THE EVOLUTION OF THE FUNCTION AND DESIGN OF SPACES IN ACADEMIC LIBRARIES THROUGH THE DIGITAL ERA

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Abstract

Along with technology development in all fields of contemporary life, activities come development regarding architectural requirements. The functions, spaces usage, types of buildings, etc. have changed. Certain architectural elements and spaces have disappeared while other functions have either disappeared or been minimized. The change has also exceeded the architectural level to the urban level, affecting the urban planning elements, sizes, and decision-making processes.

Developments in technology exert a great influence on communication as well as data entry, saving, and archiving; which, in return, has had a direct impact on libraries' spaces, operating systems, functions, and user types. As a result, the traditional space requirements and old architectural theories should be revised.

This research aims to study the theoretical requirements of architectural academic libraries and the implications of technology development for spaces, functions, and types of users in the last ten years, through analyzing ten university libraries that were recently established in Europe and the USA that use the latest technologies. The outcome is applied to a case study: the architectural academic library of Beirut Arab University on Debbieh campus. The research finds that physical libraries will not be replaced by digital libraries easily, although the extensive use of technology has led to continuous changes in library spaces. The technological revolution in the field of mobile phones and applications which facilitated the accessibility of information and the possibility of searching and indexing has boosted the trend in changing library collections from physical to digital phenomena. In addition, the ideas of shared spaces and Pop-up Campuses, where libraries are completely virtual and universities are without boundaries, will also affect these traditional library-related theories.

It is hoped that the results and recommendations will assist the development of a new approach and method regarding library design, which may consequently affect university buildings design, especially since the effect of the COVID-19 pandemic is pushing us toward social distancing and online applications.

Keywords

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1. INTRODUCTION

A library is an organized collection of print (books, magazines, etc.) and non-print (e-journals, e-magazines, e-books, etc.) items, along with the services required to make them available to given users or group of users. (Verma & Verma, 2015)

Historically, universities have helped to identify a distinct building shape for the library that is often placed in a central location on campus to attract students, from which they can easily move to other campus facilities. The change in educational requirements, especially in the eighteenth century, resulted in the construction of a new generation of libraries.

The changes in the space design, structure and function of university libraries over the past twenty years has exceeded the changes that took place during the past hundred years. Space has become more complex and multi-functional. Areas that were corridors, reading areas, or stack rooms in the past have become multi-purpose.

Today, university libraries have become more open and interactive, especially with the evolution of information technology in different aspects of life, particularly regarding the methods of teaching and learning, as readers have become researchers using electronic resources. This trend has not eliminated the existence of the classical library but has added a new role to it. Printed collections and books nowadays are not the primary choice for library users, who tend to examine electronic databases first. (Edwards, 2009) (Cunningham & Tabur, 2012)

The evolution of the physical library into a digitized one has produced many terms, including "digital library", "electronic library" and "virtual library", that are interchangeable terms, and opinions vary regarding their definition and comparison between them.

One opinion is that "An electronic library is a library consisting of electronic materials and services. Electronic materials can include all digital materials, as well as a variety of analog formats that require electricity to use. A digital library is a library consisting of digital materials and services. Digital materials are items that are stored, processed and transferred via digital (binary) devices and networks. Digital services are services (such as reference assistance) that are delivered digitally over computer networks. Both digital and electronic libraries can be virtual libraries if they exist only virtually - that is, the library does not exist "in real life." These are libraries "without walls" and also known as web based libraries." (Kude, 2013)

Other frequently-used terms are "Hybrid Library", "Library without Walls", "Gateway Library", "The world digital library" (WDL), "Smart Library", etc. (Oppenheim & Smithson, 1999).

A step further in the digital library is the Smart Library, which is a set of various electronic resources, accompanied by specialized library services, which are provided by the use of information and communication technologies.

Technology in the smart library, previously based on information and knowledge, is transformed into technologies, based on interaction and thee exchange of experience – smart technology.

Smart library creation is only possible due to the new information and communication technologies and library technology. Such technologies contain the following (Baryshev, Babina, Zakharov, Kazantseva, & Pikov, 2015) :
- Smart technology of content formation
- Smart detection of knowledge
- Smart interface (organization of interactions with the user)
- Smart services
- Mobile applications usage

2. RESEARCH AIM AND METHODOLOGY

While universities are gradually transforming from open/closed shelves libraries into digital libraries, some research shows that university libraries are on their way to becoming fully digitized, especially technical universities, while other research shows that the presence of books in university libraries positively builds up the students' learning experience as well as the library atmosphere.

This raises questions including: **what is the future of university libraries 10 years from now? Are libraries going to be purely digital? Are open shelves going to be totally replaced by other library services that incorporate the development of information technology?**

This research focuses on the impact of technological development on academic libraries in terms of spaces` design and functions (activities). It includes a literature review of the ideal design requirements, codes and common functions, focusing particularly on the last decade. It then studies the historical development of academic libraries` spaces and functions before the year 2000.

Building on the literature review, the research explores the impact of the digital era in the last decade by analyzing ten case studies established or rehabilitated in the last ten years in Europe and the USA (five in Europe and five in the USA).

The final section of the research is a case study at the local level of the architectural academic library of Beirut Arab University on Debbieh campus, where a survey is applied to provide an indicator of the local users' agreeability regarding global development in academic libraries` spaces and functions.

3. ACADEMIC LIBRARY DESIGN REQUIREMENTS

According to the standards of University Grants Committee (UGC), the Polytechnics, Colleges Funding Council (PCFC) and the Chartered Institute of Library and Information Professionals (CILIP), which are used by the UK Higher Education (HE), and Space Management Group (SMG), the library/resource center offers one place for six Full-Time Equivalency (SFTE) students. Moreover, a 2.5-3.0m2 workplace needs to be provided for each reader, while CILIP recommends 2.5-4.0m2. (Buxton, 2018) (Pickard, 2002)

Fig.1: Hierarchy of learning space attributes according to (Kent & Myrick, 2003). Maslow's (1943). (Cunningham & Tabur, 2012)

This means that 16.7% of the students should have a workplace while, according to the Canadian recommendations, this percentage is 14%, and the ISO recommendation is 15% minimum and that part-time students should be included. (ISO/TR 11219:2012, 2012)

Students are choosing the physical library as much as ever and even in increasing numbers in renovated libraries (Shill & Tonner, 2003).

Fig.2: The result of a survey on librarians, architects and consultants about learning activities that should be available in 22 academic library learning space projects. (Head, 2016)

Fred Kent, architect and founder of the Project for Public Spaces, applied "Maslow's hierarchy of needs" to what library users need from a library (see figure 1). (Cunningham & Tabur, 2012)

Project Information Literacy (PIL) (Head, 2016) conducted a survey of librarians, architects and consultants about the learning activities that should be available in 22 academic library learning space projects. The results in figure 2 show the four major academic learning categories according to percentages:

- Collaborative learning (82%): where students can work together in comfortable, technology-rich spaces like meeting rooms or group work pods.
- Individual study (73%): where students can study, read, and conduct research in a quiet, comfortable environment equipped with built-in power outlets for their laptops.
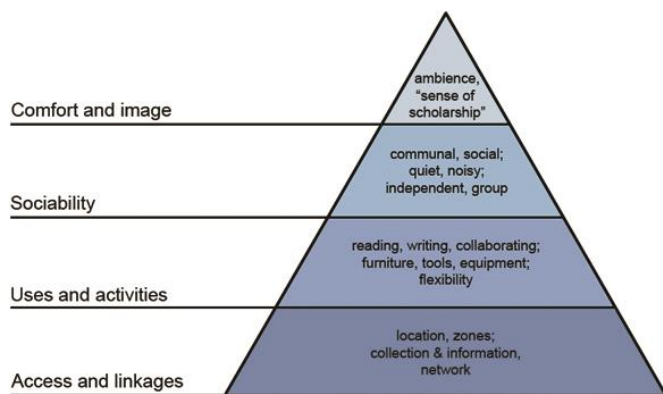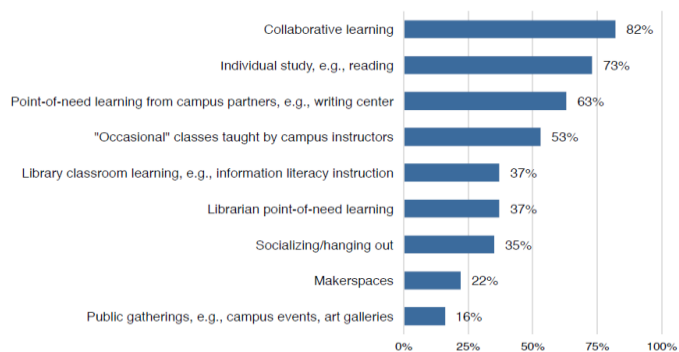
- Point-of-need learning (63%): is a major component of the learning common model, where students can benefit from a range of services, such as writing centers, math labs, workshops, excellence centers, etc. The design of such areas can include meeting pods, alcoves, cubicles, or small offices that can have glass separators for acoustic isolation.
- Occasional classes (53%): that accommodate one time meeting classes or teams working on problem solving or extra-curricular classes. They should be provided with flexible, updated software and hardware that enables them to easily switch between a formal class and a project workspace.

While the above study focused on functions that can be generally translated into physical spaces, (Oliveira, 2018) focused on functions that can be generally translated into virtual spaces. According to her, the most common services that should be offered by an information common are summarized by thirty-five elements, including information and multimedia software and services, presentation services, scanning and printing services, tutorial services, workshops, work group space services, quiet study area services, etc.

On the other hand, (Seal, 2014) defined the services of the information common by using the four C's:
- Connectivity: where students can easily access the world wide web, information, and people from inside and outside the university through computers, the internet, email, etc.
- Collaboration: where students can work together on formal assignments or informal group study. This can be facilitated through the inclusion of large tables, flexible furniture, seminar rooms, etc.
- Creation of knowledge: where students can access online data, printed collections, digital media, software, word processing documents, etc.
- Community: by specifying spaces for socializing, such as lounges, cafes, events room, etc.

4. THE DEVELOPMENT OF ACADEMIC LIBRARIES` FUNCTIONS AND SPACES THROUGH THE SECOND HALF OF THE 20TH CENTURY

The libraries` function and spaces have developed throughout history, from the papyrus rolls storage in the ancient Egyptian temples, through the Ptolemy Library in Alexandria (which contained about half a million scrolls), which was a depository for written material with only a casual distribution of reading space for scholars, to the typical stereotype of the library during the Renaissance with the Biblioteca Malatestiana and Michelangelo's Biblioteca (Edwards, 2009). This function and space design of libraries remained the same until the end of the 18th century and developed in 19th century due to the addition of specialist libraries` sections to the book stacks (open and closed) and a limited reading area (see fig. 3).

In the twentieth century, research libraries added to the previous contents (see fig. 3) with other detailed developments as follows: (Matthews Graham and Walton Graham, 2013)
- Pre-1970, the lack of physical space was a very important issue, especially at the beginning of the 1920s, as well as how to balance the ever-growing collections and the need for open access space for scholars and students. From the 1930's onward, the use of catalogue cards and microform (microfiche and microfilm) started as a solution for storing collections and books' content. However, the development of cataloging did not fundamentally solve the problem of space management (see fig. 4).
- In 1970s, the space shortage problem continued until 1977, except for the technical libraries in the United States, which raised the problem of a lack of seating areas. They applied cooperation between libraries to offer one copy for each group of libraries, and selected books according to the rates of need and demand.
  Some observations on technological development began to appear, but the number of connections, equipment and cost stood as a barrier to implementation; hence, the microfiche became the best solution for this stage.

The methods of teaching and learning were improved through sending undergraduate students more frequently to the library, which encouraged independent reading, and separate spaces were allocated to enable undergraduate students to cope with the expansion of the library collections.

- In the 1980s, there was passion for using modern technology, such as tele-facsimiles, micro-computers, CD-ROM workstations, and VCRs, as well as resetting and customizing staff spaces according to the technological development.

- From the 1990s to 2005, a shift in acquisitions from microforms to electronic formats served to accelerate the technological development, and online information and e-books began to spread. They also initiated the idea of the electronic library (E-Library) in 1998 with the study of the required funding (Kitti Canepi, Becky Ryder, Michelle Sitko & Weng, 2013).

On the other hand, the transformation of physical libraries into social spaces that emerged alongside the use of new teaching methods, such as the increased use of group work, was highlighted for the first time.
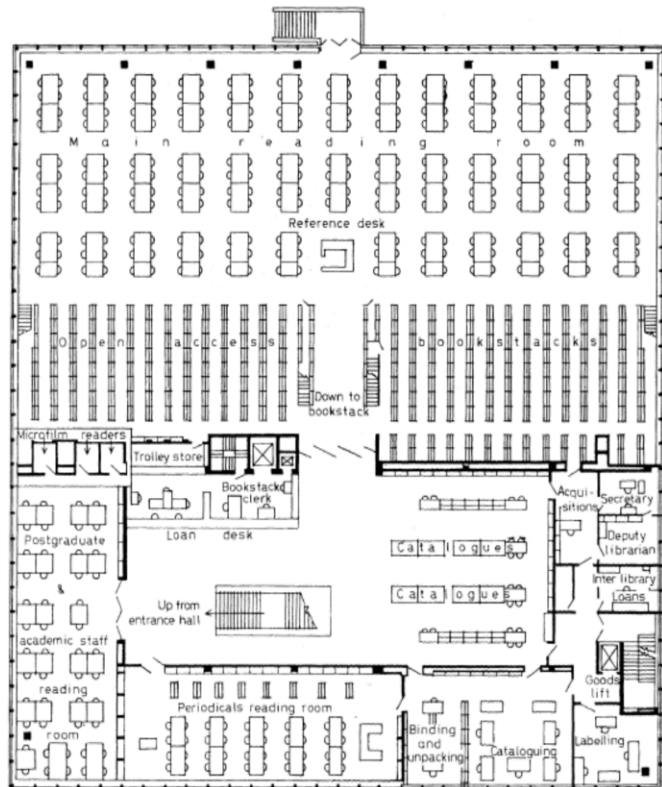

Fig.3: Sheffield University Library (1958) as a typical twentieth century plan and the compact of spaces due to the growing of collections (Edwards, 2009)
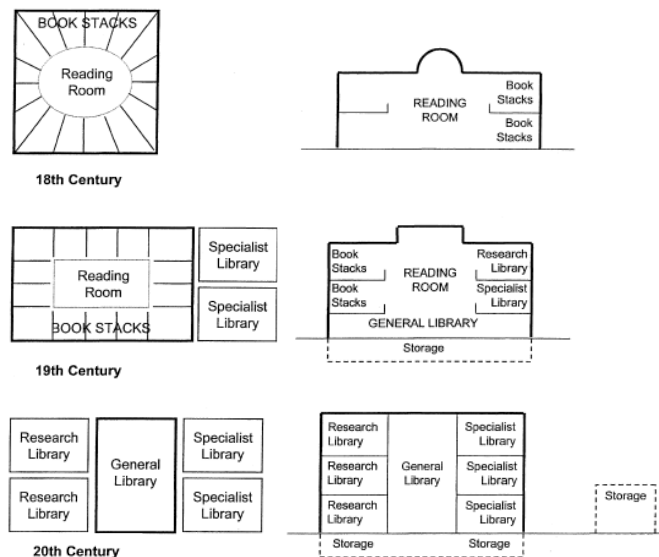

Fig.4: Plans` and sections` diagrams for changes in universities` Libraries from 18th to 20th century. (Edwards, 2009)

5. THE IMAPCT OF THE DIGITAL ERA ON ACADEMIC LIBRARIES` FUNCTIONS AND SPACES IN THE LAST DECADE

From 2006 to 2019 (including the last decade), there has been a tendency for some universities to reduce the library's physical spaces and there was a split between those who predicted that physical libraries would diminish and that the future would be virtual libraries, and those who believed that the importance of physical libraries was increasing.

However, the general tendency is to focus on the role of the library as an **educational space (Learning Resource Center)** and a link to interactive means of education by increasing the areas of group work and discussion, hence treating libraries as social spaces (see figure 5).

This part will discuss the function and space analysis of ten academic libraries in European and US universities that were established or rehabilitated between 2009 and 2019 (see table 1). The discussion will be supported by theoretical resources.
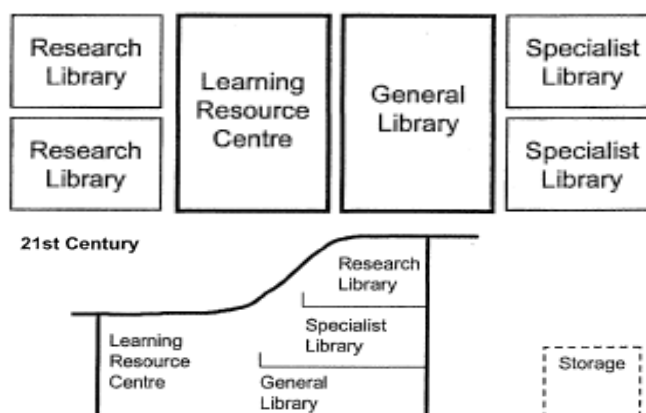

Fig.5: Plans` and sections` diagrams for changes in universities` Libraries in the 21th century. (Edwards, 2009)

Table 1: Case studies` information (Established/ Rehabilitation, Total Area, No. of Student in the University Campus, and Number of Library Collection (Soft & Hard))

	Established/ Rehabilitation	Country	Total Area (m²)	No. of Student in the University Campus	Number of Library Collection (Soft & Hard)
01- University Library of the University of Amsterdam	2009	Amsterdam, The Netherland	2300	65K	Over 4M books, 70K manuscripts, 500K letters, and 125K maps, 1 km open shelves, 96 km closed stacks, 436 databases, 426,686 e-books, 37,257 e-journals subscription
02- University of Illinois at Chicago Daley Library	2011	Chicago, US	2131.06	33,390	634 databases 504,341 e-books Over 60K journals
03- Catholic University Library	2013	Ruzomberok, Slovakia	10215.15	4,103	Over 310K books and a large archive with more than 470K volumes. More than 500 students have possibility to study there at the same time.
04- The National University Library (Rehabilitation)	2014	Strasbourg, France	18800	46,627	Over 3M documents, 35K books in the reading rooms. The others can be ordered, after looking up the catalogue, over 8.5K electronic periodicals.
05- Library of faculty of Architecture and Urbanism of the University of Ghent	2014	Ghent, Belgium	285	NA	NA
06- New Library at the University of Bedfordshire	2016	Luton, UK	10658.09	20K (Among 4 campuses)	Over 80K e-books, 300K books, 80K e-journals, 1.2K print journals, 80 databases
07- Medgar Evers College Library	2016	NY, US	4180.64	6,652	Over 90K volumes
08- Carnegie Mellon University Sorrells Library Renovation	2017	Pittsburgh, US	1507	13,961	NA
09- Palomar College Learning Resource Center	2019	San Marcos, US	16452.14	30K	NA
10- Charles Library at Temple University	2019	Philadelphia, US	20438.67	39,948	180K volumes on open shelving. 1.5M circulating volumes and 5.5m linear of special collections materials are housed in an Automated Storage and Retrieval System (ASRS)

5.1 GENERAL VIEW

The main components of spaces for the libraries discussed in the analytical study are: the main open space, enclosed spaces, and general services.

The library's main open space ranges from 28.83% of the total library space in the National University to 88.51% in the Faculty of Architecture and Urbanism at the University of Ghent, with an average of 52.16% for the ten universities in our study (see figures 6 and 7). However, if the extreme results are excluded, the libraries' main open space ranges from 38.61% of the total library space at the University of Amsterdam to 53.11% at the Catholic University, with an average of 47.17% for the seven remaining universities, where the average provides a more reliable basis for generalization.

Fig.6 Percentage averages of the three main libraries` components (Author, 2019)

The libraries' enclosed spaces range from 15.19% of the total library space at the Catholic University to 34.69% in Charles Library at Temple University, with an average of 22.62% for the ten universities (see figures 6 and 8). If the 0% result for the Faculty of Architecture and Urbanism at the University of Ghent is excluded, the average amount of enclosed space is 25.14% of the total library space.

The library services spaces range from 7.43% of the total library space at Carnegie Mellon University to 37.13% at National University, with an average of 25.22% for the ten universities (see figures 6 and 9). If the extreme results for Carnegie Mellon University and the Charles Library at Temple University are excluded, the average library services' space is 30.51% of the total library space.
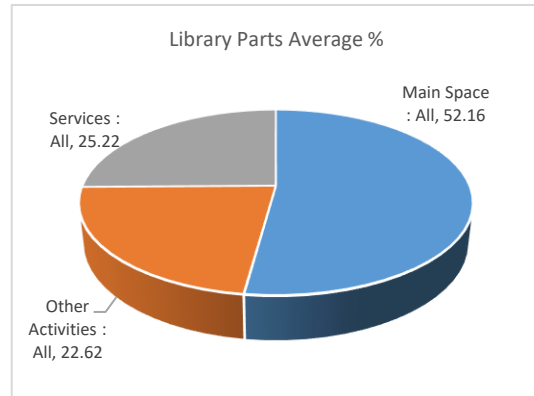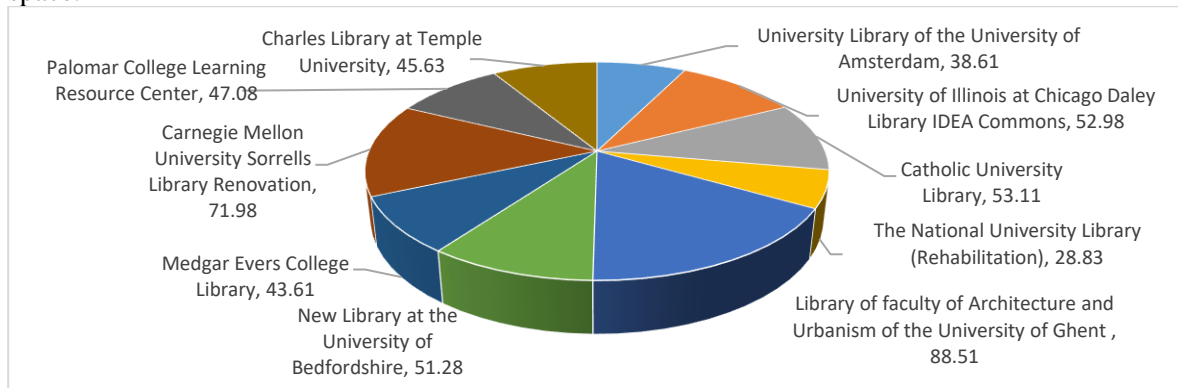

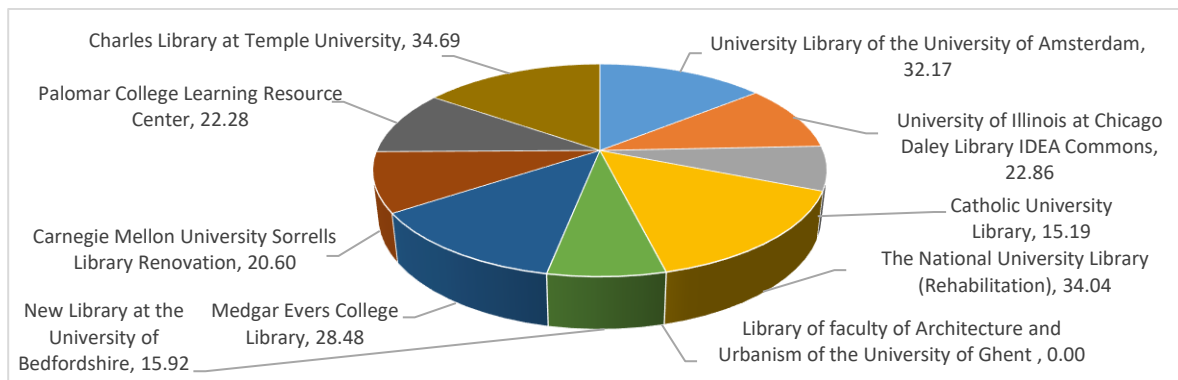Fig.7: Percentage of the main open space with respect to the library overall space (Author, 2019)

Fig.8: Percentage of enclosed spaces with respect to the library overall space (Author, 2019)
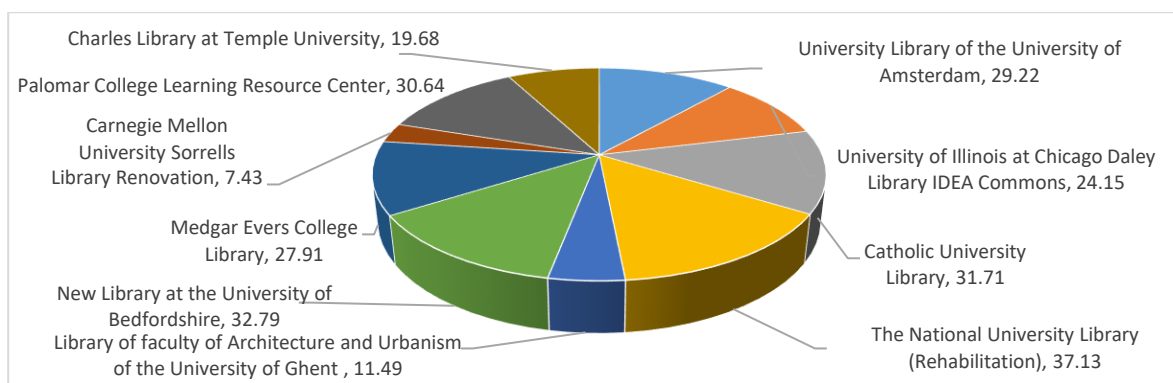
Fig.9: Percentage of the general services space with respect to the library overall space (Author, 2019)

5.2 THE LIBRARIES' MAIN OPEN SPACE

The libraries' main open space is categorized into furnished spaces designed for specific activities, and free space for circulation and multiuse activities, such as seminars, events, exhibitions, etc. The ratio of furnished spaces is almost equal to the ratio of free space in the ten universities (45.03% for furnished space and 54.97% for free space) (see figure 10).

The overall number of facilities recognized in the furnished spaces for the main open space is 13, distributed across the ten libraries, plus the atrium space that appears in four case studies.

There are six facilities that commonly exist in the furnished spaces (see figure 12), with 36.43% of the total main open space area (see figure 13):

- Reading tables, with 7.99% of the main open space area and with a traditional design and function.

- Open stacks that occupy 12.31% of the main open space. Some libraries reduce the space occupied by book shelves by using moving (automated) book stacks (see figure 11).

- Relaxation reading couches, with 4.16% of the main open space. They are of different types to provide individual/group activities, such as reading, study, or relaxation, while the connected couches could be used as small group pods (see figure 14).

- Information counter (3.67%) and catalogues/indices (1.41%), for different compacted designs to reduce the space. The most space-saving appears in Chicago Daley Library at the University of Illinois, where touch panels are used for this purpose (see figure 15).

- Study pods/tables, with 6.89% of the area. They are of different designs to provide an individual and quiet/relaxation space (see figure 17).

- 50-60% of the case studies contain Information and Communication Technologies (ICT) Clusters, Group tables, and Small Group Pods (see figure 12):

Fig.10: Library main open space in University of Illinois at Chicago Daley Library (Up) and in Catholic University Library (Down) ("Richard J. Daley Library, UIC," 2019) (Franklin, 2014)

Fig.11: Advanced automated open stacks in University of Coventry Library ("Landmark of sustainable design." 2019)
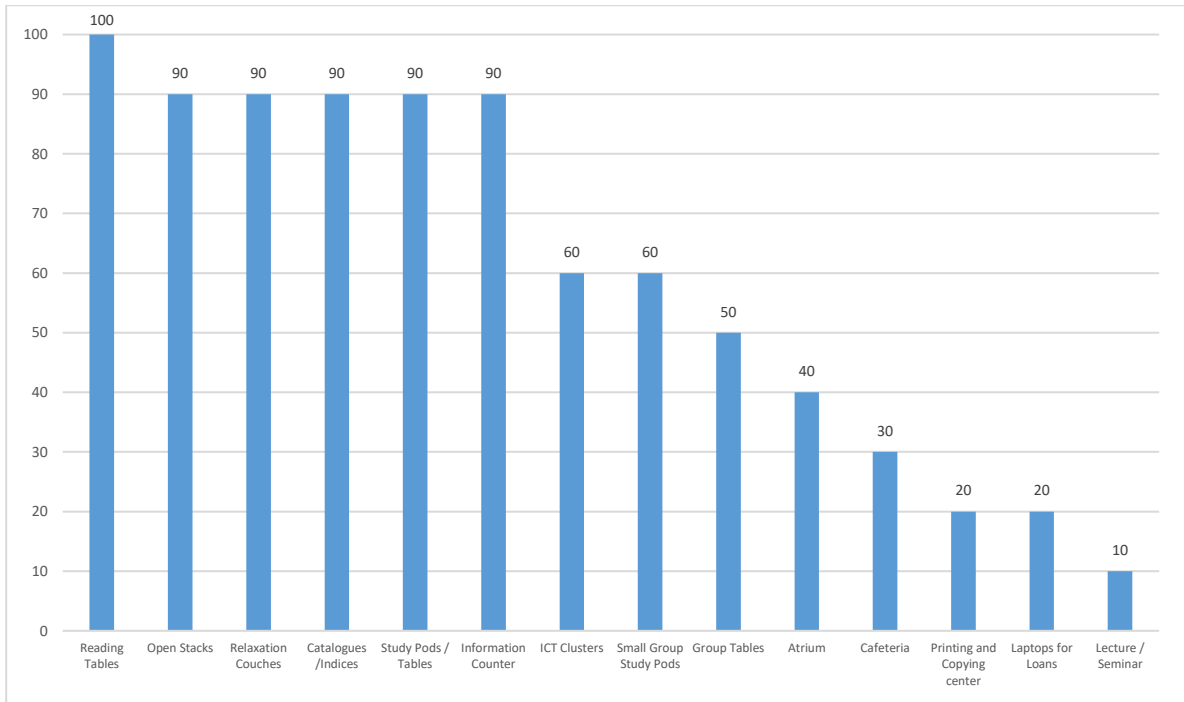
Fig.12: Existing rate of the main open space`s facilities in the 10 case studies (Author, 2019)
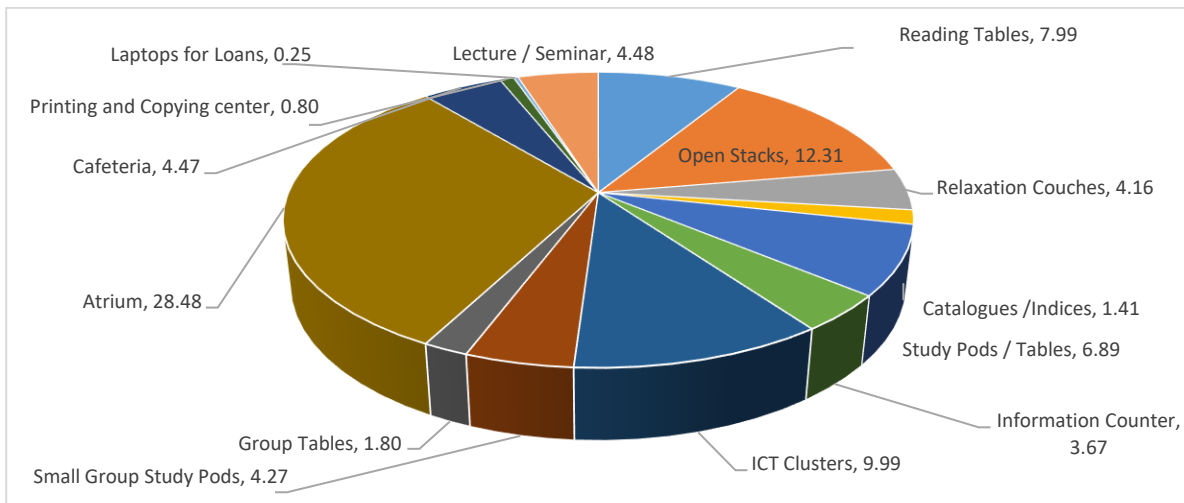

Fig.13: Area average for the existing facilities with respect to the main open space (Author, 2019)
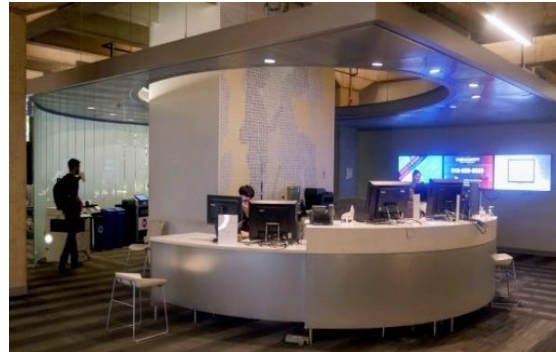
Fig.14: (Up and Mid) Individual Relaxation Couches in New Library at the University of Bedfordshire and University of Illinois at Chicago Daley Library ("University of Bedfordshire - Luton Campus Library," 2019) ("University of Illinois at Chicago Daley Library / Woodhouse Tinucci Architects," 2011)
Down: Individual Relaxation connected Couches could be used as a small group pods in Palomar College Learning Resource Center ("Palomar College Learning Resource Center," 2019b)

Fig.15: (UP) Advanced Touch screen Catalogue and Indices system in Catholic University Library.
(Mid) The main Information Hub with the Indices system, and (Down) the Printing / Copying center in of University of Illinois at Chicago Daley Library, and The New Library at the University of Bedfordshire.
("Richard J. Daley Library, UIC," 2019), (Franklin, 2014), ("University of Bedfordshire - Luton Campus Library," 2019)

- The (ICT) cluster represents around 10% of the main space area in 60% of the case studies (see figures 12 and 13). It appears in various forms, perhaps the most frequently as linear and circular tables on which computers are distributed (see figure 16). ICT helps individuals to explore the library's physical and digital resources, read the available digital resources, and search for resources on the web

Fig.16: Two types of ICT Clusters in the University of Amsterdam Library (Up) and in New Library at the University of Bedfordshire (Down) (LABARRE, 2010) (González, 2018)
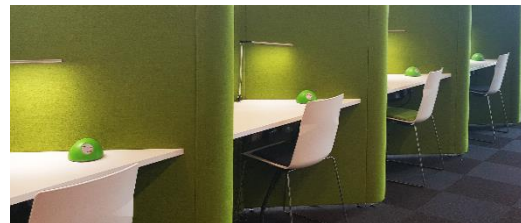
Fig.17: Three Study Pods Types in University of Coventry Library (Up and mid), and New Library at the University of Bedfordshire (Down) ("University of Bedfordshire - Luton Campus Library," 2019) ("Landmark of sustainable design,"

Fig.18: Four types of Small Group Pods in Bournemouth & Poole College Library (Up-Left), University of Coventry Library (Up-Right), New Library at the University of Bedfordshire (Down-Left) and in University of Illinois at Chicago Daley Library (Down-Right).
("University of Illinois at Chicago Daley Library / Woodhouse Tinucci Architects," 2011) (González, 2018) ("Landmark of sustainable design," 2019) ("Information at your fingertips," 2019)

- Conducting researches and completing assignments. Therefore, it tends to reduce the area of book stacks and so allow more free space.
- Small group study pods appear in 60% of the case studies, representing 4.27% of the main open space area (see figures 12 and 13). Group pods are considered one of the most important forms of interaction that attract library users, especially for group work, through research, group study, socializing or even seminars. It can be noticed that the pods' shapes differ according to their purpose (see figure 18). For instance, in the library of Bournemouth and Poole College and Bedforshire University libraries, the group pods consist of a group of couches surrounding a table, whereas at Illinonis University they consist of relaxation couches for the purpose of comfort and socializing. Another form of group pods in the library of Coventry University consists of chairs, a work table, and a data show in an enclosed area to ensure sound insulation.

Fig.19: The open space cafeteria in the entrance lobby of the New Library at the University of Bedfordshire ("University of Bedfordshire opens stunning new library,"

- An open space cafeteria, atrium, printing and copying center and laptops for loan appear in 20-40% of the case studies as part of the main open space (see figures 12 and 13):

Fig.20: Atrium Space in the National University Library (Left and Mid), and in University of Coventry Library Right) (Clubman, 2015) ("Landmark of sustainable design," 2019)

Fig.21: Two Types of Open space seminar space in Carnegie Mellon University Sorrells Library (Left), and in University of Coventry Library (Right) (Carnegie Mellon University Sorrells Library, 2019) ("Landmark of sustainable design," 2019)

- An open space cafeteria appears in three out of the ten case studies, reflecting about 4.474% of the main open space area (see figures 12 and 13). It is a relatively free zone as it does not require quietness restrictions like other reading and research areas (see figure 19).
- An atrium appears in four out of the ten case studies, representing an average of 28.48% of the main open space area (see figures 12 and 13), which is a relatively large area. It is used to provide natural lighting to the space depth (deep plan), an exhibition zone, or a space for study pods or ICT (see figure 20).

- Lecture or seminar open spaces appear only in the library at Carnegiemellon University, representing 4.48% of the main open space area (see figure 13). It is a relatively new activity in libraries, that provides not only a space for reading and studying but also a space for giving lectures and organizing events (see figure 21).
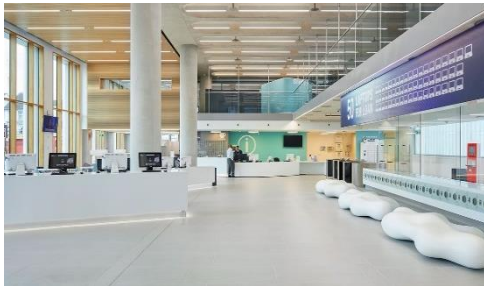

Fig. 22: (Left)The main entrance of the New Library at the University of Bedfordshire, shows the Information counter in the front, the Indices system in the right, and the unique Laptop Loan services in the left ("University of Bedfordshire opens stunning new library," 2019)
(Right) Laptop Loan services (Vending Machine) in Charles Library at Temple University ("24/7 Study Area," 2019)

- Lending laptops is another activity related to technological development that appears in two of our case studies. It is applied through vending machines or smart safe boxes (see figure 22).

A distinctive activity is the merging of inner and outer spaces through amphitheatres as at Palomar College, or through green roofs and terraces used as a reading area, and multi-use space as in the Charles Library at Temple University (see figures 23 and 24).

Fig.23: Outdoor activities (Amphitheatre and setting area in Palomar College Learning Resource Center (Palomar College Learning Resource Center, 2019a)

Fig.24: Green Roof and Outdoor Terrace in Charles Library at Temple University ("The library of the future is here," 2019) ("New library receives state support for massive green roof," 2016)

5.3 THE LIBRARIES' ENCLOSED SPACES

The enclosed spaces in the ten case studies are categorized into 14 functions (activities). The existing rate of the enclosed spaces' facilities ranges from 10 -70% of the case studies (see figure 25).
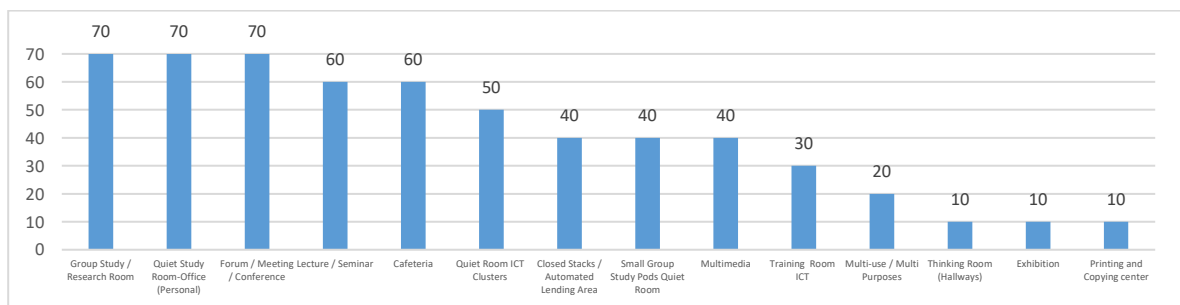

Fig. 25: Existing rate of the enclosed spaces' facilities in the 10 case studies (Author, 2019)

Six spaces are common: Group study/Research room (see figure 26), Quiet study room/Office (Personal study), Forum/Meeting/Conference room, Lecture/Seminar (see figure 31), Cafeteria, and Quiet room/ICT cluster.

Four spaces appear in 30-40% of the case studies, such as Closed Stacks/Automated Lending Area (see figure 32), Small Group Study Pods (Quiet Room), Multimedia, and Atrium, and Training Room/ICT.

The remaining spaces appear in one or two cases only (10-20%) (See figure 25) such as Exhibition space/Museum, which appears at the National University Library (see figure 27). Some of them offer new functions, like the Thinking Room (Hallways), which appears in the University of Amsterdam Library (see figure 28). This space is suitable for relaxation, thinking, imagining, etc.

The closed stacks area represents the largest area, constituting 42.33% of the total enclosed spaces area, where the rest of most of the spaces range from 11.41-18.14%, with some below 10% of the total area (see figure 29).
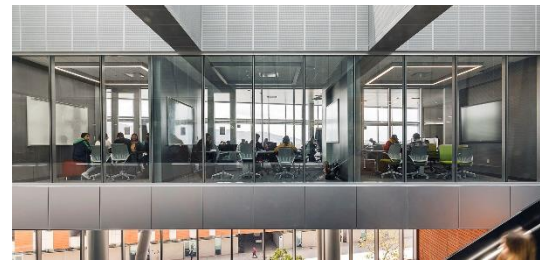

Fig.26: Quiet Group Study / Research Rooms in Palomar College Learning Resource Center (Pintos, 2019)

Fig.27: Exhibition Space in the National University Library (Sudhaus, 2015)

Fig.28: Thinking Area in University of Amsterdam Library. ("University Library of the University of Amsterdam," 2009)
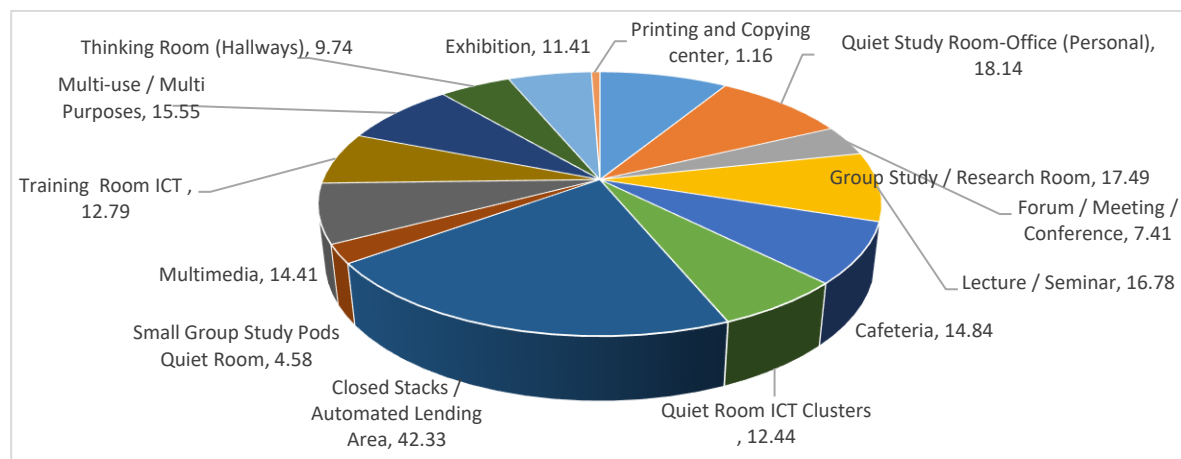

Fig. 29: Area average for the existing enclosed space types with respect to the total enclosed spaces area (Author, 2019)

The closed stacks look similar in most cases, except for Temple University and Amsterdam University, where they use automated stacks to facilitate the finding of resources and reduce the size of the areas through transforming high stacks into digital cabinets for storage purposes (see figure 30).

Fig.30: Automated Closed Stacks in Charles Library at Temple University (Left and Mid.), and Closed Stacks and Automated Lending Area in University Library of the University of Amsterdam (Right) (Etherington, 2009) (Hernández, 2019)

A quiet group study/research room is found in most of the case studies, consisting of an area representing an average of 17.49% of the main library space (see figure 29). It consists mainly of chairs, a table for group work, a data show, and a white board to ensure a suitable environment for quiet group work.

A lecture room or seminar room appears in many of the ten case studies. The main components of the lecture room are almost the same for all cases, and it mainly contains chairs, a data show, and white board to facilitate public lectures, the discussion and display of projects, or short courses (see figure 31).

Fig.31: Lecture / Seminar room in New Library at the University of Bedfordshire ("University of Bedfordshire - Luton Campus Library,"
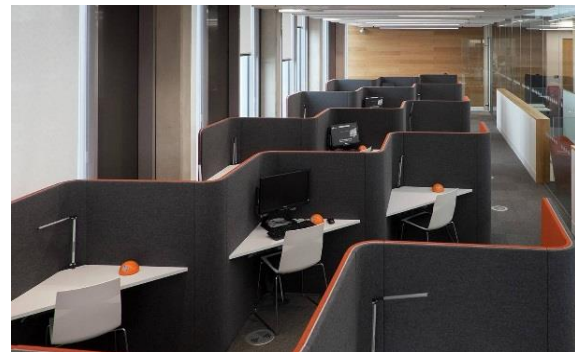

Fig.32: Quiet Study Room (Pods/ICT) in New Library at the University of Bedfordshire ("University of Bedfordshire - Luton Campus

A quiet study room/pod as well as ICT room/pod appear in most of the case studies, representing 16.78% of the main quiet study space, and 18.14% of the ICT space (see figure 32).

6. USERS' RESPONSE

A survey was conducted of students and staff from the Faculty of Architecture - Design and Built Environment at Beirut Arab University, Debbieh Campus, Lebanon. The faculty library is located inside the faculty building and serves mainly architecture students. The library area covers 383.59 m². It contains a main open space (94.85%) and a storage area (5.15%).
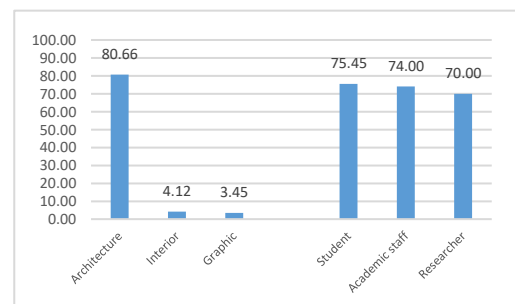

Fig.33: Response rate according to the field of specialization in the faculty and the academic level (Author, 2019)

The library's main open space contains: Reading Tables (25.06%), Group Tables/Couches (9.58%), Open Stacks (16.85%), ICT (4.06%), a Copying area (0.38%), an Information/Registration area (3.98%), Lockers (0.88%), and Circulation spaces (39.22%). These percentages differ greatly from the previous ten case studies` percentages, except for the copying, information, and registration areas, which are almost the same.

The library contains 9,840 volumes, serves about 666 students (550 Architecture students and 116 Interior, Graphic and Fashion students), 50 staff members and around 20 postgraduate students.

It is accessed by 800 users per month in the fall and spring semesters, according to the library's registration data. The amount of main open space for each student is 0.64 m^2.

The survey sought to test the frequency of accessing the library and the preferred zones in the library, as well as measure the possibility

Fig.34: Preference between Physical and Digital Libraries in reading and doing researches (Author, 2019)

of applying new functions and spaces (from the previous analyses) in the faculty and assess the interaction of users (students, researches and staff) with this model.

The questionnaire contains four sections: General information for the type of user and department, preference between Physical and Digital Libraries in reading and doing researches, the user's behavior of digital libraries, and the user's behavior of physical libraries.

The percentages show that the majority response came from the architecture specialization (80.66%), with almost equal percentages of teaching staff, students, and researchers (about 70%), while the response percentage for the interior and graphic design disciplines was only 7.57%. This led us to consider the architecture results only (see figure 33).

The survey results (see figures 34-36) show that:

- The majority of users prefer using hard copies when reading (58.93%) while they prefer digital resources for research (63.29%).

- Generally, about 50% of the users rarely use the digital and physical libraries, while the daily access to the digital library (18.28) is larger than that to the physical one (4.66%), where most of the users prefer to access the physical library 1-2 times/week, mainly for research and group work purposes.

- The majority of users accessing digital library resources often do so from home (58.13%) and on campus (33.22%) rather than in the library (4.50%) or from work (4.15%, especially postgraduate students), and prefer using computers to access digital resources (58.63%) rather than mobile phones (36.48%).

- An average of 70.33% of users consider the digital library to be useful. This percentage is distributed between 41.03% who agree and 29.3% who strongly agree.

- The majority of users do not see any problem with the current physical library facilities and services (65.83%), while some of them (34.17%) recommend improve the indexing system to make it easier to locate resources (45.07%), and others recommend increasing the library's opening hours (30.28%).

- The majority of library users prefer to use the group work area (53.82%) compared with the lounge area (25.48%). Therefore, since this result contradicts the fact that most of the users access the library for research purposes (as the survey shows), it is concluded that the type of research they prefer to do in the library is group work research.

- The majority of library users would prefer quiet study areas to be added and the ICT area to be enlarged (57.64%), in addition to expanding the group work and lounge areas (42.35%).
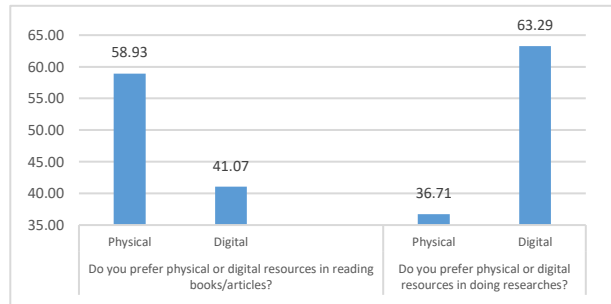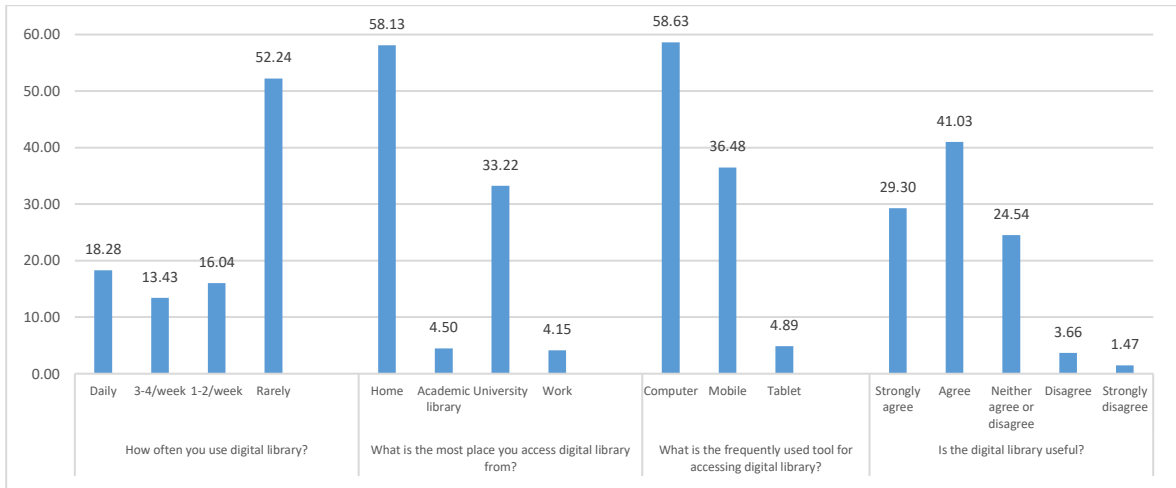
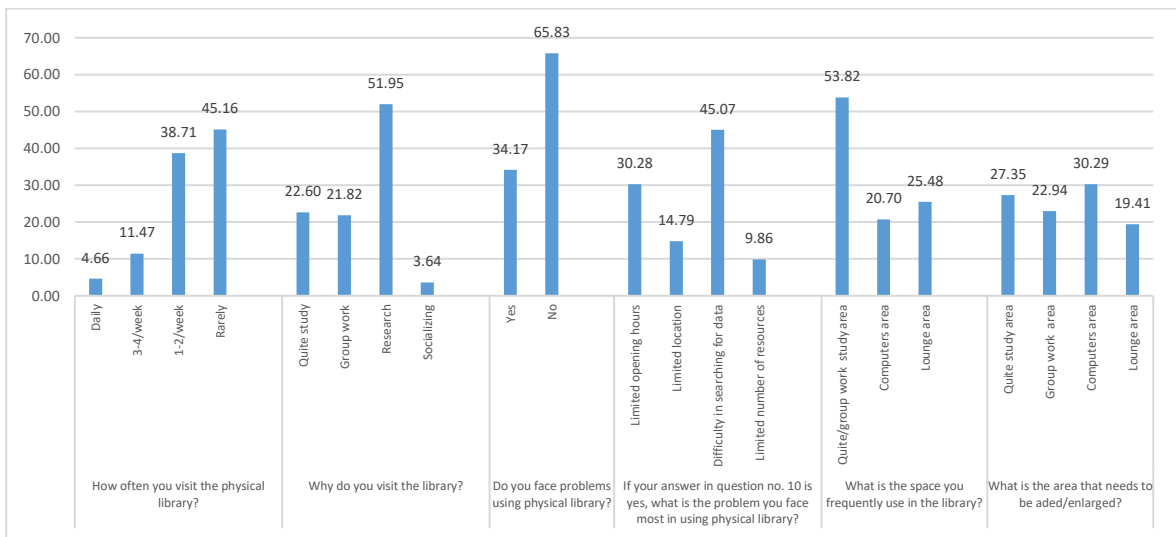Fig.35: The user's behavior of digital libraries (Author, 2019)

Fig.36: The user's behavior of physical libraries (Author, 2019)

7. DISCUSSION

Generally, distance learning, online classes and part-time study have become more popular with the increase in the student population.

The problem of the increasing number of students has diminished alongside the growing capability to use technology, especially among the younger generation. The use of a physical library has become limited to students who live on campus, and the older generation.

By reviewing the previous literature's reviews of library standards and codes, it was found that a university library space is designed to host about 15% of the students at the same time, which means that the average area specified for each student is 3 m^2. After analysing the case studies, it was noticed that the average area is actually 3.55m^2/student (see tables 1 and 2).

The average area varied between 0.38m^2/student and 14.94m^2/student and, after excluding the extreme values, the average area was found to be 3.15m^2/student, which is almost equal to the standard average area. Besides maintaining the previous averages, the number of resources has also been increasing, as clearly seen at the University of Amsterdam, which has gathered four million resources, even though, since its resources are digital, these are displayed in a limited area. Therefore, if the physical resources in the case studies have been converted into digital ones, the area needed for stacks will be reduced. This indicates the importance of reducing the areas required for book storage and physical resources, and introducing technological tools and facilities, such as ICT clusters, especially given the increasing number of resources.

Table 2: Case studies` area percentages for the whole and 1/6 of student numbers. The red highlight is for the extreme percentages that are excluded. (Author, 2020)

University Name	Library total Area		Main Open Space		Closed Spaces	
	Area for 1/6 students (%)	Area for each students (%)	Area for 1/6 students (%)	Area for each students (%)	Area for 1/6 students (%)	Area for each students (%)
01- University Library of the University of Amsterdam	0.21	0.04	0.08	0.01	0.07	0.01
02- University of Illinois at Chicago Daley Library	0.38	0.06	0.20	0.03	0.09	0.01
03- Catholic University Library	14.94	2.49	7.93	1.32	2.27	0.38
04- The National University Library (Rehabilitation)	2.42	0.40	0.65	0.11	0.92	0.15
05- Library of faculty of Architecture and Urbanism of the University of Ghent	NA	NA	NA	NA	NA	NA
06- New Library at the University of Bedfordshire	3.20	0.53	1.64	0.27	0.51	0.08
07- Medgar Evers College Library	3.77	0.63	1.48	0.25	1.34	0.22
08- Carnegie Mellon University Sorrells Library Renovation	0.65	0.11	0.47	0.08	0.13	0.02
09- Palomar College Learning Resource Center	3.29	0.55	1.46	0.24	0.88	0.15
10- Charles Library at Temple University	3.07	0.51	1.17	0.20	1.39	0.23
Average (%)	3.55	0.59	1.68	0.28	0.84	0.14
Without extremes (%)	3.15	0.52	1.28	0.21	1.36	0.23

Consequently, the average area specified per student is 1.63m2/student if the area of the main open space is calculated instead of the total area (see table 2). The average area will vary between 0.08m2/student and 7.9m2/student and, after excluding the extreme values, the average area is only 1.28m2/student, which is very far below the standard average area.

By studying the basic facilities that should be available in libraries according to references such as users and activities, sociability, comfort and image, and access and linkages, we find that these have been provided in various forms throughout history, except for sociability, that started to be available since the year 2000. Before the 19th century, the main concerns of libraries were users and activities, while the other factors were viewed as being of minimal importance. In the 19th century, these factors started to increase gradually, especially the amount of space specified for reading and a greater concern to ensure comfort in reading areas. In the 20th century, the concern was to allocate spaces for researchers and the conditions that give them comfort during their time in the library. Moreover, special attention was paid to increasing the resources' space in the 20th century, along with finding ways to solve the problem of the lack of space through using technology such as microfiches at that time. At the beginning of the 21st century, new activities, were introduced, especially those related to learning, including "The alteration of the university library from a museum for books into a learning centre." (Matthews Graham and Walton Graham, 2013) These activities have developed over the years and technology has had a great impact on this process, such as the addition of ICT, indexing, information, and laptop lending tools. All of this has increased the spaces specified for reading, research, socializing, exhibitions, seminars, etc., which have helped to offer comfort and easy access to resources for library users, especially during the last decade.

Since this study is concerned with the effect of technology on university library spaces and activities in the last decade, after analyzing the ten university libraries recently established in Europe and the USA that fulfill the modern library-related needs, the results of this study can be used as a reference for evaluating library spaces and activities and also for future research.

The pivotal role played by the activities added to the university library nowadays has been noted, such as ICT clusters, information and indexing stations, laptop lending stations, study pods, group pods, and relaxation areas, in addition to extra activities applied in some cases, such as thinking areas and seminar areas as part of the main space. Also, the integration with the outer space through terraces, green roofs, and an outdoor amphitheatre has been recognized, which support the idea that the library space is a desirable place that provides comfort, sociability, and accessibility to resources, and enhances the main role of the library as a learning space that supports learning activities.

It also supports the recent trend in regarding the role of the university library as supporting collaborative and individual study through group or private study pods, in addition to point of need learning and occasional classes, since the essential role of seminar or lecture rooms in university libraries is noted nowadays. Moreover, applying technological development to library facilities has helped to minimize the space needed for physical resources and references, such as using automated closed or open stacks.

As for the questionnaire administered at the local level, this helps to measure the extent to which these criteria can be applied at the local level and the users' response to them. It has been observed that many users who rely on digital resources prefer to access these from home, in addition to the increased use of digital resources compared with physical ones. The study also shows the interest in group work areas, lounges, and ICT areas. This study, although it cannot be relied upon alone due to its limitations in terms of space and the number of users, can be used as a guide for future research.

8. CONCLUSION:

In conclusion, the changes within pedagogy and the wide spread of technology resulted in not only creating new spaces (or changing the space requirements) in academic libraries but also produced new functions and activities, that integrate together to build a new role for academic libraries as a learning common. These functions and activities may vary from one academic library to another but should always fulfil the criteria of a learning space.

It is also noted that, in the next decade, digital libraries will depend more on technological development to explore resources for reading and research, in addition to indexing and archiving. This will result in a reduction in the space required for academic libraries, even if this falls below the standards stated in the codes, and also offer a larger space for relaxation, study (study pods), group work pods, exhibitions, and seminar rooms, which supports the concept of collaboration and sociability.

This study may offer a guideline for the future design of university libraries, especially based on the results of the analytical study and the analysis of the case studies, although the results of the survey should be expanded into a broader study in order to produce a clearer vision regarding the future of university libraries in the local environment.

As for the idea that university libraries will convert totally to digital libraries in the future, the analytical study showed that physical libraries will not be replaced easily by digital libraries. However, the distribution of the facilities and functions of the main open space may change over time, as indicated by the new activities and zones that have been introduced into some of the case study libraries, replacing book stacks and traditional reading spaces. The ramifications of the COVID-19 pandemic may boost this replacement action, although these were not considered in this research, since it started prior to the pandemic. However, the COVID-19 phenomenon will open up a new way of studying due to its impact on the future of university libraries with respect to design, function, and users.

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