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New community spaces in the library - Makerspace

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Abstract: *The rapid change of info-communication technology and the resulting impact on the world of work and society in general have also influenced the operation of libraries. One of the latest demands libraries have to face is functioning as sites of preparation for the use of info-communication technologies. On the whole society must be prepared to meet the expectations of the labour market changed by the Fourth Industrial Revolution while the cultural paradigm shift taking place in the educational sphere calls for instruction methodologies meeting the needs of the alpha generation. The Makerspace movement provides a solution to both challenges while developing cognitive and cooperative competences in a creative way. Libraries are ideal for applying and propagating the Makerspace method. Since the application of this approach is in the beginning stage in Hungary, it is important to support measures promoting its introduction in the library sphere. We hope to contribute to the realization of this goal as, in addition to describing specific methodological approaches pertaining to the basic features and devices of the Makerspace model, we will also introduce the results of the analysis of a large sample questionnaire survey administered to library managers in Hungary. The inquiry focused among others on the current availability of equipment and the respective human resources and the propagation and application of the makerspace lab methodology.*

Keywords: *Makerspace; Library; Makerspace in libraries; 3D printer; laser cutting; engraving machine; smart home*

1. Introduction

The Fourth Industrial Revolution generates a substantial effect on our daily lives. The emergence of smart homes, smart towns and cyber-physical devices has a major impact on information consumption while changing the forms of entertainment. These processes result in such new concepts as the cyber-physical society (Monostori, 2014) entailing physical and cybernetic spaces transformed due to a technological development and the related living, working and cultural environment.

Cultural paradigm shifts generate a significant impact on libraries. Such a change is taking place currently and libraries have to be prepared for these developments, analyse the expected

demands, and be ready to meet them. “Those libraries that fail to understand or embrace these technologies may, in fact, be left behind” (Lund, 2021).

Our concept the multifaceted analysis of the respective demands should include the following steps:

- Assessment of the demands imposed by society,
- Analysis of international and domestic strategic plans,
- Assessment of the competences and options of local libraries.

The interest toward Makerspace labs covers all the abovementioned three fields. Makerspace is “spaces used by people to share tools, knowledge, and ideas” (Burke, 2018).

In the following section we introduce the results of a survey taken among American users, which tend to be supported by the findings of a qualitative content analysis of international strategic documents. In Hungary the main aspects, operation, history, and structure of the makerspace movement are not well-known. In addition to promoting the popularity of the movement, our study introduces practical solutions widening the methodological arsenal of libraries willing to use this approach.

2. Demands imposed by society

Digital technologies revolutionised our lives and children grow up in a technology controlled world. Consequently the demands of the labour market changed as well (Racsko, 2021). The library-related opinions, views, and demands of American society are regularly assessed by the Pew Research Center. The survey (Horrigan, 2016) performed in 2016 confirmed that 53% of the population used the respective library services in the previous year and identified the additional services expected of libraries. As indicated below, accessibility to technology appears to be an important concern. Thus libraries are expected

1. “to offer such services, which teach people (including children and senior citizens) to use digital devices, computers, smart phones and applications,”
2. to provide more comfortable space for working and relaxation,
3. to purchase 3D printers and other digital devices enabling people to learn the use of such equipment for the production of various objects,
4. “to decrease the number of books in public areas in order to provide more space for technological centres, reading rooms, conference rooms and cultural events” (Horrigan, 2016).

In the European Union the demand is expressed on the one hand by the labour market as there is a tremendous need for experts possessing ICT competence and profound professional knowledge (Lengyel Molnár, 2013) and this concern is expressed in the strategic guidelines of the Netherlands-based IFLA as well. The 2013 IFLA strategy has identified five key themes, among them the familiarisation of the population with new technology, especially such aspects as 3D printing, blockchain technology, artificial intelligence and mobile technology. At the same time the other devices are all considered new technology by the strategy.

The code map of the 2016 IFLA strategy prepared via a computerised content analysis software (MaxQDA) indicates the strength and intensity of the respective links with the thickness of the given lines. Figure 1 shows that the 2016 IFLA strategy reinforces the need for the previous point.

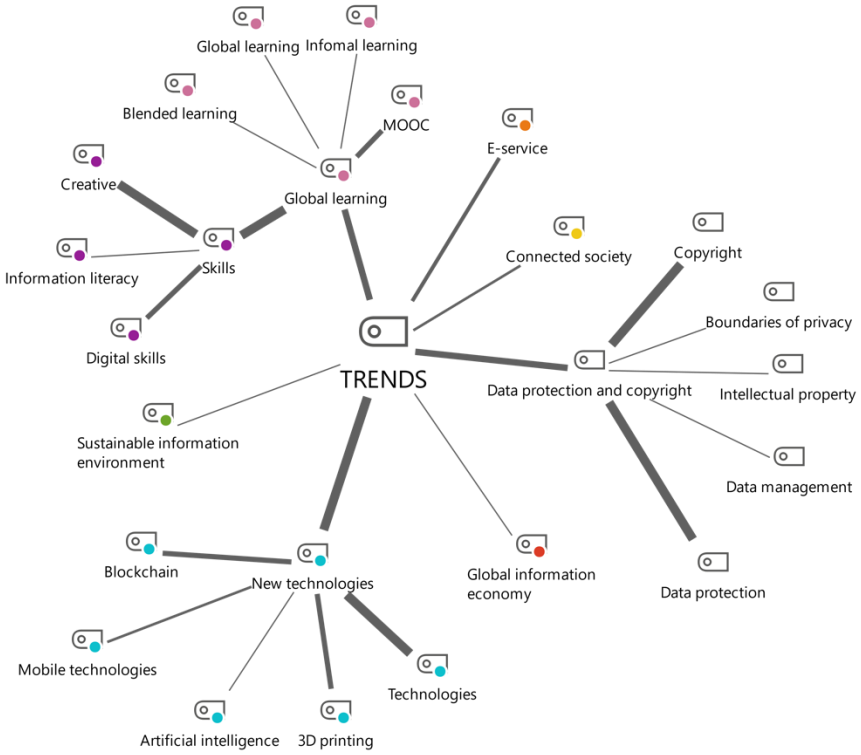

Fig. 1. IFLA Trend Report 2016 Update code-map (Lengyelné Molnár, 2020)

The 2017 IFLA strategy dedicates a separate chapter for promoting the application of the Makerspace in libraries.

In Hungary this process is still in the beginning stage as the concept, its main features, and respective potential are not yet well-known. Below we describe the conceptual system and the given means and we will propose device-specific methodological recommendations.

3. Makerspace

Makerspace entails a learning support environment utilizing state of the art technology, which enables the participants to perform creative work by the use of digital devices. Accordingly, tutors relying on thoroughly chosen methods prepare the participants to meet the demands posed by society and the labour market, develop STEM competences, and promote the experience of creation via digital means.

3.1. Historical aspects

The establishment of Makerspace centres is based on three developments (Burke, 2018):

- Hacker groups aiming to share open computer technology with the public,
- Maker Faire centres promoting the implementation of DIY and art programs in a community context,
- Fab Lab creative centres hosting Do It Yourself-type projects.

The professional community has yet to reach a consensus whether the following three terms can be considered synonymous: fab lab, hackerspace, makerspace (Holm, 2015).

Nowadays in Hungary a greater attention is given to this "movement" promoting cognitive and cooperative skills via creative learning. "Creative insights are either achieved when the existing ideas are combined in an unexpected manner, or are re-interpreted, or when they are used in non-compatible areas. Often this goal is realized via the formation of extraordinary concepts, or the discovery of analogies and connections between unrelated ideas and objects." (Turner-Bisset, 2016) Accordingly, a great change takes place in the thinking of the participants as our visceral evolutionary cognitive instincts are superseded by a group-dynamics induced social perspective. While the individual as a creative force or agent is still present, the given product can only be created via the use of shared resources. The significance of the Makerspace approach is in the creative community, the development is represented in the given creative process. Thus a venue emerges for relevant exchange of experience where raw material, device, the creator and the mentor are united in a shared creative effort.

Yet, how could we define Makerspace, a term, whose appropriate Hungarian equivalent has yet to be found? Let's start with the words themselves.

3.2. Maker

The term "maker" refers to the creator, the creative person participating at a given session and enhancing the shared knowledge with their own skills. During the creative process he or she participates as an independent entity in the process chain, where they can personally influence the respective changes or developments and the impact of such decisions will be felt at the community level as well. The module-based work processes enable the participants to function independently, or contribute their personal characteristics or expertise to making the shared product. The process has no upper age limit as the creative effort is eternal and the types of goals to be realised are only limited by the interest of the participants and the same applies to the lower age limit as well. It must be emphasized that the creative process is based on teamwork as the given products are so complex that one person could not prepare them on their own.

3.3. The community of creative individuals

The participants always learn and work in teams and experience failure and success as a team too. This way the creators will form a creative community, whose members will perform partial tasks while developing their cooperation skills during making the final product. Each member of the given group gains new experiences resulting in the development of their cognitive skills and eventually altering their overall perspectives. The obtained knowledge can be inspiring either on the community or individual level of the creative process and can even impact the respective reality modeling methods. Due to mutual learning the creative participants can bridge over social barriers while developing new networks, exchanging information and enjoying the benefits of experience-based learning. Consequently discourses, debates and opposing arguments can be formed promoting community building and critical thinking. The fostering of critical thinking skills is only one of the aptitudes demanded by 21st century society and the formation of a community creative space can contribute to this goal. The implementation of the 4C model includes Collaboration, Communication, Critical Thinking, and Creativity (Sipayung et.al., 2018). External stimuli help participants of the group sessions to adapt to the potentially emerging challenges. The road to the solution of the given tasks starts with the recognition of perspectives embodied in a relevant action. The group can only reach its goals if the members can focus on the solution in a complex way and communicate effectively during the implementation of the various modules while the respective questions and answers contribute to finding the given solutions.

The Makerspace context does not determine the aspects of the creative process as these are up to the participants. The required technological knowledge is delivered by a proficient mentor. The mentors provide guidance, introduce the various themes, and foster the thought process of group members in order to facilitate goal implementation. Due to the several decision-making options this process can be continuously changed according to the needs of the group members. A mentor can regulate the difficulty level or stop the process even at one module as these components can function independently. The overall goal is not performing an exhausting intellectual or physical effort but obtaining shared experiences.

3.3.1. The modularity of the creative process

Although the topics of the Makerspace sessions are determined by the mentors, the preferences of the group and the technological background of the given creative workshop are taken into consideration as well. The creative process can imply an ordinary project such as a smart home, but in our thoughts we can explore the universe and prepare a tool or device for the solution of a virtual problem. There are several effective, and well-functioning options including 3D printing, editing A/V or still images, VR, AR, gastronomy, green cities, smart home, security technology, or even programming.

3.4. Makerspace

3.4.1. Current policies

Such workshops have already been integrated in the education system in the United States, the Benelux countries, Spain, Denmark, and China. Makerspace is a project space enabling participants to become familiar with a wide selection of community-based creation options and work processes. Fortunately, this process has already become part of the Hungarian education sphere and educational policy making. Accordingly, the 2020 version of the National Core Curriculum includes Digital Culture as a special subject. The creative process has already been popularized in the United States since the beginning of the 21st century and in 2006 more than 900 projects have been displayed on the Maker Fair event aimed to promote creative activities, new devices and tinkering activities. The Maker Fair has turned into a major international event and will be held in Europe in special venues as Vienna is expected to hold the event in 2021. It must be noted that the "Maker Movement" has already arranged several special programs in that city.

3.4.2. Makerspace in libraries

The project spaces entail a creative workshop equipped with a variety of state of the art hardware and other technology. The wide selection of the devices available in one location encourages the community to strive for more complex solutions in realizing their goals. Thus the creative workshops become a special unit made up of skills and machines within the organizational structure of the libraries. Currently libraries are considered as sites for learning and information acquisition in addition to the traditional function of borrowing and returning books. These facilities financed either by tender grants or by the institution's own resources provide an ideal space for community organizations. The integration of makerspace labs into a library environment started as a natural process since libraries have always applied the achievements of technology in an innovative way and the available infrastructure is sufficient to launch such efforts. Such solutions do not always require a major financial investment as relatively low-priced programming equipment, worth a few thousand HUF, can be used by mentors to develop high quality sessions. Larger informatics investments with a potential to attract creative participants require additional financial resources.

3.4.3. The history of creative communities

Makerspace solutions were always based on contemporary technological achievements. At the beginning of the nineteenth century the artificially lit spaces facilitated the unification of libraries, lecture halls, and laboratories in Scotland. In 1826 a faculty was established in the Maryland Institute College of Art in Baltimore to promote the training and shared thinking operations of merchants, mechanics, and builders. The Maker Fair series had a predecessor as well since an exhibition organised in San Francisco in 1857 targeting manufacturers and inventors displayed 900 exhibits. While these events were not fully open to the public as only registered members could take part in learning or creative activities, these facilities paved the road toward a more complex creative process. In 1876 Thomas Edison established a research laboratory in Menlo Park followed by the first Bell Lab brought about by Alexander Bell. The Bell Labs assigned high significance to cooperation along with the possession of state of the art equipment. Until 1940 entrepreneurs and inventors established an additional 350 creative spaces and during the second half of the twentieth century creative workshops were transferred to libraries and schools (Holman, 2015). In 1938 John Dewey called on teachers to arouse the curiosity of students in order to promote the desire to learn and to set such educational goals which can be achieved with an appropriate intensity of experience-based learning. In his view

the Makerspace would combine the complexity of relevant experience and the interests of the community with the use of devices and materials (Williams, 2017). Seymour Papert (1980) integrated computers into creative spaces, while informatics devices were considered as cognitive tools and part of the creative process.

3.4.4. The library as a makerspace hub

The new creative workshops primarily need good ideas and a creative team, rather than devices. Makerspace type of thematic community activities have already been implemented in Hungary, one such example is egg colouring sessions at Easter. While in Makerspace the given group has to be familiarised with the use of new and innovative devices, the currently available machinery can be enhanced, as modularity is one of the basic aspects of informatics.

In addition to the development of creativity and the ability to function in groups workshop participants become familiar with the use of the given devices. Consequently such individuals gain a competitive edge in the labour market. Therefore these workshop-based creative activities help in enabling the general public to meet the challenges posed by the world of work impacted by the Fourth Industrial Revolution.

3.5. Typical devices in a Makerspace lab

The most typical Maker space lab devices include robots, but we know of libraries maintaining a full makerspace lab as well (Figure 2).

Fig. 2. Békés County Library Makerspace (Genczinger, 2019.)

Let's take a closer in-depth look at what tools you can find in a lab and how you can teach how to use them in a library session!

3.5.1. 3D printer

One of the tools effectively used in creative spaces is the 3D printer. The 3D printer represents a new perspective and technology as the three dimensional creative process utilizes a melted material, the filament. Participants become familiar with the design process along with several new concepts. Three dimensional creative activities require more creativity compared to production in a vertical and horizontal direction. During the shared design effort (Figure 3) several skills of the other participants develop unwittingly in a playful form as the group focuses on the joy of shared creation. The end result is an object produced by a new technology, a 3D printer (Figure 4), building on the creativity of the group members making various objects from the filaments with heat either as a sub-task of a module or a final outcome of a given project.

Fig. 3. Craftware 3D editing program in use[1]

Fig. 4. 3D printing, demonstrating the internal structure of the given object

3.5.2. Laser cutting and engraving machine

Laser cutting machines (Figure 5) are suitable for cutting, engraving, or marking a variety of materials. This device can provide useful and exciting options in the Makerspace for marking the form designed by the participants themselves or even for the transmission of the given information entailing the engraving of a QR code or a certificate number. Participants should be familiarised with more materials and their features partly determining the goal of the creative process. Those participating in the creative effort will experience how the image on the screen will turn into a tangible (Figure 6) object after being forwarded to the laser engraving machine and performing the respective operations.

[1] The pictures or photos displayed in the article (Figures 3-9) were made in the Bródy Sándor County Library.

Fig. 5. Laser engraving machine

Fig. 6. Laser engraved CD-ROM, as a Bakelite record

3.5.3. Sewing machine

The sewing machines can be successfully integrated into the analog and digital equipment pool of Makerspace labs in libraries. While the creative process remained essentially unchanged throughout the years, new materials and implementation methods emerged. Learning the use of microprocessor controlled sewing machines takes less time than the previously described innovative devices. Such a feature implies an ideal opportunity for working together and making pieces of clothing, puppets, or even objects.

3.5.4. Microbit

The Microbit is an open source code hardware device designed by the BBC with a LED display, several buttons and sensors, and numerous output and input functions. The Microbit provides an ideal option for the solution of an imagined or real problem. Its application in libraries promotes creativity and cooperation while developing algorithmic thinking skills, thus it can be a well-integrated and valuable component of the Makerspace lab. A unique feature of the system is that as a result of the program prepared in the laboratory the screen displays not a value, but the result of the program process promoting changes on a little device. (Figure 7) Programming languages can be learned in a playful manner and the group becomes motivated in acquiring or becoming familiar with a new language and ways of thinking. (Sentance et.al, 2017)

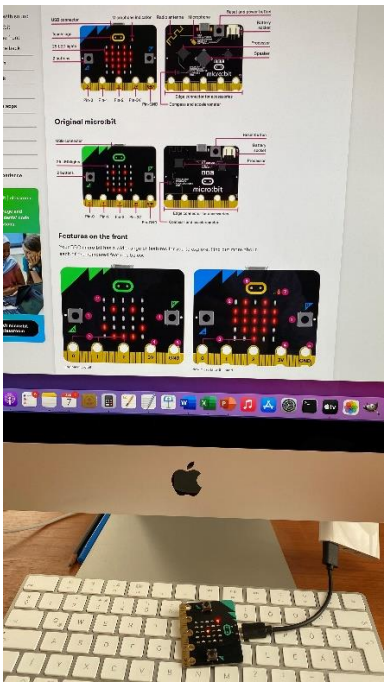

Fig. 7. BBC micro: bit programming

3.5.5. Smart home

While the new innovative devices have become part of our homes and perform several tasks and improve the living standards, the respective options are not widely known and people tend to be reluctant to apply them. The demonstration of the use of such devices in the library sessions widens one's perspective and contributes to the general increase of digital competences. Makerspace labs provide an opportunity for the participants to become familiar with such devices, including programing them or giving them commands. Such an exercise would be programming a light switch to come on after opening a door.

3.5.6. New and novel areas

There are several innovations which are not part of our everyday life, but provide or imply exciting opportunities. One such solution is the LiFi offering an alternative to WiFi technology. In this case the group can perform thought experiments, exploring their legitimacy and the given area where this technology can be used, and the respective alternatives. Also working solutions can be introduced and the technological advantages can be pointed out to the participants. (Scace, 2018) The profile of the Makerspace lab can be enhanced by identifying and introducing similar innovations.

3.5.7. VR/AR

During application of virtual reality in libraries we can familiarise visitors with commercially available virtual reality programs prepared for educational and entertainment purposes. Makerspace labs participants can not only try the application of augmented reality, but can create and program such solutions with the guidance of their mentor. For example, Figure 8 shows an implementation of AR created with a smart phone. The modeled object (Burdea & Coiffet, 2017) positioned in a virtual space can be enhanced with interactive features as well.

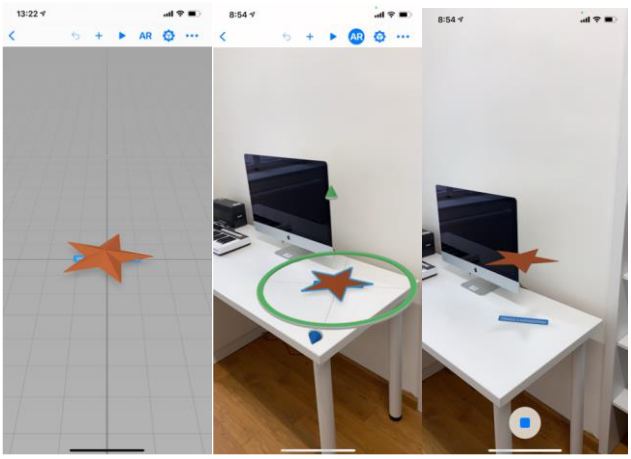

Fig. 8. The implementation of AR with a smart phone

3.5.8. Sound and video labs

We can produce and edit audiovisual materials or various peripheries can be combined into (Figure 9) a solution similar to the YOUmedia Network in the United States where the latter functions as a community project facilitating extracurricular learning (YOUMEDIA, n.d.). Preparing a podcast dealing with real problems requires only editing and disseminating the respective content in addition to the demonstration of the given tools.

Fig. 9. A/V laboratory

3.5.9. Drones

These trendy devices facilitate the performance of interesting and exciting tasks, and can provide excellent opportunities for learning. Having obtained the required navigation skills, pictures can be taken or videos be recorded which can be forwarded to the video lab for editing. The session leader and the group can cooperate in making a shared project based upon the compatibility of the other devices.

3.5.10. Mobile devices

The mobile telephones and laptops can function as ideal devices for collaboration. Participants in Makerspace programs should be made familiar with the given applications and the methodological options via pictures, video recordings, sound recordings or social media along with the creative use of various services available via cloud solutions. During a larger project it is worth to rely on own devices for the preparation of photo or video documentation in order to trace and record the respective work processes.

3.5.11. Drawings

The digital drawing board is perhaps the easiest to integrate. Accordingly, independent programs can be implemented including preparing an artefact connected to a common theme or event. Pictures can be converted into images processable by laser engraving in addition to making moving picture series. Thus an additional new technology is integrated into the creative activities at the Makerspace lab.

3.5.12. Digital story telling with LEGO devices

Digital story telling combines classic narration with the methodology of multimedia based processing and presentation (Antal, 2019). The LEGO Education developed a comprehensive tool kit for digital story telling including software, which enables users to convert the photographs of the episodes of the stories constructed from LEGO elements into digital works complemented by subtitles, backgrounds, and video clips. Since digital storytelling is an ideal method for processing reading experience, it is becoming an integral aspect of the methodological arsenal of libraries.

3.5.13. Team development

The Makerspace lab not only develops personal digital competences and promotes creativity and collaborative skills, but it has a significant impact on socialization as well. The sessions result in the development of a team as in the Makerspace movement the library provides the resources for the community, and the librarian functions as the mentor, fulfilling the most important role, that is the helper. The mentor supported by their qualification and creativity supervises the whole team formation process, introduces the various technologies and provides advice in order to help the group to realize its goal. Furthermore, in addition to a high proficiency level the mentor is expected to adapt to the skill level of the group and differentiate or distinguish between the difficulties related to implementation. In case of a product containing several modules utilizing various devices and technologies it is useful if the mentor customizes their approach as the given group can contain people with differing ability and skill levels. The result of this effort would be the promotion of professional communities on the long run.

4. The situation in Hungary

4.1. Research questions

The main focus of our research is helping Hungarian libraries to catch up with the international library sphere. Consequently, we explored the current state of the respective domestic institutions from such aspects as infrastructure and human resources. Our inquiry extends into attitudes related to innovation and training along with specific plans for the improvement of technology and various training programs. We aim to draw conclusions regarding the potential significance of the given concerns along with evaluating the present efforts and future perspectives related to the popularization of the makerspace approach.

4.2. Methods

We administered an online questionnaire: (tinyurl.com/akonyvtarakdigitalisatallasa) to a comprehensive sample of all library managers of Hungary in the spring of 2021. The respondents included

- leaders of national libraries (3 institutions),
- leaders of university and college libraries (68 university and college libraries),
- leaders of county libraries (19 managers of county libraries and institutions maintained by the given county library, summary 3389),

- all principals of public education institutions where a school library operates (4482 institutions).

We sent individual emails to the heads of the institutions inviting them to fill in the questionnaire, and responses were voluntary.

4.3. Sample

We received one response from each institution, for a total of 502 responses and 415 could be considered valid since the given questionnaires were fully completed.

4.4. Results

Although the library managers were asked to respond, the breakdown of respondents by function is as follows:

84.6% of the respondents in the case of academic libraries were in a managerial position, 49.2% of the respondents in the case of public libraries were managers, 100% in the case of academic libraries, while school librarians and librarian teachers were the respondents in the case of school libraries, but only 3.9% of them were in a managerial position.

In terms of gender, 10.6% of respondents are male, 87.6% are female and 8 respondents (1.8%) did not wish to specify their gender.

The primary objective of the survey is to assess the institutions providing Makerspace services. The responses revealed that presently 2,18% of school libraries and 8,73% of public libraries provide such service. The proportion of libraries providing Makerspace services is 4,1% (Table 1)

Table 1 Institutions providing Makerspace services

Type of library	**Number of respondents**	**Number of institutions providing Makerspace services**	**Rate of institutions providing Makerspace services**
library affiliated with a higher education institution	13	0	0,00%
school library	275	6	2,18%
public library	126	11	8,73%
scientific and professional library	1	0	0,00%
Total	**415**	**17**	**4,1%**

The survey indicated that more than half (54,36%) of the responding libraries are equipped with tablets or smart devices, and in 40% of the respective facilities digital boards are available as well, so some technological element is already present in library services, but they are not used as makerspace services.

As can be seen in Figure 10, tablets and smart devices are present in all types of libraries, while interactive whiteboards are most common in school libraries.

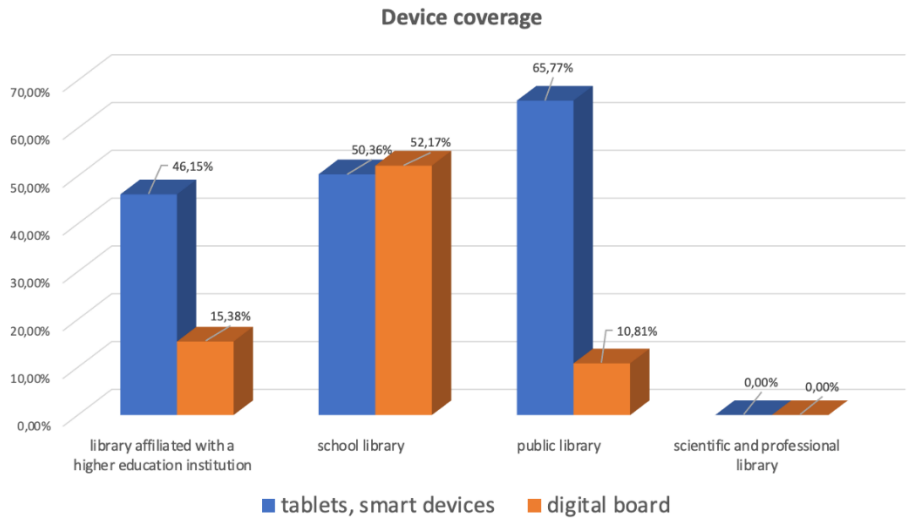

Fig. 10. Device coverage

The survey also explored whether appropriate human resources are available for the operation of Makerspace labs. The respective data confirm a low rate of participation in such training programs (Figure 10).

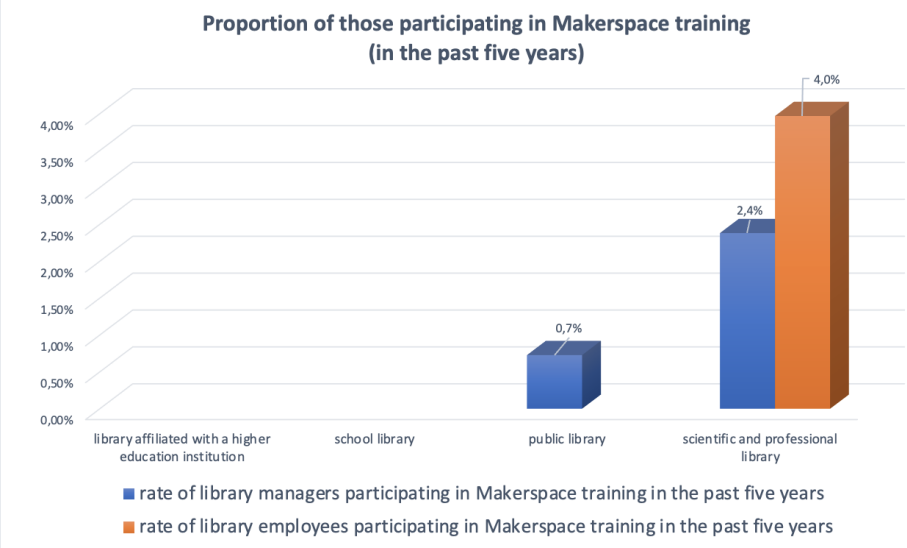

Fig. 10. Proportion of participants in Makerspace training in the past five years

It is encouraging that the survey confirmed high demand for such training. In all library field find like library managers across the board would either like to participate on their own, or would want their employees to take part in such programs (Figure 11).

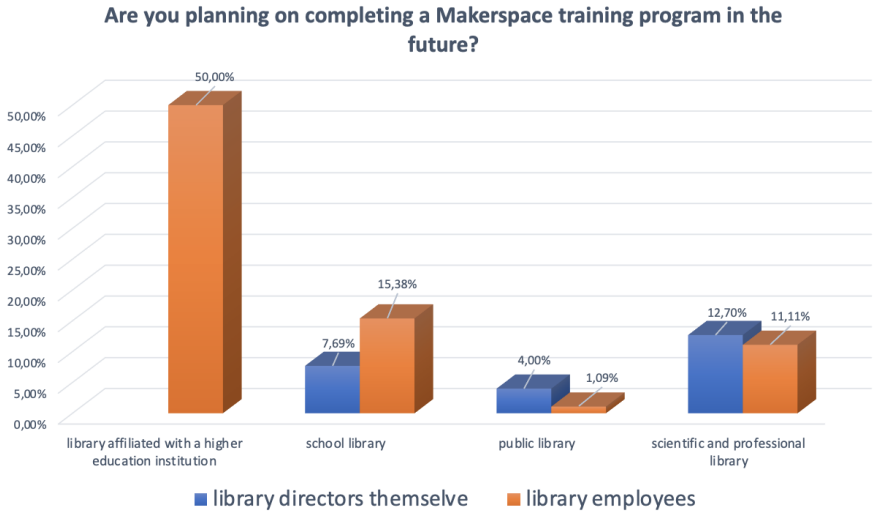

Fig. 11. Proportion of those planning to complete a Makerspace training course

5. Conclusion

Answering the research questions the libraries abroad and at Hungary as well have implemented various positive activities and innovations. Such developments are supported by library strategies too outlining definite trends for further progress. Answering the research question the libraries are open to methodologies based on technological tools.

While in the near future more and more Makerspace labs are expected to operate in Hungary, compared to the international sphere the respective development is slow. Although the 2013 library strategy contained such guidelines, the first Makerspace lab was only established in 2019 and not more than 17 institutions have offered such services two years later. The development of libraries into makespace centres is also an opportunity for schools, which could in the future learn to use the tools that schools lack.

Yet, the increasing interest is encouraging as not only school and public libraries are open to such innovation as libraries associated with higher education institutions and scientific and professional libraries also expressed their intention to host or develop Makerspace labs.

As a last word of encouragement we can expect that librarians will be needed in the future. as Lengyelné Molnár (2020) states, “Nevertheless, the preservation of the name of the profession cannot be guaranteed, as in the 21st century the rate of information presented in the form of traditional books is expected to decrease. At any rate the library experts of the future have to

be highly trained in the retrieval of information and the discipline of informatics." Additional responsibilities include the preservation of cultural heritage, the people the transmission of general culture and prepare the population for technical challenges.

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