mansueto Library at the University of Chicago has taken this procedure one step further, as its function is based solely on roboters, something that rises expectancies for even higher potentialities, such as for example using robotics and drones for serving remote areas [IFLA].

Other implementations that could be considered in academic libraries include virtual tours, guidance through spaces and collections, event management, availability of spaces, machines or material, strengthening the library security systems, alerting services, provide personalized services, and promote information literacy. [Gupta & Singh, 2018; Wojick, 2016; Wang & Zhao, 2015; and Makori, 2017]. The virtual tours can be performed via mobile apps and will help users familiarize with the library space, but more importantly will enhance information literacy, as they are self-guided by each user [Gupta & Singh, 2018; and Potter, 2014]. The virtual resource on the other hand encloses huge potentialities for maximizing personalized services to individuals. Users can create their profiles and reading lists, identify the location of their desired resources, and be guided to the physical location of these resources via audio guides for example. Then the self-checkout saves time and allows the user to feel independent, as the human interaction is minimized when they wish so. Additionally, IoT could be used to communicate with the users for books on hold or new additions within their area of interest according to their search and borrowing history, for their account status, or even library events [Gupta & Singh, 2018; Pujar & Satyanarayana, 2015; Fleisch, 2010; and Wojick, 2016]. In terms of availability of machines and spaces, users are able to place on hold collaboration rooms, reading areas, or even photocopiers and scanners, without spending time in visiting the library first and waiting in lines for the use of such facilities. With the use of virtual library cards real time data for the users and library spaces can be exploited in such a way, so that academic libraries can focus on creating environments in alignment with their values [Fernandez, 2015; Wojick, 2016; and Gupta & Singh, 2018].

Last but not least, IoT has the ability to expand access to education, information, and communication without time or space restrictions, as well as transform and change academic and research information organizations [Makori, 2017]. Their use leads to improved building management systems that are environmental friendly and energy saving, and can even expand to digital libraries (DLs) with the implementation of smart objects. Smart objects would make it possible to efficiently support the discovery, inquiries, and management by using the tools and facilities offered by contemporary DLs, and could even allow us to expand the scope of already-existing DLs leading to the creation of smart DLs [Fortino, 2016; and Noh, 2015]. Similar accomplishments have occurred with an IoT reference mode for reviewing DLs, and for increasing traceability of physical objects via unique identification marks [Mohideen et al., 2017; and Stefanidis & Tsakonas, 2015].

As in every case where the internet has made a leap to the IoT and data can be transferred without human intervention though, such implementations also include challenges that may lead to resistance to change. IoT is based on the interconnection of devices, and hence the issue of data security has been risen as unsecured connections pose a serious risk to both library administration and patron privacy, leaving room for cyberattacks. [Massis, 2016]. Moreover, according to the Internet Society [2015] IoT revives concerns about surveillance when using technical equipment. In order for IoT adoption in libraries to go smoothly, library management must design a strategy that includes defining user privacy expectations and developing users' privacy rights in order to foster trust in the technology [Internet Society, 2015; and Taddeo & Floridi, 2011]. On a practical point of view, libraries also have to consider technical challenges that might occur, as the issue of interoperability is of big concern when various types of devices have to communicate with each other. Such changes of course also require the speculation of economic resources availability not only to update the technology and spaces, but also to train the existing staff accordingly.

Big Data

Big data is a term that refers to massive amounts of high velocity, complicated, and variable data that can be collected, stored, distributed, managed, and analyzed only by using innovative technologies and techniques. According to Fereeder 2016, this data “involves four Vs: volume, the scale of data; velocity, the speed at which data are created; variety, the type of data; and veracity,

the reliability and integrity of data.” Similarly, OECD 2015 describes big data as extremely large data sets that can reveal patterns, trends and associations related to human interaction and behavior, after being analyzed with specific techniques. Nowadays big data is becoming essential for the success of an organisation, based on the fact that as described in 2020 “businesses across the globe generate nearly 2.5 quintillion bytes of data daily. Almost 90% of the world data has been produced in the last two years alone.” [Rai et al., 2020].

In terms of academic libraries, there are numerous studies that support the introduction of big data technologies to strengthen their operations and increase their services towards users. To begin with, the digital collection that libraries have developed is a treasure of raw, riotous data. Instead of employing author surveys, libraries could use big data to assist their decision making processes in terms of collection and service development [Tella & Kadri, 2021]. The amount of data kept in university libraries is enormous. These might include unstructured or structured data derived from the library catalog, and data in various formats from digital materials. This data is constantly being supplemented with information available online, which not only changes user behavior but also presents huge opportunities for libraries. This information includes texts, metadata, photos, audio files, video files, research data, software, and 3D digital copies, hence academic libraries face challenges in exploiting both structured and unstructured data. On top of this, big data that is generated by users of social media, the internet, smartphones, and other location-enabled applications, is growing more important and hides great opportunities for academic libraries to benefit from [Tella & Kadri, 2021; and Zhan & Widen, 2018].

Ball 2019 has identified three main models of big data application in academic libraries, based on the IFLA Big Data Interest Group approach on 2018: data sources, data analytics and data visualization. Big data sources include archetypal sources, that derive from science projects, industries and the government. Additionally, crowdsource big data sources bring back a huge volume of data from public citizenship, including social networks and web-related commercial services (e.g., the Facebook and Twitter pages, or the webpage of a library). Finally, the long-tail big data sources that mainly occur in scholarly publishing, and the sensor stream big data sources that may come from wearable devices or surveillance and environmental systems, in cases of security cameras, temperature control systems, or even smart library cards [IFLA, 2018]. In terms of analytics and visualization, a combination of approaches and technologies are required to extract significant information from this data, as they are unique, complicated, and gigantic in scale, and

to visually represent this information in formats that people will be able to comprehend and use for problem solving [Tella & Kadri, 2021].

The benefits of big data in academic libraries can vary, as well as the tools and techniques that can be used to reach those benefits. Al-Barashdi & Al-Karousi, 2018, have proceeded with a systematic literature review for the exploitation of big data in academic libraries and concluded that statistics, machine learning, data mining, signal processing and visualization techniques can provide academic libraries with the maximum advantages in the areas of management, knowledge of the value of data, provision of premium support to researchers, and identification and investment in opportunities [Al-Barashdi & Al-Karousi, 2018]. Similarly, studies mention that libraries could exploit big data to encourage the development of knowledge within their communities, with data scientists and specialists turning massive datasets into useful knowledge by applying analytical thinking techniques [Virkus & Garoufallou, 2020]. Big data analytics can be used to assess and enhance library services aiming to higher quality, personalized services that will adapt to each user's needs. Taking it one step further, big data analytics in social media and webpages of academic libraries can be very valuable to improve the perception of products and services they provide to their users [Garoufallou & Gaitanou, 2021; Blummer & Kenton, 2019; and Cervone, 2016]. Finally, Yi et al. emphasizes on the necessity of theoretical understanding of big data mining, as they suggest the development of customized recommendation systems based on clustering analysis and association rules theory, to provide personalized services as close as possible to each user's behavior [Yi et al., 2014].

Transformation of services and processes

Academic libraries are among the industries that have been affected the most from the technological evolution, as activities, procedures, and services started becoming automated as soon as technology started rising, and are still evolving. To summarize the academic library services, ITHAKA (a not-for-profit organization that aims to help the academic community use digital technologies) outnumbers the academic library's commitments as:

- Engaging the campus communities, with venues and programs that will encourage participation and ensure bigger outreach;

- Empower academic success, by supporting education and learning, promoting information literacy and facilitating progress;
- Ensure access to information, by providing a plethora of information resources and supporting preservation of collections;
- Encourage creation and research, by delivering knowledge, guidance, equipment and services;
- Endorse inclusivity, with the elimination of accessibility issues and support of all student teams regarding ethnicity, studying mode, geographical area, etc.;
- Conserve and promote unique collections, ensuring the efficient use of special materials and rare collections;
- Providing the physical spaces for collaboration and academic work to flourish, supported by technological advances and tools that are hard to access individually;
- Display academic expertise, and encouraging academics and associates to conduct excellent research and achieve recognition in their fields;
- Renovate scholarly publishing, with the promotion of updated business models and means, such as the inclusion of open access activities, preprint materials, modern methods for data management, etc. [ITHAKA, 2018].

All these services have been undoubtedly impacted by the digitalisation of libraries, not only due to the internal processes being transformed, but also in terms of how they reach the end users. The current state of research and innovation is highly dependent on the internet, and so are the means academic libraries have been using to align with their mission and goals.

To understand the roadmap of evolution emerging technologies brought in academic libraries, three timelines are presented below: the first one refers to the technological evolutions that affected the library processes, the second is an example of introduction of technological tools in Auckland libraries, and the third one is the evolution timeline of information retrieval, as affected by the digital progress of resources.

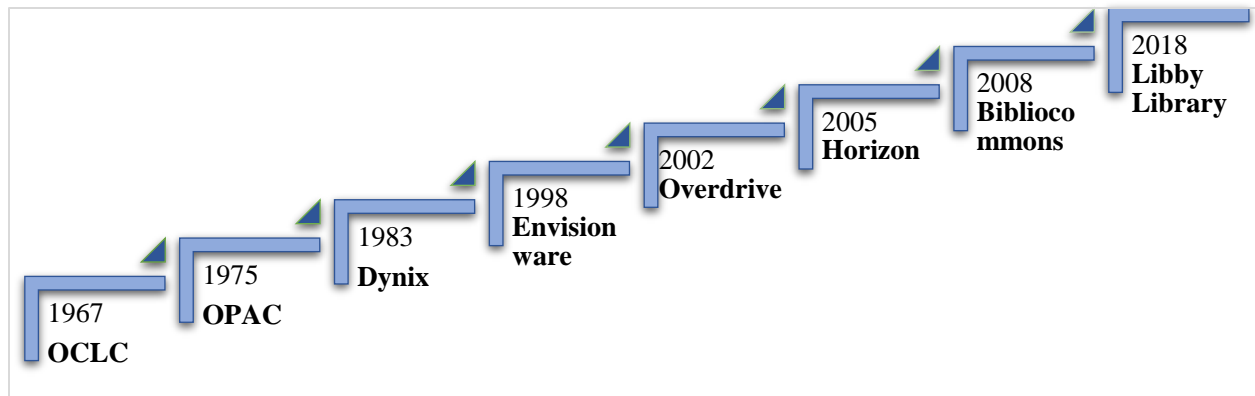


Figure 1. The evolution of library technology

As presented in figure 1, the important steps in the digitalisation of library processes started occurring in 1967 with the introduction of OCLC. In 1975 the first version of the online card catalogue was launched, and in 1983 the integrated library system was introduced to replace the card catalogue. Then in 1998 the first library programs started to appear, including possibilities for transforming some of the library processes such as financial management and e-commerce. In 2002, Overdrive was the first digital online platform for libraries to download in their computers, including digital rights management and e-materials. Horizon was first introduced in 2005 and is still used by most of the libraries, as it is constantly being updated to the current trends. It is the first software that allowed interchange of data, trends, news and other resources among libraries. Bibliocommons in 2008 presented the first front end interactive catalogue for libraries, and finally, Libby Library in 2018 released the first alternative way to enter a library's catalogue: an app [Grantham, 2022; Breeding, 2020; SIRSI, 2022; and Bibliocommons, 2021].

As presented in the second figure, the introduction of technology tools started a few years earlier in the case of Oakland libraries, with the photocopier. Each one of these evolutions has contributed gradually to the digitisation of material and digitalisation of services, especially for the period between 1977-1998 were some processes such as the bibliographic retrieval, the catalog search, the referencing system, and even the entrance to the library started being automated based on technology systems [Oakland University Archive].

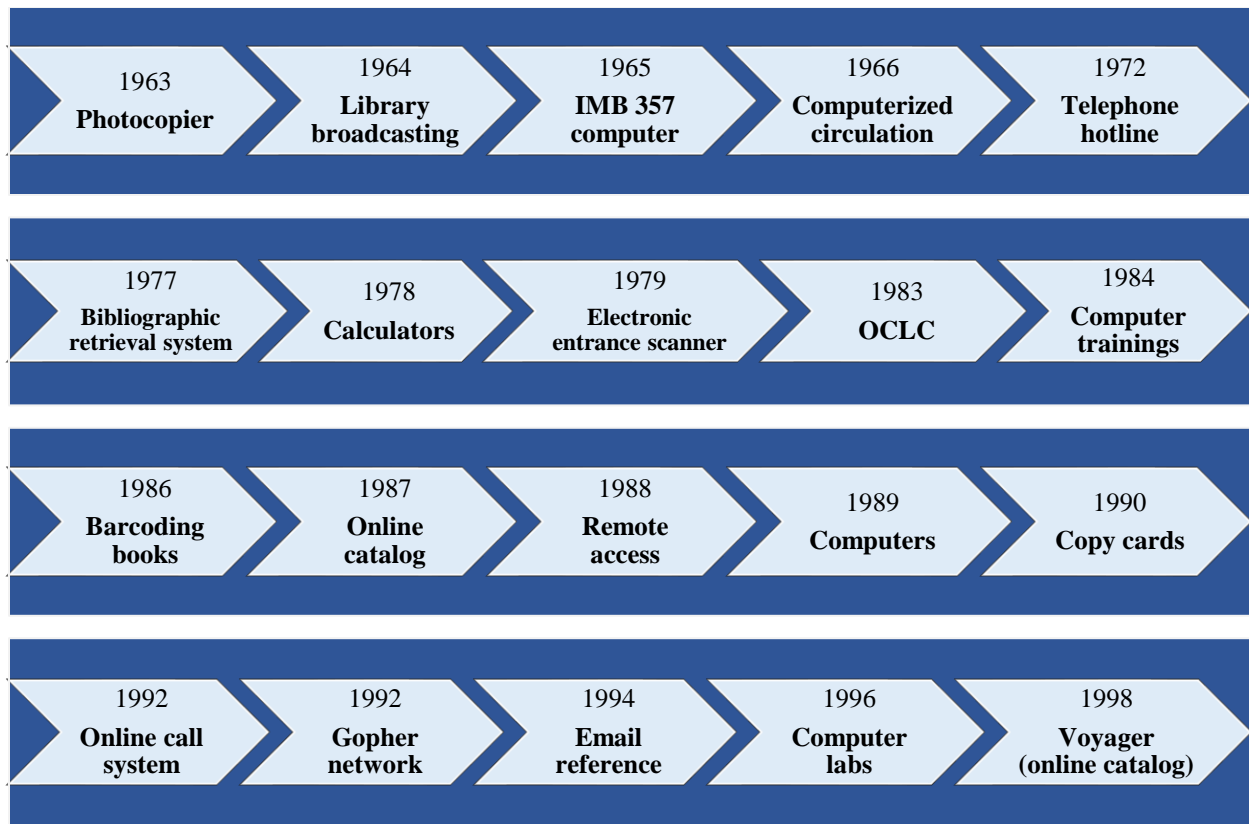


Figure 2. OU libraries timeline: technology

Information retrieval is a basic function of libraries, especially when it comes to academic libraries that are actively engaged to research activities. After the development of the World Wide Web (WWW), innumerable changes have occurred in the form of information and the means they are disseminated with. Apart from physical material, information now dominates in electronic format, including e-books, online articles, and webpages, usually in electronic collections or digital libraries. Hence, information retrieval also evolved importantly during the period 1960-2010, as predicted by Schatz [1997].

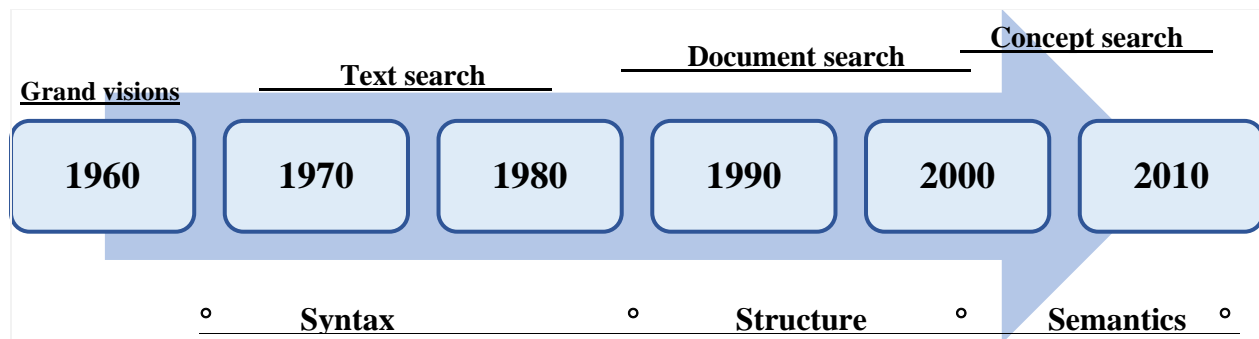


Figure 3. Timeline of the generations of information retrieval in digital libraries.

The high degree of automation possibilities of various profiles has naturally affected academic libraries, by mainly altering process chains and leading users to independently using the library services. Additionally, automation of library services and digitisation of material have even affected how availability is displayed in the catalog. Services dealing with how to extend operation on a 24 our basis and including remote access. Internal processes such as request management and budget planning are also part of this ongoing procedure. In comparison to previous years, we could barely identify processes that have remained the same, especially if we try to analyse the core processes of a library.

Examining those processes individually, below are some details on the changes that have occurred through the years, leading to gradually moving to fully digital operation environment:

- *Cataloguing* is one of the core processes for libraries and it refers to the procedure where metadata are created for the library material while following international standards, to enable access universally. During the digital era this procedure has been affected by the appearance of new forms of digital material (CDs, DVDs, e-books, etc.), and hence new core metadata elements were required to adequately describe this material. For example, MARC standards were updated to MARC 21, and OEB and XML formats are now officially used for this purpose [Jantz, 2001; Vijayakumar & Sheshadri, 2019; and Librarianships Studies & Information Technology; 2020].
- *Classification* of materials (that includes organising in groups, using codes, arranging position, etc.) was originally performed manually, but the current processes include the involvement of expert systems such as Coal SORT, EP-X, and BIOSIS [Vijayakumar & Sheshadri, 2019; and Librarianships Studies & Information Technology; 2020].
- *Circulation*, that includes all the processes related to the library material flow, such as loans, renewals, reservations to materials, check ins/outs, repairs, etc. Apart from gradually moving from paper to digital formats, libraries have also started loaning e-readers with multiple titles, accompanied with the appropriate hardware and instructions [Jantz, 2001; and Librarianships Studies & Information Technology; 2020].
- *Subject indexing* process is the process were a systematic guide is created including detailed information for the material it refers to, such as main title and other titles, authors, keywords, etc., aiming to the location and retrieval of the material with alternate ways. This process was also impacted by the creation of expert systems that can automatically retrieve and arrange this

information. Good examples that are used in academic libraries are the Med Index, Scopus, and the Web of Science Indexes [Vijayakumar & Sheshadri, 2019; and Librarianships Studies & Information Technology; 2019].

- *Collection management* is an operation that encloses several processes, with the two mains being handling acquisitions and withdrawals of material. During the automation process many efforts have been made to create effective collection management systems (CMS), with the first of them being GRIPHOS, that was created by a New York Museum's group in 1967. Current CMSs are mainly operating via the internet, and libraries access them via cloud [Vijayakumar & Sheshadri, 2019; and Wikipedia, 2022].
- *Preservation* of materials has also jumped to a new level, as by digitizing material libraries can now ensure that the material will not be damaged, and it will continue to be used in the long term [Jantz, 2001].

Given the disruptive character and the cross-organizational consequences, digital technologies are seen as a key asset for leveraging organizational transformation. Successful digital transformation is approached not only from a technology centric side, but also from the role of actors' perspective. It requires changes that apply across many organizational levels, including the core business being adjusted, resources and aptitudes being reevaluated, processes and structures being rearranged, leadership being modified, and the adoption of a vibrant digital culture [Nadkarni & Prüg, 2021; Yeow et al., 2018; and Singh & Hess, 2017]. Hence, digital technologies, digitisation and digitalisation are enablers for transformation, though non-technical factors like leadership, culture, and personnel training are the most significant to achieve organisational change in terms of structures, processes, business models, and capabilities. Organisations need managers and leaders that will have a digital mindset, being able to envision the transition process and reconsider their methods and practices [Nadkarni & Prüg, 2021]

In terms of this change, academic libraries are making an effort not only to re-imagine services and embrace the emerging technologies, but also take the initiative in providing leadership and equip the new digital society with the appropriate skills. Apart from knowledge preservation, new roles have emerged aiming to the systemic knowledge gathering, retrieval, evaluation and access. For example, research informationist is a new librarian position that has emerged as a result of the demand for better research data management. Research informationists are specialists that offer

expert advice on data management and preservation, bibliometric analysis, expert search, and adherence to funding policies related to open access [Federer, 2013]. According to Cox, 2021, further new specialties that have emerged with the implementation of digital technologies in academic libraries are the systems librarians, digital and institutional repository librarians, electronic resource librarians, digital curators/research data managers, metadata and copyright managers, and of course teaching librarians/information literacy librarians. All these roles require a deep understanding of the importance of data and technology, as they are called to bridge the gap between the library and the digital requirements of users. Most of these roles require a novel thinking approach and new types of collaborations, as it is usual that significant components of other professional groups are used such emerging roles. For example, research data management may be considered to be a “hybrid profession” among the work of a librarian, an archivist, and a researcher [Cox, 2022; and Koltay, 2019].

Electronic resource librarians have also been one popular way to combine the traditional skills of collection development with the digital collections’ creation needs. The need for librarians taking the responsibility of collecting research digital resources, as well as for professionals accountable for negotiations with e-journals, publishers, copyrights of electronic sources, as well as preservation and archiving of the new OA forms of material, has led to the necessity of reconsidering the traditional skills of a collection developer [Dunlap, 2008]. Similarly, reference librarians have swiftly embraced blogs, wikis, discussion boards, chat programs, instant messaging, social media, and even the use of virtual worlds via mobile phones as alternative ways to provide their services to users, leading to the collapse of the physical space as boundaries to their services [Anuradha; 2018]. Given the enormous challenges of digital transformation, the Chief Data Officer is also a new role that has emerged, which on top of primary leadership responsibilities the role involves leading digital change [Tumbas et al., 2017].

Transformational change in academic libraries though has been highly dependent by other industries too, as changes in scholarly communication and how research is published and disseminated have led to information access without intermediaries. In terms of redesigning their services, many academic libraries now offer research counseling centers, practice spaces, improved use of technology, provide services via the internet, and increased access to digital facilities. Especially after the pandemic, the focus has been transferred on how to provide training

and support remotely, as well as how to adequately equip the users in order to be able to exploit the digitized content and the digitalized services [Martzoukou, 2020].

Undoubtedly, the pandemic has played a crucial role in transforming the mindset of academic libraries and their employees, as either having full conscious or not, they were led to adopting practices that belong within the spectrum of a digital mindset. Of course, academic institutions have been using techniques of collaborative teaching and remote research activities prior the COVID-19 crisis too. The provision of a variety of online resources and activities such as digitized learning materials, academic/teaching related content, synchronous and asynchronous online teaching and communication sessions, as well as tutorials and screen captured material for demonstration had already started transforming the mindset of all people being involved in the process. Hence, according to the European Bureau of Library Information and Documentation Associations report released in 2020, since there already was long utilization of online resources from libraries COVID-19 emergency state for remote operations resulted to moderate growth, comparing to other industries [Martzoukou, 2020; Jones, 2020; and EBLIDA, 2020].

Since both technologies and people are required to be able to discuss for digital transformation though [Hess et al., 2016], other studies focus more on how academic librarians had to reform their personal skills in order to achieve the most effective communication, given the circumstances. For example, Deol & Brar [2021] state that librarians had to be in uninterrupted collaboration with researchers while also fulfilling their social roles in terms of raise and dissemination of COVID-19 related evolvments. The issue with this though is that, looking back, most libraries identified that they had focused on applying closure measures rather than emphasizing on the fact that their services will be available online in their majority [Decker, 2021; and Ayre, 2020]. Additionally, many librarians who were working remotely during the lockdowns were prepared to help patrons, though their mindset focused on providing services as a simulation of the face-to-face interaction with the users [Hunter, 2020]. This situation was also found to be partially depended to the digital divide, where people may not have known they could access their library online or may not have had the means to do so [Ayre & Craner, 2020].

The more experienced professionals in this case were able to identify the opportunities for further development of digital social skills, to achieve engagement via online collaboration and communication, digital interaction, knowledge acquisition, and problem-solving [Martzoukou, 2020]. Goddard, 2020, mentions that this situation has been a great opportunity for many libraries

to re-evaluate their role and operational models, and set new expectations on user interaction and engagement [Goddard, 2020]. Additionally, terms such as collaboration, interaction and provision of services effortlessly changed via the experience of remote working leading to a more digital mindset, as people had to also ensure that all team members corresponded equally to the demands of the new reality. Making certain that stress did not affect their or their colleagues performance, online trainings to achieve the better possible result in the provision of services, working from home, and exploiting as many online tools as possible for collaboration both between librarians and with their patrons, became the new normal [Breslin, 2020; and Risley, 2020].

One good example of a digital tool boost during the pandemic is the one of LibChat. LibChat is an integrated part of LibAnswers system that allows online communication. It can be embedded in the Library website, or any other website you wish, and also allows internal communication within a library. By the end of March, when most countries were lead to lockdowns, the LibChat service rapidly developed into a vitally important virtual help desk for the college community, particularly for new users of the library. Users unexpectedly found themselves without the traditional venue to get their inquiries answered when the pandemic forced the closure of the libraries, though this gap was filled easily due to the availability of LibChat. This also positively affected the relationships between employees, as librarians improved their performance because serving chat hours together was more equitable [Decker, 2021]. Alongside with the rise of LibChat, other chat and email services also gained great acknowledgement, as well as platforms like Google Meet and Zoom were used for the provision of services, especially the Interlibrary Loans and book chapter requests that rose unexpectedly. Surprisingly, the use of the libraries' websites, online catalogues and discovery systems declined during this period [Conell, 2021].

METHODOLOGY

Research design

This study aims to identify which emerging technologies academic libraries in Greece are familiar with, and how these technologies have impacted the library services. Additionally, it aims to recognize the levels of awareness and readiness for digital transformation in academic libraries,

and the barriers according to academic librarians' opinion. More precisely, the research questions of the study were formed as below:

RQ 1. What emerging technologies are academic libraries in Greece familiar with?

RQ 2. How have these technologies impacted the academic library services?

RQ 3. What are the levels of awareness and readiness for DT in academic libraries, and which are the most important challenges according to librarians?

In order for the research questions to be answered, this was designed as a quantitative study. First, the background was set finding valid literature related to the topic, and the questionnaire was designed. For the identification of literature, various searches were performed in Google Scholar, Scopus and Web of Science. Keywords that were used belonged in two groups: the first group of keywords was related to the digital/technological part of the research questions, and included the keywords “digitisation”, “digitalisation”, and “digital transformation”. The second group on the other hand, was comprised by terms related to the sector of our interest for the particular research, and included both very specific and targeted keywords such as “academic librar*”, “university librar*”, “library services”, as well as more generic related to the public sector, such as “organisations”, “public sector”, and “public institution*”. The search strategies included a variety of combinations of keywords among those two groups, combined by the Boolean term “AND”.

For digital transformation articles the search timeframe was restricted to the last decade (2012-2022), while for digitisation and digitalisation there was no limitation related to the publication year of the articles retrieved, in order to identify when each process started and finished in the sector of academic libraries. All literature used for the research was published in English.

The tool used for data gathering was a questionnaire. The questionnaire was designed in Google forms and included an introductory paragraph where participants were informed for the purpose of the study. Participation in the study was anonymous, and was deemed informed consent as it was voluntarily. The questionnaire consisted of three parts, including 21 questions. In order to eliminate missing values, all questions were closed-ended and mandatory. The first part of the questionnaire was related to demographics. The questions in this part were multiple choice questions (including single and multi-answers allowed) and gathered data related to age and gender of the users, years of experience, which library they are occupied in, and in which position. The second part was related to emerging technologies. In the second part, 5-point Likert scale questions (not at all – a lot) were used to identify the levels of familiarization with the emerging technologies

of cloud computing, big data, IoT and AI. Additionally, multiple choice and dichotomous questions (yes/no) were also included to define the use of such technologies and which academic library operations they have influenced. Finally, the third part was related to digital transformation. To help participants comprehend the difference between digitisation, digitalisation and digital transformation, three short definitions were provided in the beginning of this section. Then the questions followed were dichotomous questions of yes/no answers, 5-point Likert scale questions (not at all – a lot), and multiple choice questions (of single or multi answers allowed). These questions focused on digital transformation comprehension, readiness and challenges identification from the librarians participating in the research (full questionnaire available in Appendix I).

The questionnaire was tested with five library professionals, three of which were former academic librarians currently being occupied in related fields (academia and digital libraries), and two of which were active academic librarians. After the testing, minor changes occurred mainly in grammar and wording, to ensure better understanding of the questions. Finally, the questionnaire was distributed in 367 library professionals among 18 Greek academic libraries, via emails sent by Gmail. Participants were retrieved manually after related google search. Data gathering occurred between 3 December 2022 – 17 December 2022, and 46 answers were gathered in total.

Data analysis

The data gathered was analyzed using the statistical analysis program Stata v.16, which is a general-purpose statistical software package used for data manipulation, visualization, statistics, and automated reporting [StataCorp, 2022].

First, data were exported from Google forms in xls format, and converted to DTA (format readable by Stata) with the following code:

```
* Translate data from XLSX to DTA  
qui drop _all  
set more off  
qui cd "${xlsdir}"  
qui import excel using "Untitled form (Responses).xlsx", sheet("Form responses 1")
```

All questions were named for easier identification and navigation within the program interface, and data were cleaned to ensure any possible duplicates would be excluded from the analysis.

** Rename variables*

```
qui rename (A-BG) (Time Q1_Gender Q2_Age Q3_Experience Q4_Library Q5_Position ///  
Q6_Permanent Q7a_Familiar_CloudComp Q7b_Familiar_Inet Q7c_Familiar_AI ///  
Q7d_Familiar_BigData Q8a_Cloud_FileShare Q8b_Cloud_Video Q8c_Cloud_InfoCollect ///  
Q8d_Cloud_Calendar Q8e_Cloud_OnlinePres Q8f_Cloud_Editing Q8g_Cloud_Image ///  
Q8h_Cloud_Marketing Q9a_IoT_HeatCool Q9b_IoT_Security Q9c_IoT_Wearables ///  
Q9d_IoT_Tracking Q10a_AI_Assistant Q10b_AI_Chatbot Q10c_AI_SelfCheck ///  
Q10d_AI_VirtualBook Q10e_AI_Social Q11a_BigData Q11b_BigData Q11c_BigData ///  
Q11d_BigData Q11e_BigData Q11f_BigData Q11g_BigData Q11h_BigData ///  
Q12a_EmTech Q12b_EmTech Q12c_EmTech Q12d_EmTech Q12e_EmTech Q12f_EmTech  
///  
Q12g_EmTech Q12h_EmTech Q12i_EmTech Q12j_EmTech Q12k_EmTech  
Q13_DgtRedesign ///  
Q14_Train_DgtSkills Q15_Train_DataM Q16_Involvement Q17_Dgt Q18_Dgt ///  
Q19a_Exclusion Q19b_Exclusion Q19c_Exclusion Q19d_Exclusion Q20_Covid Q21_Covid)
```

** Clean data*

```
qui drop in 1/1  
qui gen id = _n  
qui order id
```

Finally, a variety of commands were used for the creation of one-way and two-way frequencies and percentages tables, as well as graphs and pies for data visualization [extended file with commands available in Appendix II]. After each question was individually analyzed, tables were tested in search of relations among participants answers (e.g., between use of emerging technologies and trainings received, between trainings received and service redesign, as well as between experience with emerging technologies and fear of substitute, or between participants age and fear of substitute).

RESULTS

The analysis of data gathered in the research provided interesting information on the levels of familiarity of Greek academic librarians with emerging technologies, as well as their perception of how and to what level they are used within the library operations. Additionally, they help us form an initial approach on the awareness of digital transformation term, readiness, and obstacles academic libraries may internally face. All participants answered all the questions, leading to a solid analysis without missing values to any of the questions.

Demographics

Starting from the demographic analysis of the sample, most librarians that participated in the research were female (84.8%), instead of male (15.2%). The age groups were provided according to generations, in order to be cross validated with questions related to familiarization, awareness and readiness in an effort to identify whether any interesting patterns occur based on generation gaps. In this sample, 78.2% of the participants belong to Gen X (aged between 42-57), 15.2% are Millennials (aged 26-41), and only 4.3% and 2.2% belonged to Boomers (aged 58-67) and Gen X (aged >25) correspondingly.

Table 1. Demographic characteristics of participants (gender and age)

	Freq.	%	Cum.
Gender			
<i>Female</i>	39	84.78	84.78
<i>Male</i>	7	15.22	100.00
Total	46	100.00	
Age			
<i>26-41</i>	7	15.22	15.22
<i>42-57</i>	36	78.26	93.48
<i>58-67</i>	2	4.35	97.83
<i>>25</i>	1	2.17	100.00
Total	46	100.00	

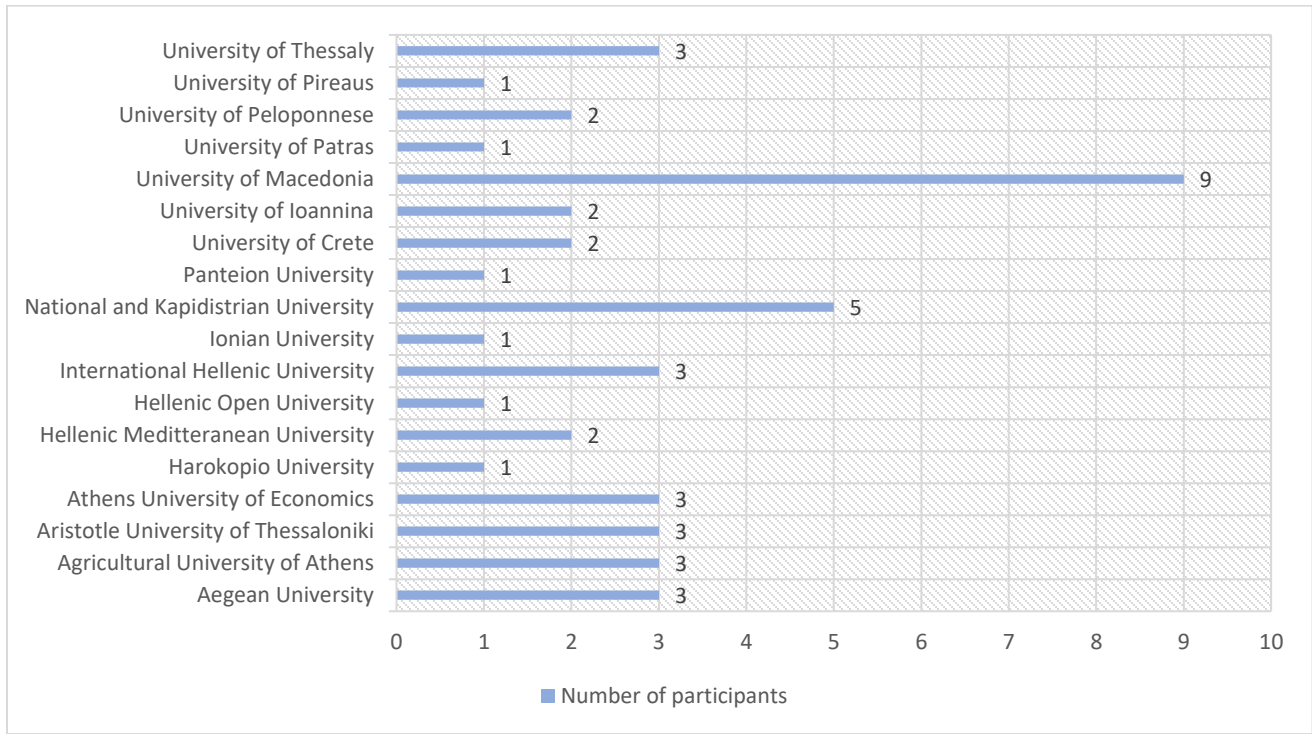
Most of the participants in the study had over 21 years of experience in academic libraries, followed by those who have been working in the field for 16-20 years. Following on the academic library from which professionals participated in the research, the most significant contribution in the research occurred from the University of Macedonia, as well as from the National and Kapodistrian University of Athens.

Table 2. Participants years of experience as academic librarians

	Freq.	%	Cum.
<i>11-15</i>	9	19.57	19.57
<i>16-20</i>	10	21.74	41.30
<i>6-10</i>	4	8.70	50.00

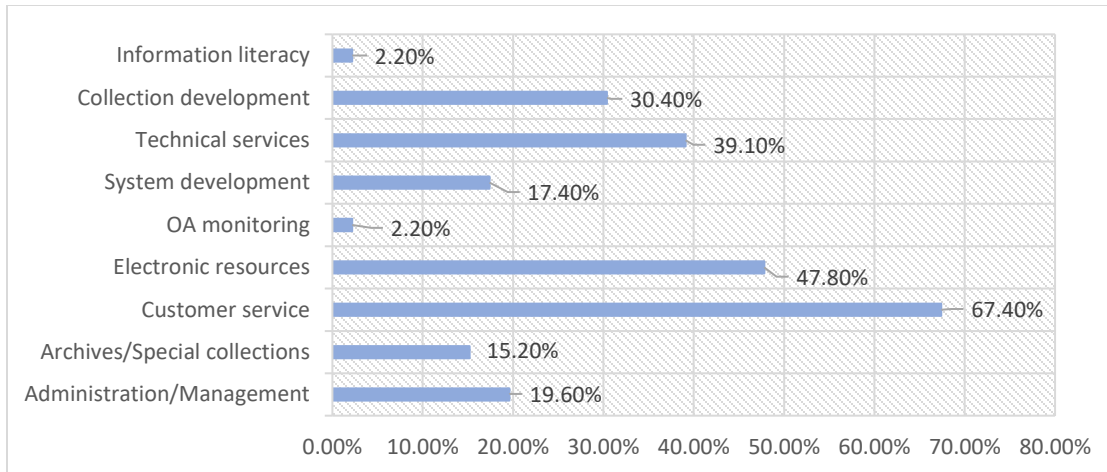
<5	4	8.70	58.70
>21	19	41.30	100.00
Total	46	100.00	

Graph 1. Academic libraries participants were retrieved from.



Then there has been an effort to identify in which positions librarians are mostly occupied in their library. Based on the fact that in Greece there is no there is no substantial distinction in areas of expertise according to the professional title for librarians, and hence they usually have more hybrid profiles, this was a multiple answer question. In graph 2 it is represented that most participants are occupied in customer service positions (67.4%), including front desk, reference and research librarians, followed by the electronic recourses/online databases librarians (47.8%). Quite significant is also the percentage of people being occupied in collection development (30.8%), while significantly low is the percentage of those being involved in open access and information literacy (2.2% for each).

Graph 2. Positions participants are occupied in.



Familiarization with emerging technologies

The second part of the questionnaire aimed to the identification of familiarization of users with the emerging technologies that have contributed to the digitalisation of academic libraries services, and have been often considered as a prerequisite for digital transformation. Additionally, the questions included some characteristic examples of usage of those technologies, in order to help participants identify them in their workflows. As presented in table 3, participants generally felt more familiar with the terms of cloud computing and AI (41.3% and 28.2%; and 32.6% and 30.4% of rather much and very much familiarization correspondingly). On the contrary, IoT was considered to be the least familiar term for the participants, with percentages of 19.6% little, or 15.2% any familiarization at all.

Table 3. Percentage of familiarization level with emerging technologies

	Not at all	A little	To some extent	Rather much	Very much	Total
<i>Cloud computing</i>	4.35	4.35	21.74	41.30	28.26	100%
<i>Internet of Things</i>	15.22	19.57	10.87	30.43	23.91	100%
<i>Artificial Intelligence</i>	8.70	8.70	19.57	32.61	30.43	100%
<i>Big data</i>	10.87	8.70	23.91	28.26	28.26	100%

In table 4, it is minutely represented whether such emerging technologies are used in the daily workflows of academic librarians in Greece. In terms of cloud computing, file sharing services such as Google Drive and Dropbox were the more popular for the participants with a percentage of 87% of use, followed by 76.1% using document editing services (such as google docs, google spreadsheets etc.). Surprisingly, online image editing tools such as Pic Monkey, and cloud-based marketing services such as Mailchimp and Moosend were rather unpopular among the librarians, with percentages of 8.7% use each.

Moving on, we observe that the use of IoT technologies in Greek academic libraries remains rather low. 76.1% of participants replied that their libraries do not use smart heating or cooling systems, 78% do not use any smart wearables (such as user bands), 67% does not use any smart book tracking systems, and only 19.5% of libraries participated in the research have smart security systems.

Quite similar are the results for the use of AI technologies, as only 10.9% of libraries use smart assistants and 15.2% chatbots for the servicing of their online requests. Librarians seem to be a bit more familiar with social media monitoring and metrics though (34%), and with the provision of online/virtual bookings for reading areas, study rooms, group working areas etc. (32.6%).

In terms of the use of big data techniques to retrieve valuable information, it seems that academic libraries in Greece are more experienced when it comes to understanding user needs (39.1%) and evaluating their services (32.6%). In contrast, the use of big data for identification of search trends in the library catalogue is quite lower (19.6%). Similarly low is the use of big data to identify cost reduction opportunities, and the application of big data in digitally preserved material for the acquirement of insights related to accessibility of materials (19.6% each).

Table 4. Usage percentages of emerging technologies in daily workflows

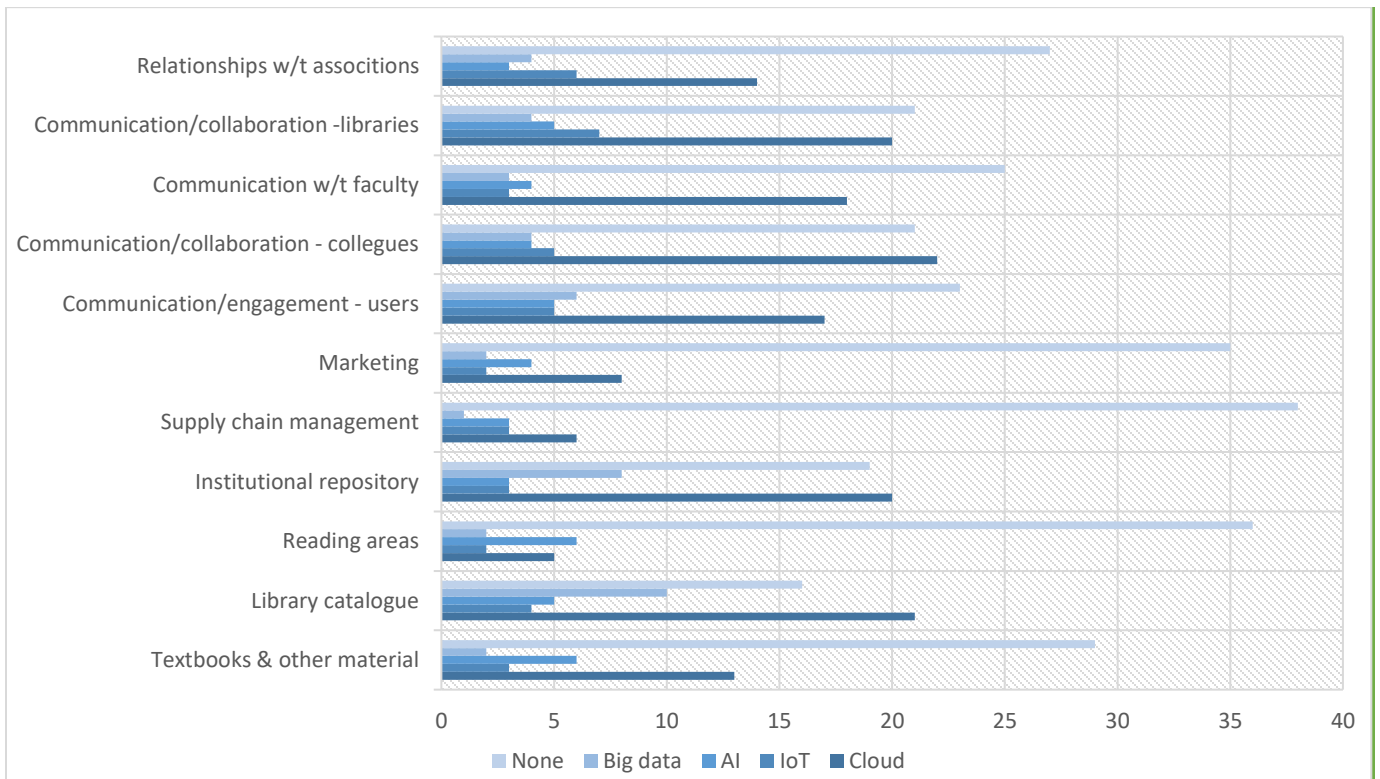
	Yes	No	Not sure	Total
Cloud computing				
<i>File sharing</i>	86.96	10.87	2.17	100%
<i>Video services</i>	58.70	36.96	4.35	100%
<i>Information collection tools</i>	69.57	26.09	4.35	100%
<i>Cloud-based calendar</i>	67.39	30.43	2.17	100%
<i>Online presentation services</i>	56.52	34.78	8.70	100%
<i>Document editing</i>	76.09	21.74	2.17	100%
<i>Online image editing</i>	8.70	76.09	15.22	100%

<i>Cloud-based marketing tools</i>	8.70	73.91	17.39	100%
Internet of Things				
<i>Smart temperature systems</i>	15.22	76.09	8.70	100%
<i>Smart security systems</i>	19.57	63.04	17.39	100%
<i>Smart wearables</i>	15.22	78.26	6.52	100%
<i>Smart book tracking systems</i>	28.26	67.39	4.35	100%
Artificial Intelligence				
<i>Smart assistants</i>	10.87	86.96	2.17	100%
<i>Chatbots</i>	15.22	76.09	8.70	100%
<i>Self-check in/out machines</i>	28.26	71.74	0	100%
<i>Virtual bookings</i>	32.61	67.39	0	100%
<i>Social media monitoring</i>	36.96	54.35	0	100%
Big Data				
<i>Evaluation of library services</i>	32.61	56.52	10.87	100%
<i>Decision making</i>	30.43	54.35	15.22	100%
<i>Understanding of user needs</i>	39.13	52.17	8.70	100%
<i>Social media use evaluation</i>	21.74	65.22	13.04	100%
<i>Identification of trends</i>	19.57	56.52	23.91	100%
<i>Cost reduction</i>	19.57	54.35	26.09	100%
<i>Tool development</i>	26.09	47.83	26.09	100%
<i>Digital preservation methods</i>	19.57	56.52	23.91	100%

When it comes to the impact these emerging technologies have had in academic libraries services, 29 of the 46 participants mentioned that none of them has impacted textbooks or other physical materials (63%), and only 28% have identified some impact from cloud computing. Similarly, 36 out of 46 participants (78%) believe that study rooms, reading areas and group workspaces have not been impacted by any emerging technologies. In the contrary, 41% of the participants have stated that cloud computing technologies have impacted the library catalogue, and 41% that IoT, big data and AI have also impacted it. Also, 43.4% (20 out of 46 participants) support that cloud computing has had a significant impact in institutional repositories. Additionally, a significant percentage of librarians mentioned that there is no impact on supply chain management (82%), and 76% support that none of the technologies has affected their marketing techniques. 36% of the librarians mentioned that cloud computing has affected their collaboration with the users, 39% the communication with faculty, 43% the collaboration with other libraries, and 47.8% the communication and collaboration with their colleagues. In all the

communication and collaboration related operations, the percentages of influence of IoT, big data and AI in these operations rate between 8.7% and 15% (meaning, only 4-7 out of 46 people believe that IoT, big data or AI play a significant role on how they manage their communications and achieve collaboration among stakeholders).

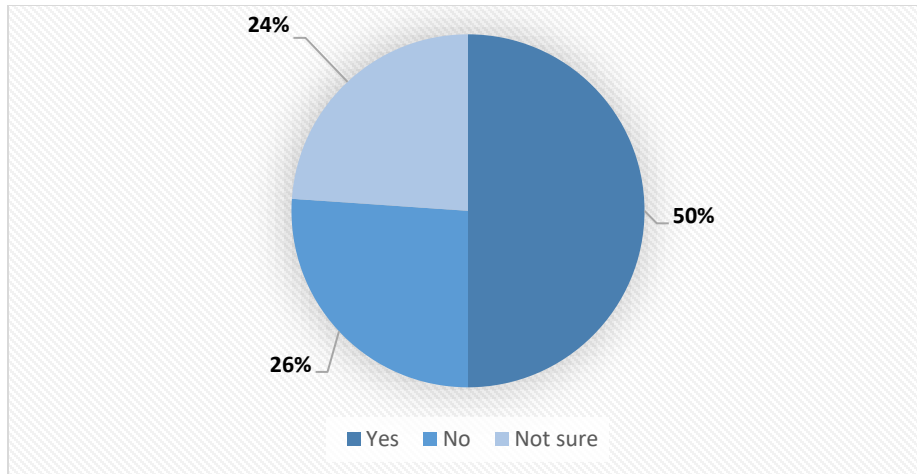
Graph 3. Emerging technologies impact in academic library services



Digital transformation

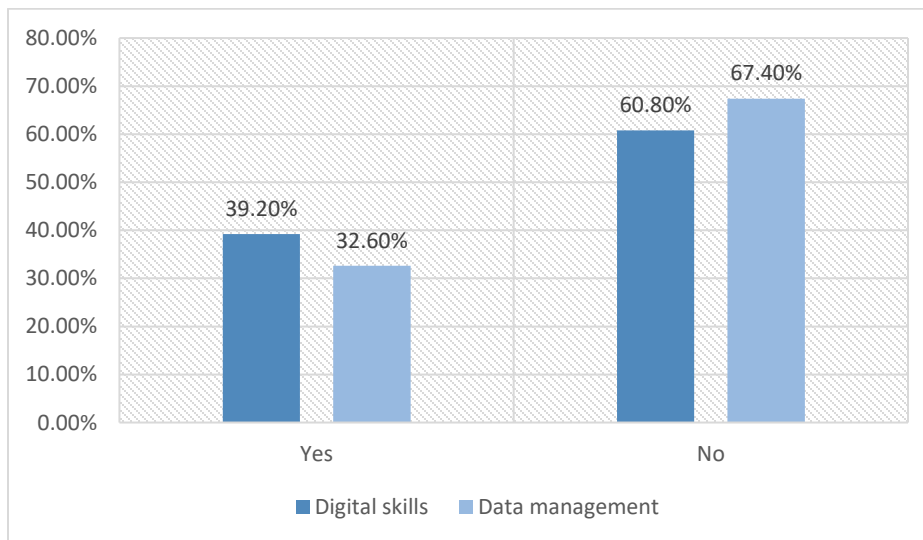
The third part of the questionnaire was developed with a focus in digital transformation readiness, including questions related to people, processes, and culture. Surprisingly, only 50% of the participants mentioned that their library experiences service redesign in terms of digital transformation, while 24% of them were not even sure.

Graph 4. Library services redesign in terms of DT



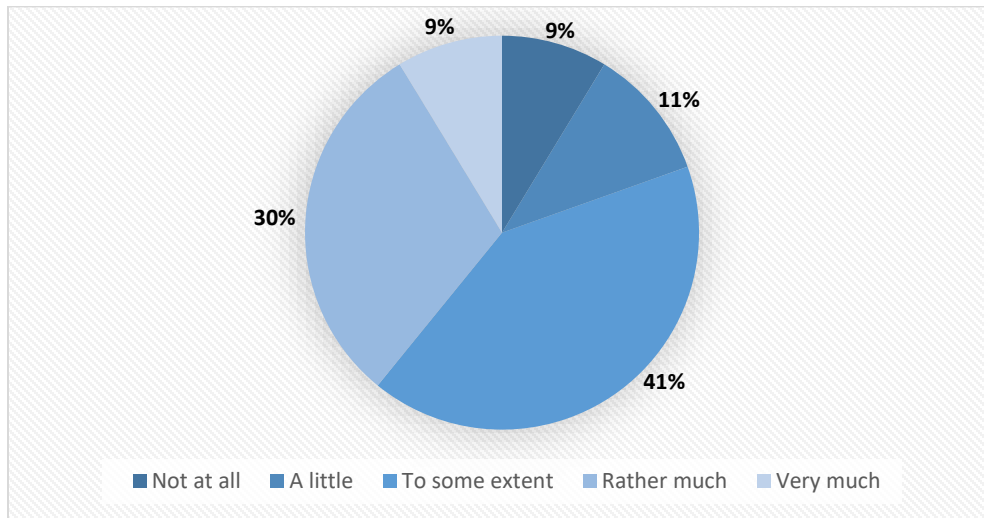
Following on the transformation of people, the below questions aimed to identify whether academic librarians are in the process of acquiring digital skills, or enhancing their already existing capabilities that are required in digital businesses/organisations. As presented in graph 5, 60.8% do not attend any training targeted to digital skills such digital content creation, social media management and analytics, digital marketing, or digital communication and collaboration. The percentage of data management trainings seem to be even lower, although with a small difference, with 67.4% mentioning that they are not involved in any related trainings aiming to the provision of insights for the organisational performance and the establishment of baselines and goals via data management techniques.

Graph 5. Library staff training attendance in terms of DT



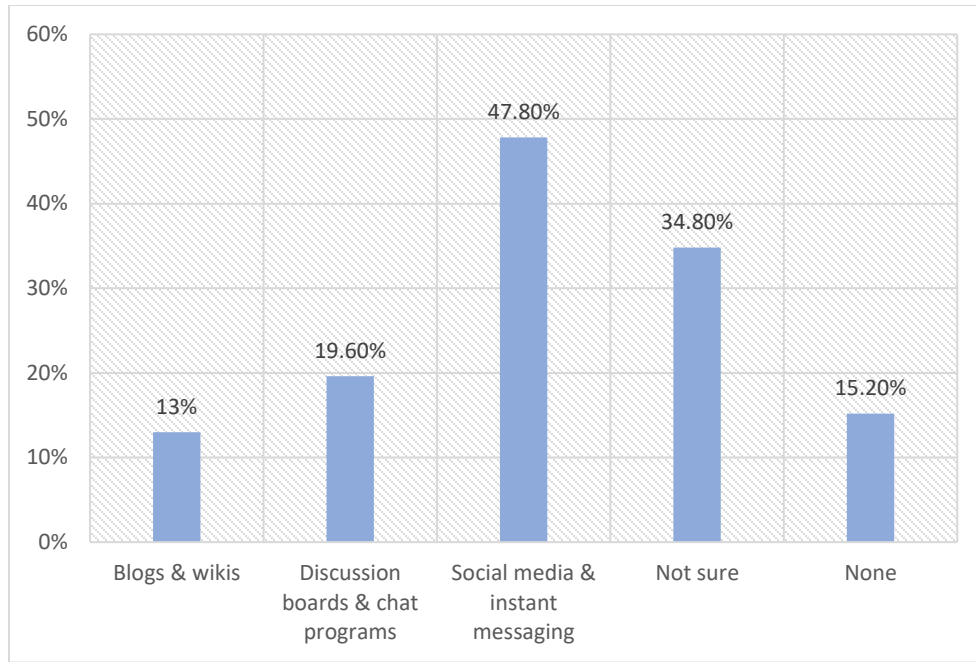
When it comes to the role academic libraries play as intermediaries that need to bridge the gap between technology and their users, 41% of the librarians mentioned they are somewhat involved in this process, 20% were involved to a very small extent or not at all, 30% were quite involved in the process, and only 9% characterized their role as very active.

Graph 6. Involvement in users' digital skills



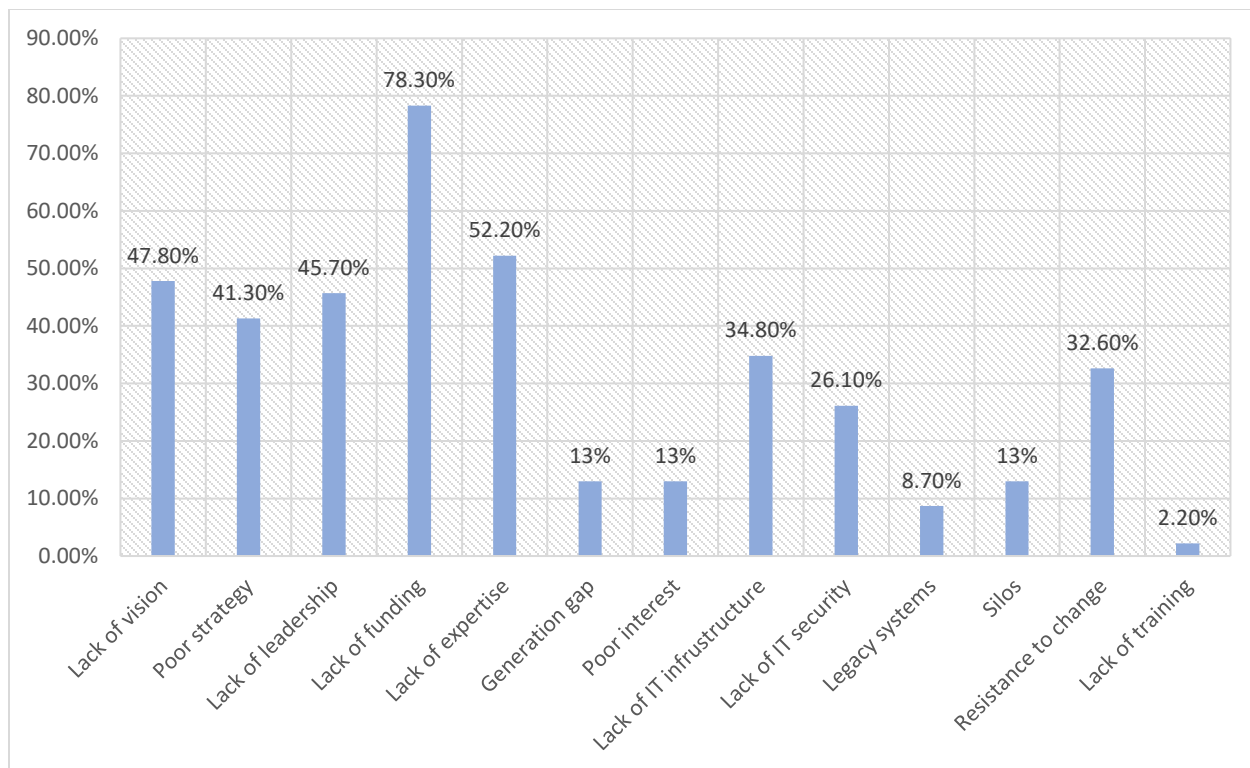
The already experienced digital users though, as well as the new form of research teams that have been largely affected by the digital boost need a structured environment to support their activities. Such activities mainly encompass the provision of services via new channels that have emerged, or the further exploitation of already existing ones. Participants in this research have stated that only 13% of them are taking advantage of related blogs and wikis to reach their new generation users and 19.6% of them use discussion boards and chat programs, while the percentage is significantly higher for the those that use social media and instant messaging as tools for provision of digital services (graph 7).

Graph 7. Support of research activities via new channels



The most important challenge participants have identified as a blocker in digital transformation implementation has been the lack of funding, with a percentage of 78.3%. Right after, lack of expertise follows with a percentage of 52.2%, and lack of vision and leadership have received a significant amount of answers (47.8% and 45.7% respectively). Naturally, poor strategies that follow the lack of vision and leadership have been identified as a barrier of 41.3% of the participants. In opposition to this, some aspects that are considered a bit more technical and later on in the pipeline of the digital transformation process, such as legacy systems and silos, have been identified as barriers by only 8.7% and 13% respectively. Likewise, challenges of insignificant importance appear to be considered the generation gap between users and librarians and the poor interest by employees to be involved in the digital transformation process.

Graph 8. Challenges of digital transformation implementation in Greek academic libraries



In terms of the fear of substitutes, data show that academic librarians are not particularly concerned that they might be superseded by the digital transformation process. Changes to processes seem to be a bit more alarming for them, as 19.6% responded that they are afraid that their role might be excluded from academic libraries in the future due to such changes. But changes to people, culture and related to technology are not similarly alarming for them.

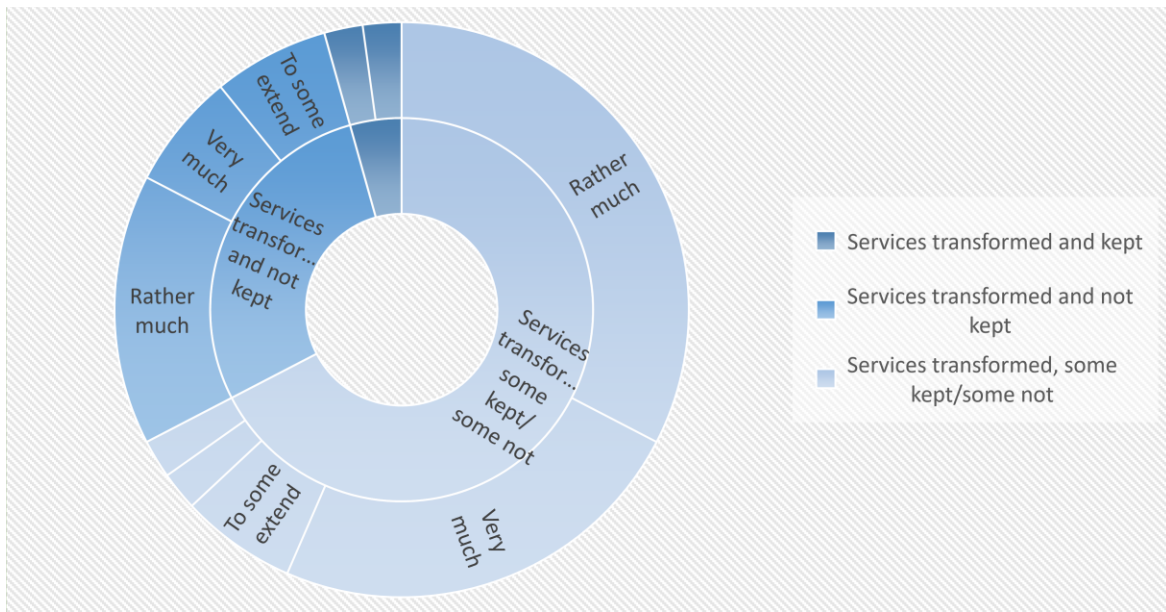
Table 5. Fear of substitute

	Yes	No	Not sure
<i>Changes to people</i>	8.7%	73.9%	17.4%
<i>Changes to processes</i>	19.6%	63.0%	17.4%
<i>Changes to culture</i>	6.5%	63.0%	30.5%
<i>Technological changes</i>	8.8%	65.2%	26.0%

Finally, as Covid-19 is considered a significant milestone towards the transformation of many businesses, the last two questions aimed to the participants identifying the impact this period has played on the provision of their services. As seen in table 6, 50% of the participants mentioned that their services were transformed quite enough, 30.4% that they were transformed a lot, and

13% that they were medium impacted, while only 6.6% stated that there was no change at all in their operations. Furthermore, participants were asked whether the redesign they experienced was kept after the operations returned to the physical spaces, and only 4.3% mentioned that it did. 28.3% stated that all operations returned to their previous format, and 67.4% that some operations were found to be useful when redesigned to remotely serve users and were kept this way, while some others returned to the previous format for practical reasons.

Graph 9. Covid-19 and transformation and upkeep of services



DISCUSSION

Data gathered during this research lead to noteworthy conclusions related to the levels of use of emerging technologies in academic libraries in Greece, as well as to digital transformation readiness. To begin with, most participants in the research were aged between 42-57 years old, and 63.1% of the participants have been working in academic libraries for over 16 years. Combined with the fact that the average use of emerging technologies related to cloud is 54%, we reach the conclusion that librarians strive to build upon skills related to the technological evolutions of the last decade, which have been tremendous. For emerging technologies related to IoT, AI, and big data the average use is even smaller, with 19.5%, 24.7% and 26% respectively. These technologies

usually require extended economic investment, something that academic libraries in Greece are having a hard time with the last decade [Papadaki & Kostagiolas; 2014].

Analyzing the academic institute from which participants are from, we observe that some institutes' participation in research was rather low, compared to the number of staff the library has. For example, the participation rate for the University of Macedonia was 40%, while for the University of Thessaly it was only 4.6%. Hence, it would be rather unsafe to proceed with further analysis per institution, as for most institutions the participation rate was quite low.

Most participants of the study mentioned that they are mainly occupied in customer service positions. As in academic libraries in Greece it is rather common that one person is involved in more than one responsibility areas, this question was a multiple choice question allowing more than one answers. Hence the results that accrue from this analysis give insights more on the areas that are more common for a librarian to work on, rather than creating a clear distinction of how many people are occupied per post or expertise. Surprisingly, the percentage of people being involved in OA initiatives and information literacy is really low (2.2% per each case), while such actions should actually be among the top priorities of academic libraries wanting to approach and satisfy the needs of the new generation of users, who are technologically qualified and utilize information by various sources [Frey, 2010].

In terms of emerging technologies, participants seem to be generally more experienced with cloud computing. In detail, 87% of librarians mentioned that file sharing is used in their daily workflows, 67.4% that they use online calendars, 70% that cloud based information collection tools have been implemented in regular workflows, 76% are aware and use cloud-based document editing tools, and 57% prefer online presentation services. Online video services such as Vimeo are also quite common (58%), something that is not equally followed though in terms of cloud-based image editing and marketing tools. For cloud particularly, results are quite satisfactory as cloud services are now necessary to achieve effective collaboration and communication among all stakeholders involved in an organisation: colleagues, users, suppliers, and other collaborators. A bit more effort could be pursued in marketing related operations, though generally this feature is not among top priorities for academic libraries in Greece.

During the last decade, library management systems, policies and procedures that operate under a central infrastructure in terms of an Integrated Library System have been (IISAS) integrated in 26 academic libraries in Greece (including university libraries and technological

institute libraries), by Uni Systems [Uni Systems, 2022]. This initiation was completed in an effort to conserve resources and give instructors, library staff, and students better support services, making a step towards smart libraries with objects capable of transferring data without human intervention. The baseline of this initiation included the integration of RFID technologies in library materials, which usually include smart book tracking systems within the library space, via self-scanning. Surprisingly though, 67% of the participants in this study mention that they do not use smart book tracking systems. This statement brings up the conclusion that either libraries do not use these systems up to their full potential, or that the librarians are fully aware of the capabilities provided by the smart systems implemented in their library. To add in this conclusion, 71% have responded that they do not offer the self-check in/out service in terms of AI implementation in academic libraries, while this service is also supported by RFID technology with a simple addition of the corresponding infrastructure – a self-check in/out machine.

Use of big data in academic institutions could now be considered indispensable, as academic and other institutions produce a tremendous amount of intricate data. In their effort to handle big data internally and use it to create services, libraries face new difficulties. In most cases, libraries will not have the knowledge or the technical skills to develop new services on their own. Libraries have traditionally been information handlers and early adopters of technology; hence, the context in which they operate is undoubtedly impacted by big data technologies [Garoufallou & Gaitanou, 2021]. According to this research, libraries are just starting to realize the importance of big data for such initiatives, as an average of 26% have already implemented big data technologies in their workflows for decision making, evaluation of services, identification of user needs and search trends, cost reduction and tool development, and 32% of the participants have attended training related to data management. Evaluating the individual responses related to data management though, it is observed that the percentages of implementation in evaluation of library services, decision making and understanding user needs are higher (32.6%, 30.4% and 39.1% respectively), while the percentage for identification of search trends and digital preservation methods is significantly lower (19.6% in both cases). Hence, this could be associated with the conclusion of Decker [2021] and Hunter [2020], where even under pressure to serve more digital users' libraries had focused on the transfer of their services in the digital environment, rather than on how to reform them and gain insights from the data that derive via this process. Consequently, most

academic libraries have yet to realize the opportunities raised by the implementation of such technologies and the investment to build relevant skills internally.

Participants were also asked which of these emerging technologies have impacted academic library services and operations, such as textbooks and other materials, the library catalogue, reading areas, institutional repositories, supply chain management, communication/engagement with patrons, communication/collaboration with colleagues, communication with faculty, communication/collaboration with other libraries, and relationships with associations. Generally, in all operations related to collaboration and communication with other stakeholders, most participants gave weight in the use and implementation of cloud. Percentages related to AI and big data implementation in catalogue (19%) or repository services (28%) were somewhat popular, though their impact recognition still remained low for other services, especially for supply chain management (only 6.5%). Considering that this area can be largely benefited from data extraction when moving operations to the digital environment, this leads to the inference that there are huge potentialities for the organisational transformation via emerging technologies that remain unexploited.

When identifying and describing the occurrence of digital transformation, a sizable segment of the literature is related to the technologies that distinguish such initiatives, while a rather smaller part of work tackles the shift or transformation in other organizational terms. The organisational change, or redesign framework, should be taken into account as a larger context for the digital transformation of an organization. The interdependence of important elements, including strategy, structure, procedures, human resources, culture, and leadership, is emphasized by a number of well-established models of organizational design [Fabac, 2021]. Also, supposing that we accept the statement that digitalisation is a prerequisite to proceed with the digital transformation of an organisation [Jedynak et al., 2021; and Ostmeier, 2022], results from the emerging technologies section already foreshadowed that further effort needs to be made to achieve digital transformation.

Moving on to further considering the aspects of strategy, structure, procedures, human resources, and leadership, the third section of the questionnaire aimed to identify the perceptions of currently active academic librarians in terms of current transformation efforts, their personal participation in those efforts, and the challenges they currently identify. To begin with, 50% mention that their organisation has experienced some kind of redesign in terms of digital transformation, fact that is also supported by the participants answers that during the Covid-19

pandemic organisational services were per 50% rather much redesigned, and per 30% very much redesigned.

In current organisations, digitalization and digital transformation represent a new concept that leads the drive for improved performance and competitive advantage. Despite this fact, the acquisition of knowledge by people, groups, and organizations throughout the digital transformation modifies the roles and responsibilities of all employees levels, and technology is one of the primary environmentally driven sources that enable this organizational change [Fabac, 2021]. During this process, there is a long and expanding list of digital roles and responsibilities. There are currently roles such as chief digital officers, digital managers, digital marketing experts, and digital engagement specialists [Kane et al., 2016]. Hence, people that are already occupied in organisations that plan to implement digital transformation need to enhance their related digital skills, in order to avoid communication gap and be able to benefit to the full potential both as employees, and as part of the organisation. In this research, 39.2% of the participants responded that they have attended training related to digital skills, including digital content creation, social media management and analytics, digital marketing, and digital communication and collaboration. Additionally, 32.6% are those that have attended training related to data management to be able to better understand and analyze the organisational performance and allow the establishment of baselines and goals. These percentages do not state highly motivated or rapid change in people to achieve digital transformation, fact that contradicts a bit with the 2.2% rate of lack of training being considered a challenge for digital transformation.

According to Shaughnessy [2018], values and work flow taken into consideration for digital projects are conceivable to create new sets of practices that concentrate on developing multi-layered, daily innovation delivery. Few leading companies have already embraced the principles of FLOW-Agile, as this approach is called, which is an variation of the Agile framework created to allow small teams to complete rapid iterations of projects that are customer oriented, in order to facilitate the cultural and technical changes that are a hallmark of successful digital transformation. For academic libraries in particular, in terms of their capacity as social institutions, they are entitled to promote awareness and access to the most recent and valid information. However, users may not always reach the most accurate and trustworthy sources, due to the numerous information sources and the confusion multiple communications channels may create. Hence, academic libraries are also responsible for equipping the research and the broader community with the

appropriate skills and qualifications to overcome these information obstacles. In this case, the results of the research are quite satisfactory, as 41% of the participants responded that they are involved to some extent in transforming their users digital skills, 30% are rather much involved, and 9% very much.

Academic library services and their processes are frequently revised slowly and systematically driven by redirecting objectives or the development of new technologies, and changes in demands stated from the user's perspective [Goddard, 2020]. The use of smart student assistants though and structured environments for the provision of reference services, such as chats and wikis, is essential in the era of digital users and it should not be considered that devalues the expertise of professional librarians [Goss and Decker, 2022]. Besides, especially during the Covid-19 outburst the shift to further digital communication channels has been essential for libraries to demonstrate their value to the community, by the continuous offer of their resources to users with the purpose of their uninterrupted information and entertainment. The use of further digital communication channels such as LibChat, LibAnswers, wikis and blogs, FAQs, and even the use of social media and instant messaging, provided immediate and direct communication for academic libraries to assist their users in reaching the most of their resources [Goddard, 2020].

Most libraries have already been active in such communication channels, though the pandemic situation and the lockdowns that brought physical access restrictions provided an excellent opportunity for the libraries to promote such actions and participate in the digital shift research community has also started to show off. Participants in this research mentioned that as part of the digital communities' research teams have formed, their libraries are currently being involved per 47.8% in social media and instant messaging channels, 19.6% use discussion boards and chat programs, and 13% use blogs and wikis in terms of reaching their digital communities and providing quality services in a more structured environment.

The digital transformation process is typically iterative and frequently necessitates quick adaptation through a participatory approach. Strong leadership, an adaptable and scalable core, and a distinct focus on user interaction and digitized solutions are requirements to be successful in digitally transforming an organisation. In many cases, issues associated with legacy IT infrastructure have been identified, a fact that requires prompt solution for businesses to succeed in the digital era. Management and leadership must maintain their attention on how they employ the knowledge gained from the data and inspire, and align employees under the same scope, while

setting their strategic goals by taking into account data that accrue from this process [Schneider and Kokshagina, 2021].

Similarly, participants in this research have identified that poor leadership, lack of vision, and poor strategies are among the greatest challenges an organisation can come up with during their digital transformation journey. The fact that poor leadership has been identified as a significant challenge is important, as librarians recognize that digital transformation comes from radical changes in people and culture of an organisation. Lack of funding though still seems to remain in the first blocker, followed by lack of expertise, probably due to the fact that most academic libraries in Greece remain understaffed and staff feels that they have not achieved the level of digitalisation as a prerequisite to exploit the potentialities it offers to proceed with digital transformation. On the contrary, legacy systems and silos seem to be considered of low importance, something that comes as a natural conclusion if we think that libraries worldwide have radically changed the way they operate and serve users during the decades of digital evolution. The integration of computer systems, efforts for unified catalogues and use of international standards, are only a small example of leaps that have been successfully achieved. Silos and legacy systems still exist of course, though resistance to change seems to be relatively low compared to the average of businesses (32.6% in this research, while according to Forbes businesses tend to fail in their change programs per 70%, due to employee resistance) [Kogan, 2020].

Approaching digital transformation is a socio-cultural process, it is translated as an effort to change the organization's thinking and culture while ensuring that technology is used to maximize the organization's effect. During this process, the clever integration of digital technologies, reformation of processes, and competences across all levels and functions of the organization, it aims to achieve to the cultural, organizational, and operational change of an organization. Librarians seem to generally feel low levels of fear substitute when it comes to changes in people, culture, and technology, hence we can conclude that there is a significant number of professionals that comprehend the opportunities that deluge from digital transformation and believe that this process will positively affect the operation of the organisation and the provision of services. Changes to processes though seem to rise a bit bigger concern, probably due to the fact that as organisations rethink their processes they present the tendency to reform them in a way that it is simpler (step elimination), and faster. Hence, people might assume that some expertise among the current ones in the library landscape might eclipse.

It is undeniable that in order to achieve transformational change an organisation aims to understand that he ought to be part of the societal and cultural change too. Although the pandemic has played a crucial role in the transformation of services, it seems that the hustle of reforming the services with a more digital mindset has not been enough to achieve radical and consistent transformation, as when returning to the physical spaces many libraries returned to their previous models of offering services [Decker, 2020]. Similar seems to have been the case for academic libraries in Greece, as 80.4% have responded that their services have been rather much/very much reformed during the pandemic, though only 4.3% mentioned that they have permanently adopted the new models and operation procedures. To further add to this conclusion, 28.3% of the participants mention that services completely returned to their previous format. There is still a percentage of 67.4%, which has been trying to balance achieving digital transformation and adjusting the models as the best possible way to correspond to the users needs. This percentage has identified that the new operation procedures have had beneficial effect with the communication of the digital society and researchers, and hence has kept those services that have been successfully transformed in their new form, while returning to the previous operations for those that deemed appropriate.

Limitations

This research has two limitations. In the first place, the sample of participants is quite limited considering that only 1/6 of the people contacted participated in the research. Further participation could provide better and more accurate insights to the purpose of the research. Secondly, if a bigger sample is provided, further analysis in search of correlations could be done, to identify whether there is any important linkage among answers related to how often people use emerging technologies, and how deeply they comprehend the term and challenges of digital transformation.

CONCLUSIONS

Technological evolutions have brought up multiple challenges for libraries as educational and cultural organisations. Alongside museums and archives, libraries have faced the difficulty of digitalisation and availability of digitized materials, which has had substantial impact on their

operation models and overall activity. Acting as digital ambassadors, libraries are expected to set the route for inclusion and empowerment in their societies, as well as promoting participation and open culture. At the same time, networking, communication and collaboration, and information sharing remain on the top expectations of their users, while seeking interaction via multiple media and digital channels. Such cases requisite the development of effective alternative operational models and services, and to a further extend the overall reformation of the organisational culture, to be able to meet the constantly changing requirements of the demanding audiences.

Digitalisation has inevitably brought notable changes in the role of academic libraries in particular, as the emergence of new technologies and electronic materials, digital libraries and repositories, automated library systems, and open access have created a completely new setting for them to operate. The roles of professionals have evolved to meet the demands of this setting, requiring a completely new set of skills specialized on digital related material and activities [Walek, 2018]. Libraries seem to continuously evolve to effectively correspond to the demands of the new environment, by constantly updating their technologies, processes, and even their products, while at the same time significant effort is being done for the librarians to stay up to date and developing their digital skills.

Both literature and the results of this research have indicated that constant efforts are being done for the emergence of new technologies. In case of Greek academic libraries, the high importance being given in cloud computing could be justified by the fact that not only it is valuable for enhancing collaboration and communication among stakeholders, but most importantly, many cloud computing services/features are available without financial commitment, a matter that Greek academic libraries are highly concerned with. Librarians are quite familiar with further important emerging technologies, such as IoT, AI, and Big Data, even if such technologies are not incorporated in their daily processes to a great extent. Especially in the cases of IoT and AI, which are usually high cost enabled technologies, results of being used as enablers for expanding libraries' operations are quite limited.

Digital transformation is also a term that deeply affects the perspective of the organisational culture and structure, though comes bearing different challenges as the focus of this process is more people centric. A successful example to better understand the demands of digital transformation within the context of libraries, is the one of National Library of Greece (NLG) transition to the Stavros Niarchos Foundation Cultural Center (NSF). NLG has gone through a

significant transformation before its relocation during 2015-2018, with the collection being digitized, services being digitalized, and people being trained and reskilled to fit within the digital culture context of the foundation. The overall process was granted by 5€ million for the development of initiatives related to collection development and transition to the new building, digital services development, public library department remodeling, audience expansion and staff training, all within the framework of the transition program [Elmaloglou et al., 2019].

Before moving on with the transition program, part of the NLG's electronic recourses were only available via the Hellenic Academic Libraries Link Consortium (HealLink), there was limited acquisition of foreign bibliography, IT infrastructure was outdated, NLG did not have a dedicated communications department, and NLG provided limited support to researchers. On top of all, NLG was understaffed with half of the employees being teachers instead of librarians, and 1/5 of the librarians occupied in the NLG were one-step before retirement, hence there was limited capacity to invest in training and digital skills development. The transition program included the development of a new digital page to represent the cultural foundation, the development and reorganization of collections, the modernization of services, the design of new services within the framework of digital transformation, the inclusion of related trained staff and the appropriate training of the current staff, and finally, the expansion of audiences focuses on inclusiveness of various groups [Elmaloglou et al., 2019].

Throughout this process, the Transition Task Force utilized a human-centered approach for the process design, integrating organizational change principles with a significant community participation element, supported by the organization's broader digital transformation. In an effort to modernize the NLG's definition of "public services," user requirements were positioned at the center of the service design process, and participatory leadership was tested in real-world settings. The Transition Program enabled participating actors to embrace complexity, unlock creativity, and co-create new possibilities by bringing together a constellation of partners and specialists from diverse disciplines who were motivated by a noble cause and a shared goal. Adopting a lean management style in this framework was crucial for dealing with the unknown aspects that arose during deployment. The NLG's visionary leadership and the SNF's supportive funding structure greatly increased the possibility of systemic reform [Elmaloglou et al., 2019].

Preparing the library staff to effectively address the expanded and complex operating demands at the new facilities, was another goal set. Transition workshops were held on a monthly basis in

order to assist organizational change, providing the chance to disclose concerns, deal with interpersonal problems, talk about ongoing initiatives, offer solutions, and strengthen goal alignment. In order to keep all staff adequately informed about projects' implementation, outcomes, and overall progress, to familiarize them with the new services under development, and to provide a platform where they could express questions and interest in joining particular Project Teams, weekly mutual learning sessions with presentations by various contractors and partners were also organized. Despite the initial opposition to change, the framework for cross-sector collaboration was developed successfully, via participatory leadership, the establishment and use of co-working tools throughout the Program's implementation, and by creating of relationships of trust. Online project management and communication tools (such as Basecamp, Google Docs, and Skype) were used to enable remote and collaborative work between the contractors and the library staff and to hasten decision-making processes in addition to daily presence and regular meetings with staff across NLG buildings. Given that the NLG has never utilized such tools at the organizational level, the Transition Program's contribution to improving internal procedures and increasing project management capability is of utmost significance [Elmaloglou et al., 2019].

Considering this successful example of the Transition Program, where technical infrastructures are expanded, staff skills are improved, and a new set of services and programs for the public have been developed, we can identify a few gaps between Greek academic libraries and digital transformation. Numerous factors were already classified by the participants of this research, such as the lack of vision, leadership, and effective strategies, but most importantly, the lack of funding. Digital transformation offers a chance to provide extra value to the organisations, and adjust to changing market demands while enhancing its capacity, something that should be deeply comprehended by the organizations' leadership in the first place. Furthermore, transitioning to a digital operational model increases competence, limits down the time and cost of operation, while enhancing stakeholders relationships and provides further capacity for employee and user satisfaction. Though taking under consideration the fact that this is a people-centric process that it is enabled via the implementation of digital technologies, it requires strong leadership and unwavering vision, as well as insightful management to align people under the same scope.

Further research

This study is an attempt to define the levels of acquaintance with emerging technologies in terms of digitalisation in Greek academic libraries, as well as forms an initial approach to the understanding of digital transformation as a term. As digitalisation refers to information processing and transfer to a digital format, it influences every human activity while providing a complete new set of possibilities and assets related to information availability and distribution. As a consequence, digital transformation as a socio-cultural process will be inevitable in a few years, with some organisations being the fast movers whilst others may strive to modernize accordingly.

Results of this study have indicated that there is room for improvement in terms of the digital skills related to the emerging technologies, though most academic libraries are already in the process of implementing some of them in their workflows. Additionally, academic libraries have made a few steps towards a more digital mindset before and during the pandemic, though it would not be valid to support that cultural change towards digital transformation has been completely concurred. For further research, an extended deep dive into opinions related to the reasons why libraries are not yet ready to form a digital culture and adopt a digital mindset could be done. Additionally, pre- , during, and after- Covid-19 standard operating procedures could be analyzed, as an example of what worked well during transforming their processes and the reasons why some of them have failed.

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APPENDIX I

Research Questionnaire

Digitization and digital transformation in academic libraries in Greece

This questionnaire was designed in terms of my MSc thesis in E-business and Digital Marketing. The questionnaire aims to identify which emerging technologies academic libraries in Greece are familiar with, and how these technologies have impacted the library services. Additionally, it aims to recognize the levels of awareness and readiness for digital transformation in academic libraries, and the barriers according to academic librarians opinion.

Participation in the survey is voluntarily and anonymous, and data gathered will be used only for the purposes of the research.

Thank you in advance for your time!

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Demographics

1. Please state your gender
 - Male
 - Female
 - Other/prefer not to say
2. Please state your age
 - <25
 - 26-41
 - 42-57
 - 58-67
 - >68
3. How many years have you been working in an academic library?
 - <4
 - 6-10
 - 11-15
 - 16-20

>21

4. Which academic library are you currently working in?
Drop down list ...
5. What position are you currently occupied in?
Customer service (front desk librarians, reference librarians, research librarians, etc.)
Technical service (cataloguing, classification, order requests, subscriptions, etc.)
Collection development (acquisitions, withdrawals, etc.)
Electronic resources/online databases
Archives/Special collections
System development (library management systems)
Administration/Management
Marketing/Outreach/Programs
Other (please specify) _____
6. How many librarians are working in your library on a permanent basis?
Solo librarian
2-4
5-7
8-10
>11

Emerging technologies

7. How familiar are you with the below terms and technologies?
- | | | | | | | | |
|------------------------------|---|---|---|---|---|-----------|--|
| Artificial intelligence (AI) | | | | | | | |
| Not at all | 1 | 2 | 3 | 4 | 5 | Very much | |
| Cloud computing | | | | | | | |
| Not at all | 1 | 2 | 3 | 4 | 5 | Very much | |
| Internet of things (IoT) | | | | | | | |
| Not at all | 1 | 2 | 3 | 4 | 5 | Very much | |
| Big data | | | | | | | |
| Not at all | 1 | 2 | 3 | 4 | 5 | Very much | |
8. Do you use any of the following types of Cloud computing in your workflows?
Sharing files (Google Drive, Dropbox)
Video services (YouTube, Vimeo)
Information collection services (Google Forms, Survey monkey)
Cloud-based calendar (Google calendar, Outlook calendar)
Online presentation services (SlideShare, Canvas)
Document editing (Google docs)
Online image editing services (Pic Monkey)

Cloud-based marketing/dissemination services (Mailchimp, Moosend)

9. Do you use any of the following types of AI in your workflows?
Smart assistants
Chatbots
Self-check in/check out machines
Virtual bookings
Social media monitoring
10. Do you use any of the following types of IoT in your workflows?
Smart heating/cooling systems
Smart security systems
Smart wearables (e.g., bands/cards that gather user data while in the library)
Smart book tracking systems
11. Big Data technologies are used to analyze, process and extract information from extremely complex and large data sets. These might include preparation, processing, data mining, etc.
Do you use any Big Data technologies for the following operations?
To evaluate and enhance library services
To take decisions related to collection development
To better understand researcher's needs
To evaluate the library's SM impact
To identify searching trends
To reduce operation costs
To develop new tools for the users
To develop digital preservation methods
12. Which these emerging technologies have impacted the below services?
- | | | | | |
|---|-------|-----|----------|------|
| Textbooks & other material | | | | |
| AI | Cloud | IoT | Big data | None |
| Library catalogue | | | | |
| AI | Cloud | IoT | Big data | None |
| Reading areas/study rooms | | | | |
| AI | Cloud | IoT | Big data | None |
| Institutional repository | | | | |
| AI | Cloud | IoT | Big data | None |
| Supply chain management | | | | |
| AI | Cloud | IoT | Big data | None |
| Marketing | | | | |
| AI | Cloud | IoT | Big data | None |
| Communication/engagement with patrons | | | | |
| AI | Cloud | IoT | Big data | None |
| Communication with faculty | | | | |
| AI | Cloud | IoT | Big data | None |
| Communication/collaboration with colleagues | | | | |
| AI | Cloud | IoT | Big data | None |

Communication/collaboration with other libraries				
AI	Cloud	IoT	Big data	None
Relationships with associations/committees				
AI	Cloud	IoT	Big data	None

Digital transformation

To proceed in the following section, please take a look on the differences among the concepts of digitisation, digitalisation and digital transformation.

Digitisation is the technical process where analog data and processes are converted into a machine-readable format (e.g., paper forms to web forms).

Digitalisation is a socio-technical process where the use of digital technologies, data, and inter-connections result in new activities, or in changes in the existing activities of an organisation.

Digital transformation on the other hand, is a socio-cultural process. It refers to the cultural, organisational and operational change of an organisation, through a smart integration of digital technologies, processes and competencies across all levels and functions of the organisation. Its major focus is to transform the mindset and culture of the organisation, to ensure that technology is deployed to maximise the impact of the organisation.

13. Has your library experienced any service redesigning in terms of DT? (such as counseling centers, practice spaces, increased access to digital facilities, provision of services via the internet, etc.)
 Yes No Not sure

14. Do library staff attend any special training targeted to digital skills (digital content creation, social media management & analytics, digital marketing, digital communication & collaboration, etc.)?
 Yes No

15. Data are of great importance for organisations, as they provide great insights for the organisational performance and allow the establishment of baselines and goals. Do library staff attend any special training targeted to data management?
 Yes No

16. To what level is your library involved in transforming the digital skills of its users?
 Not at all 1 2 3 4 5 Very much

17. Research teams have become more digital and they need a structured environment to support their activities. Has your library been involved to any of the following actions, as part of the digital communities research teams have formed?
 (please check all that apply)
 Yes, in blogs and wikis
 Yes, in discussion boards and chat programs
 Yes, in social media and instant messaging

No
Not sure

18. What were/are the biggest challenges when implemented/planning to implement DT in your library?

Lack of vision and understanding of possibilities

Poor strategy/policies

Lack of digital leadership and management support

Lack of funding

Lack of expertise and digital skills

Generation gap (between librarians & students)

Poor interest in technology

Lack of IT infrastructure

Legacy systems

Lack of IT security and support

Silos (isolated systems that do not communicate/exchange information)

Resistance to change

Other (please state)_____

19. Are you afraid that your position might be excluded from academic libraries due to the following?

Changes to people (substitution with people with a digital mindset or with more digital skills)

Changes to processes

Changes to culture of the organisation

New technologies merge

20. To what level were services reformed in your library in order to correspond to the demands of its users during the Covid-19 lockdowns?

Not at all 1 2 3 4 5 Very much

21. Did your library return to its pre-Covid operations after the lockdowns?

No, services were reformed to remotely respond to users' needs and are kept this way

Yes, since users physically returned to the library services are operated as they were before Covid-19

Some services returned to their previous form, some of them are still operated digitally

APPENDIX II

Data analysis

* Set paths

```
qui global maindir "C:\Users\Documents\Xrysa\  
qui global dopath "${maindir}do-files" // do-files  
qui global dtadir "${maindir}dta-files" // dta-files  
qui global logdir "${maindir}log-files" // log-files  
qui global pdfdir "${maindir}pdf-files" // pdf-files  
qui global pngdir "${maindir}png-files" // png-files  
qui global xlsxdir "${maindir}xlsx-files" // excel-files
```

* Translate data from XLSX to DTA

```
qui drop _all  
set more off  
qui cd "${xlsxdir}"  
qui import excel using "Untitled form (Responses).xlsx", sheet("Form responses 1")
```

* Rename variables

```
qui rename (A-BG) (Time Q1_Gender Q2_Age Q3_Experience Q4_Library Q5_Position ///  
        Q6_Permanent Q7a_Familiar_CloudComp Q7b_Familiar_Inet Q7c_Familiar_AI ///  
        Q7d_Familiar_BigData          Q8a_Cloud_FileShare          Q8b_Cloud_Video  
        Q8c_Cloud_InfoCollect ///  
        Q8d_Cloud_Calendar Q8e_Cloud_OnlinePres Q8f_Cloud_Editing Q8g_Cloud_Image ///  
        Q8h_Cloud_Marketing Q9a_IoT_HeatCool Q9b_IoT_Security Q9c_IoT_Wearables ///  
        Q9d_IoT_Tracking Q10a_AI_Assistant Q10b_AI_Chatbot Q10c_AI_SelfCheck ///  
        Q10d_AI_VirtualBook Q10e_AI_Social Q11a_BigData Q11b_BigData Q11c_BigData ///  
        Q11d_BigData Q11e_BigData Q11f_BigData Q11g_BigData Q11h_BigData ///  
        Q12a_EmTech  Q12b_EmTech  Q12c_EmTech  Q12d_EmTech  Q12e_EmTech  
        Q12f_EmTech ///
```

Q12g_EmTech Q12h_EmTech Q12i_EmTech Q12j_EmTech Q12k_EmTech
Q13_DgtRedesign ///
Q14_Train_DgtSkills Q15_Train_DataM Q16_Involvement Q17_Dgt Q18_Dgt ///
Q19a_Exclusion Q19b_Exclusion Q19c_Exclusion Q19d_Exclusion Q20_Covid
Q21_Covid)

* Clean data

qui drop in 1/1

qui gen id = _n

qui order id

* Set global macro

qui global ALL_QUESTIONS ///

Q1_Gender Q2_Age Q3_Experience Q4_Library Q5_Position ///

Q6_Permanent Q7a_Familiar_CloudComp Q7b_Familiar_Inet Q7c_Familiar_AI ///

Q7d_Familiar_BigData Q8a_Cloud_FileShare Q8b_Cloud_Video

Q8c_Cloud_InfoCollect ///

Q8d_Cloud_Calendar Q8e_Cloud_OnlinePres Q8f_Cloud_Editing Q8g_Cloud_Image ///

Q8h_Cloud_Marketing Q9a_IoT_HeatCool Q9b_IoT_Security Q9c_IoT_Wearables ///

Q9d_IoT_Tracking Q10a_AI_Assistant Q10b_AI_Chatbot Q10c_AI_SelfCheck ///

Q10d_AI_VirtualBook Q10e_AI_Social Q11a_BigData Q11b_BigData Q11c_BigData ///

Q11d_BigData Q11e_BigData Q11f_BigData Q11g_BigData Q11h_BigData ///

Q12a_EmTech Q12b_EmTech Q12c_EmTech Q12d_EmTech Q12e_EmTech

Q12f_EmTech ///

Q12g_EmTech Q12h_EmTech Q12i_EmTech Q12j_EmTech Q12k_EmTech

Q13_DgtRedesign ///

Q14_Train_DgtSkills Q15_Train_DataM Q16_Involvement Q17_Dgt Q18_Dgt ///

Q19a_Exclusion Q19b_Exclusion Q19c_Exclusion Q19d_Exclusion Q20_Covid

Q21_Covid

* Open log-file

qui log using "\${logdir}/Results_Tables.log", replace

*

* Part 1/3: One-way tables

*

* Create all tables

foreach question in \$ALL_QUESTIONS {

 di " "

 di "***** `question' *****"

 tab `question'

 di " "

 di " "

 di " "

}

break

*

* Part 2/3: Two-way tables

*

* Q14 + Q17

tab Q17_Dgt Q14_Train_DgtSkills

* Q11 + Q15

```

foreach Q11 in Q11a_BigData Q11b_BigData Q11c_BigData Q11d_BigData ///
    Q11e_BigData Q11f_BigData Q11g_BigData Q11h_BigData {
    di " "
    di "***** `Q11' vs. Q15_Train_DataM *****"
    tab `Q11' Q15_Train_DataM
    di " "
    di " "
    di " "
}
break

```

* Q21 + Q8-11

```

foreach Q_ in Q8a_Cloud_FileShare Q8b_Cloud_Video Q8c_Cloud_InfoCollect ///
    Q8d_Cloud_Calendar Q8e_Cloud_OnlinePres Q8f_Cloud_Editing Q8g_Cloud_Image ///
    Q8h_Cloud_Marketing Q9a_IoT_HeatCool Q9b_IoT_Security Q9c_IoT_Wearables ///
    Q9d_IoT_Tracking Q10a_AI_Assistant Q10b_AI_Chatbot Q10c_AI_SelfCheck ///
    Q10d_AI_VirtualBook Q10e_AI_Social Q11a_BigData Q11b_BigData Q11c_BigData ///
    Q11d_BigData Q11e_BigData Q11f_BigData Q11g_BigData Q11h_BigData {
    di " "
    di "***** Q21_Covid vs. `Q_' *****"
    tab Q21_Covid `Q_'
    di " "
    di " "
    di " "
}
break

```

* Q13 + Q14-17

```

foreach Q_ in Q14_Train_DgtSkills Q15_Train_DataM Q16_Involvement Q17_Dgt {
    di " "
    di "***** `Q_' vs. Q13_DgtRedesign *****"
}

```



```
    tab `Q_' Q13_DgtRedesign
    di " "
    di " "
    di " "
}
break
```

```
* Q19 + Q2
```

```
foreach Q_ in Q19a_Exclusion Q19b_Exclusion Q19c_Exclusion Q19d_Exclusion {
    di " "
    di "***** Q2_Age vs. `Q_' *****"
    tab Q2_Age `Q_'
    di " "
    di " "
    di " "
}
break
```

```
* Q19 + Q7
```

```
qui local Q19 Q19a_Exclusion Q19b_Exclusion Q19c_Exclusion Q19d_Exclusion
qui local Q7 Q7a_Familiar_CloudComp Q7b_Familiar_Inet Q7c_Familiar_AI ///
    Q7d_Familiar_BigData
foreach i1 in `Q19' {
    foreach i2 in `Q7' {
        di " "
        di "***** `i1' vs. `i2' *****"
        tab `i2' `i1'
        di " "
        di " "
        di " "
    }
}
```

```

    }
}
break

* Close log-file
log close

*****

*
* Part 3/3: Graphs
*****

*

qui cd "${pngdir}"
qui set graphics on

* Q1
graph pie, over(Q1_Gender) plabel(_all percent, orientation(horizontal) ///
    size(*1.2) color(white) format(%3.1f)) title(Q1_Gender)
qui graph export Q1_Gender.png, as(png) wid(1000) replace

* Q2
graph pie, over(Q2_Age) plabel(_all percent, orientation(horizontal) ///
    size(*1.2) color(white) format(%3.1f)) title(Q2_Age)
qui graph export Q2_Age.png, as(png) wid(1000) replace

* Q3
graph pie, over(Q3_Experience) plabel(_all percent, orientation(horizontal) ///
    size(*1.2) color(white) format(%3.1f)) title(Q3_Experience)
qui graph export Q3_Experience.png, as(png) wid(1000) replace

```

* Q6

```
graph pie, over(Q6_Permanent) plabel(_all percent, orientation(horizontal) ///
    size(*1.2) color(white) format(%3.1f)) title(Q6_Permanent)
qui graph export Q6_Permanent.png, as(png) wid(1000) replace
```

* Q13

```
graph pie, over(Q13_DgtRedesign) plabel(_all percent, orientation(horizontal) ///
    size(*1.2) color(white) format(%3.1f)) title(Q13_DgtRedesign)
qui graph export Q13_DgtRedesign.png, as(png) wid(1000) replace
```

* Q16

```
graph bar (count), over(Q16_Involvement, label(labsize(medlarge))) ///
    ylabel(,angle(horizontal),,labsize(medlarge)) ///
    ytitle("Frequency",size(medlarge)) ///
    graphregion(color(white)) bgcolor(white) ///
    plotregion(lc(black)) plotregion(ic(none)) ///
    title("Q16_Involvement",size(large))
qui graph export Q16_Involvement.png, as(png) wid(1000) replace
```

* Q21

```
qui replace Q21_Covid = "Yes" if strpos(Q21_Covid,"Yes, since")
qui replace Q21_Covid = "No" if strpos(Q21_Covid,"No, services")
qui replace Q21_Covid = "Only some" if strpos(Q21_Covid,"Some services")
graph bar (count), over(Q21_Covid, label(labsize(medlarge))) ///
    ylabel(,angle(horizontal),,labsize(medlarge)) ///
    ytitle("Frequency",size(medlarge)) ///
    graphregion(color(white)) bgcolor(white) ///
    plotregion(lc(black)) plotregion(ic(none)) ///
    title("Q21_Covid",size(large)) bar(1,fcolor(dkgreen))
qui graph export Q21_Covid.png, as(png) wid(1000) replace
```