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REGULATIONS FOR THE USE OF 3D PRINTING IN ACADEMIC LIBRARIES



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KEYWORDS: 3D printing. Academic libraries. Public and private universities. 3DP sharing regulations.

ABSTRACT: **Thesis/purpose of the article** – the purpose of the article is to present the main components in the content of the regulations for making 3D printing available in academic libraries. **Research methods** – this study examined the content of regulations available in 86 academic libraries at public universities and 34 libraries at private universities in the United States that provided 3D printing services. **The most important results** – the final analysis distinguished five thematic groups indicated within the regulations: 1. introductory data, preliminary requirements, general work rules, occupational health and safety; 2. equipment, equipment availability, location, FAQ, contact information; 3. limits, restrictions, fees, laws, warranties; 4. workflow; 5. additional information, tips, suggestions, ideas, and inspirations. **Conclusions** – there is no single template for creating

regulations, but most of the content studied references to the categories indicated above. Each library included content in these categories to a different extent in the rules applicable to its institutions. Moreover, the most frequently indicated components of the regulations included information about the following: available printer models (65%); appropriate software (42%); ways of contacting library staff (41%); warnings that you can only print objects that comply with applicable law (40%); and objects that are not dangerous (39%).

INTRODUCTION

Cheap 3D printers appeared on the retail market at the end of the first decade of the 21st century. Since then, 3D printing technology (the abbreviation 3DP comes from the words three-dimensional printing) in the USA has also started to be implemented in the activities of academic libraries. The widespread implementation of 3DP in American academic libraries has resulted in the need for appropriate rules and regulations for working with this still relatively young technology. These regulations help in the efficient provision of services. Libraries have regulations for making all their resources available, as well as for providing the services they offer. The introduction of a new service, in this case, 3DP, requires libraries to create appropriate procedures in this area to make work easier and more efficient for both library staff and users.

Libraries apply different rules for working with 3DP, which is why they have different provisions in the regulations in force there. Since there are no top-down guidelines in this area, each library developed this type of guidelines in its own way. As a consequence, in each of the analyzed facilities, the regulations used had a different structure, i.e. they contained different provisions, often original ones. Moreover, even the same aspects indicated in the regulations could have a different scope in different facilities, e.g. the maximum time of using 3D printers was different.

PURPOSE OF THE ARTICLE AND METHODS

This article aims to present the main components of the content of the regulations for providing 3D printing in academic libraries to assemble the key elements of the regulations that should be considered standard.

To achieve this research goal, 86 academic libraries at American public universities and 34 libraries at private universities providing 3DP services were selected, a total of 120 libraries combined. The libraries in question were selected using *The Best National University Rankings* (2023), covering a total of 443 institutions. The 120 selected libraries were all that offered 3DP out of 443 institutions included in the ranking. In July 2023, the

websites of these selected libraries were examined. Academic libraries at universities in the USA were selected because they were the first to implement 3DP. The first one was the University of Nevada, Reno library (Chin, 2012). This means that 3DP technology is already well established there. This guaranteed obtaining numerous research material.

When analyzing the regulations available in these institutions, the components selected were those that appeared in at least 12 (10%) of the regulations among all the libraries. In the part presenting the research results there is a Table 1 with numerical data indicating how many of the analyzed regulations (from institutions offering 3DP) contained references to the identified components.

Creating a set of points necessary to include in the structure of the regulations will allow to understand how work with 3DP is organized in this type of libraries, and therefore what should be regulated and what information and data should be included in such regulations. The points of the regulations present both the point of view of the user and the library, so they are important for the client and the institution. The regulations used for this research were developed on the basis of: 3DP implementations; pilot projects; experience in working with 3DP.

This research suggests that each library that includes 3D printing in its services should develop appropriate regulations that discuss every aspect of working with 3DP. In Poland, practically no academic library of a public university offers 3D printing services to all interested parties (Kotula, 2024). Therefore, the findings collected here may be useful when developing regulations for the provision of 3DP services in an academic library wishing to implement 3DP. In addition, these results can be a reference point when conducting comparative research on information contained in regulations within American libraries.

Creating a set of points necessary to include in the structure of the regulations will allow you to understand how work with 3DP is organized in this type of libraries, including: what is important; what to pay attention to; what needs to be regulated; what is the scope of regulation; what information and data should be included in such regulations. The points of the regulations, which are answers to the questions formulated above, present both the point of view of the user and the library, and therefore are important for the client and the institution.

REVIEW OF THE LITERATURE

In the scientific discourse on 3D printing in academic libraries, little attention has been paid to the strict regulations of working with this technology. Top-down guidelines for creating regulations have not been de-

veloped anywhere, so libraries have implemented 3DP in individual ways according to individual activities; thus, they have developed appropriate regulations according to their individual needs.

There are works providing general guidelines on how to create this type of regulations in various types of libraries. For example, the American Library Association postulates that such policies should:

- “identify those eligible to use the library’s 3-D printer;
- outline all rules and regulations concerning user access, fees, and training requirements;
- bar use of the library’s 3-D printing facilities for illegal activities;
- include a statement informing users that all other library policies apply when using the library’s 3-D printer or printing services, including policies addressing user behavior, acceptable use, cybersecurity, copyright, intellectual freedom and user privacy” (ALA, 2018).

Policies may also address legal issues, copyright, illegal items. Printing dangerous items such as weapons should not be allowed (ALA, 2018). Moreover, also „a mission statement or statement of purpose should encourage users to learn about new technologies, exercise their imaginations, and assure their freedom to create, and design new projects within the parameters imposed by the technology” (ALA, 2018).

In another work, the sample 3D printing policy was indicated. It contains basic information, i.e. that 3DP is intended for employees and students. This sample policy consisted of 5 parts. The first one provides basic information, i.e. that objects can be printed in accordance with applicable law and those that are not dangerous. The second points that the library may reject a print application; each printed item can be photographed and placed on the library’s website. The third one contains information about the lack of fees for printing for members of the academic community. The next states that printed items must be collected within 7 days, after which they become the property of the university. The last part contains information that the entire process is handled only by authorized personnel (Chan 2016).

The following articles present the results of analyzes of existing regulations. In one of the few works on this topic, Jennifer Horton (2017) analyzed the content of 50 regulations on the principles of working with 3DP in academic libraries in order to find common features. She identified five main themes: the policy’s purpose, potential users of the 3D printers, 3D printing procedures, the acceptable uses of the 3D printers, and user privacy considerations (Horton, 2017). Many regulations included explanations of what 3DP was. It was pointed out that the purpose of making 3D printing available is, among others, stimulating imagination, providing access to modern technologies, promoting creativity. Libraries have always clarified who can work with 3D printers (users themselves, under

staff supervision, or only library employees). It was instructed which printouts are treated as a priority, e.g. those needed for the implementation of classes and scientific and research projects. Personal printouts will only be possible when there are no printouts from the first group in the queue. In addition, there was information about possible fees, collecting prints and issues related to the quality of the models. Libraries regulated the permissible use of printers, i.e. printouts had to be in accordance with the law and the rules applicable at the university and in the library. It was explained that dangerous items, weapons and those protected by intellectual property rights could not be printed. Finally, there was always a clause stating that the library could refuse to print without giving a reason. Generally, prints intended only for non-commercial use were allowed. (Horton, 2017).

Another article explains how to organize work with modern technologies, specifically 3DP, in the makerspaces of academic libraries (Schmalbeck, 2020). The first step is to determine the necessary procedures for organizing a work workshop. The procedures include identifying and establishing qualified users, training, fees, safety, acceptable materials, defects, occupational health and safety, and storage of printouts. Second, a makerspace must be adapted to the regulations of a given library. Third, everything must comply with the laws of a given country. Fourth, the goals and mission of a given makerspace should be clearly defined. Finally, when developing regulations, the principles of simplicity and accessibility should be followed so that everyone familiar with the regulations quickly obtains a clear picture of what they are allowed to do and how they are allowed to do it (Schmalbeck, 2020, pp. 7-10).

FINDINGS

Exactly 27% of the academic libraries of the public and private universities mentioned above had a makerspace, maker studio, or other laboratories fulfilling the same tasks, i.e. creative work spaces with 3D printers. In two cases, the creative space with 3D printers was just about to be opened, and demands were collected from the academic community regarding possible equipment. In three other cases, libraries stopped providing 3D printers. One of the university libraries had printers currently under repair. The library currently implementing 3DP as part of a pilot program was informed that the currently applicable regulations may change later.

The remaining libraries of universities included in the indicated ranking did not have makerspaces or provided 3DP services, which does not mean that there were no appropriate makerspaces at universities. However, they were supervised by other university units.

In the libraries analyzed for this study, there were appropriate, more or less extensive, regulations for working with 3DP. Sometimes they were very sparse in words, limited to a few basic, yet important pieces of information (one was only half an A4 page). Other times, they were very extensive, multi-page documents or multi-tabbed websites with numerous sub-pages. During the analyses, it was possible to distinguish five thematic groups that were included in the regulations.

It should be added here that libraries that did not have 3DP rarely informed about it on their websites and directed to other university units where three-dimensional printing could be made. It is also worth adding that each university had stations with 3D printers available to the academic community, which were located in libraries and/or other university units.

In most cases, access to 3D printers was wide for every member of the local academic community interested in using them. However, very rarely (1 case) 3D printers were used to produce models for specific, individualized needs of the laboratory operating there. In other words, they were made available in a strictly defined manner when creating objects related to the activities of this laboratory, and not for individual, arbitrary projects of library users. Strict regulations regarding the use of 3D printing were not always available. It happened that printers were promoted and users were encouraged to work with them, but no detailed regulations were available. Instead of regulations, obligatory online courses or training workshops were available during which participants were to learn all the necessary data related to the rules of using 3DP in a given facility. Sometimes it was obligatory to complete the course in an online or blended formula.

In total, approximately 15% of libraries provided courses (approximately 9% of the libraries of private universities and approximately 15% of the libraries of public universities). Courses were offered by approximately 14% of the libraries of public universities and 9% of the libraries of private universities, and in total by approximately 12.5% of all the libraries surveyed. Only about 3% of public university libraries offered courses instead of regulations, which is about 2.5% of all academic libraries. The regulations themselves were in place in approximately 74% of the libraries of public universities and approximately 85% of the libraries of private universities. In total, approximately 77.5% of all libraries. Neither regulations nor courses were made available by approximately 11.5% of the libraries of public universities and approximately 6% of the libraries of private universities, while in total it was approximately 10% of all libraries.

The available courses were something like library training for all first-year students, but in this case they concerned 3DP technology and were

intended for willing users of a given library. In those libraries that had extensive courses, no separate regulations were available. All important issues were included in the course content. The course can be considered as a more attractive form than the typically descriptive regulations.

1. INTRODUCTORY DATA, PRELIMINARY REQUIREMENTS, GENERAL WORK RULES, OCCUPATIONAL HEALTH AND SAFETY

The introduction provided information on 3D printing and occasionally explained why the library offered a 3D printing service. It was pointed out that creating a three-dimensional design is a much more effective method of checking whether this object fulfills its tasks – in accordance with the concept – than just discussing it and showing drawings. It was recalled that the main point of 3D printing is that it provides the opportunity for quick prototyping, i.e. creating a prototype for an item that will later be produced in a traditional way when it is ready.

Users were rarely familiar with the dictionary of basic terms related to 3DP. The terms included, among others, ABS, Cura, dual extruder, extruder, FDM, FFF, filament, mesh, axes (X, Y, Z), PLA, support, print surface, slicer, worktable, filling, size, etc.

If there were entry requirements, they were also included in the introduction. These requirements provided guidelines requiring one to fill out an application form before starting to work with 3D printers. In addition, some libraries require users to take part in an introductory online course – some were very short (about 20 minutes), others were much more extensive, taking up to almost 80 minutes. Available courses included descriptive parts, infographics, photos and audio-video materials. In one case, users had to prove their qualification for 3D printing by creating a personalized design of an item (with their own name/surname) and presenting it to the staff. A properly executed project was the sine qua non for using 3D printers in this makerspace. Users were also required to pass library training on the general principles of using library resources.

The equipment was operated either by staff, by users themselves, or by users under the supervision of staff and/or other supporting persons such as volunteers or more experienced students. Therefore, it was necessary to either deliver the file with the 3D model (usually in STL format) to the library (via e-mail, form, in person). In one case the user was asked to monitor the printout for the first 30 minutes to ensure that the design was correct. In most cases, the user had to be present during the entire printout. If the staff made printouts themselves, in case of errors, the printout attempt was repeated. However, it was noted that two failed attempts suggested that something was wrong with the design, so such prints were rejected. Printed objects should be removed from the work table and their supports

should be removed. Therefore, it was informed that all these tasks were the responsibility of the clients, who should do it themselves and outside the makerspace.

In most cases, it was noted that the library staff did not edit the files or interfere in any way with the model design. The only exception were printouts made by library employees, but then librarians prepared them only in slicers, i.e. programs that convert the file with a 3D model into a form understandable by the printer so as to effectively print the whole thing. In this context, it was recalled that a poorly made project may not be printed.

Prints at the customer's request (3DP on demand) were made within 2 to 15 business days, which of course depended on the adopted guidelines regarding the maximum allowable size of the object and/or filament consumption. The printed objects had to be collected within the specified time, e.g. within 7 days. Printouts not collected after this time were usually thrown away. Some libraries had appropriate procedures for recycling unused printing material or unclaimed prints.

Some regulations require the use of masks due to harmful fumes released during printing. It was also recommended to wear protective clothing, e.g. glasses.

2. EQUIPMENT, EQUIPMENT AVAILABILITY, LOCATION, FAQ CONTACT INFORMATION

The available regulations included mandatory detailed data on the 3D printer models owned by the library and information on the exact location of the makerspace with the printers. In addition, exact working hours and hours during which 3D printing could be performed were also provided.

Libraries were equipped with 1 to 52 3D printers. These were different models, both open-source and proprietary, with closed and open housings. Different printers had different print parameters, especially the surface area (usually from 20cm x 20cm x 20cm to 60cm x 60cm x 60cm). Depending on the selected model, the user could incur fees for the material used as well as the work created on the printer. Information was also provided about available printing materials, such as filaments and resins (depending on the available equipment). Various were distinguished among them, including: ASA, ABS, PLA, CPE, PP, TPU, PC, Acrylic, HDPE, PET, PETg, NinjaFlex, nGen, Nylon, PVC, PVB, PTFE, PolyWood, woodFill, UV curing resin, hard resin (thought resin), flexible resin, castable resin. Mostly, however, they were printed in PLA, also in various colors to choose from. It was not always possible to choose a color, because sometimes the library reserved the right to print in any color. It was pointed out that only filaments purchased by the library are acceptable. In other units, purchases of specific filaments by users were allowed. The information

also included what 3D printing technologies were available in the library, e.g., FDM (fused deposition modeling).

If the library also included 3D pens, they were also discussed in more detail. Similarly to the descriptions of printers, all the details were provided, explaining what capabilities they have.

An FAQ (frequently asked questions) was often listed as well. It included all important information and data related to 3DP in a given facility, or it supplemented the previous ones. Details of people to contact for further information and/or assistance related to 3DP were also included. Finally, participants were given opportunities to sign up for on-demand or periodic workshops.

3. LIMITS, RESTRICTIONS, FEES, LAWS, AND WARRANTIES

This part included information that the 3DP service was available only to students and university employees. Some institutions also allowed people from outside the university to make printouts. However, their projects were not treated as a priority.

For the most part, no fees were introduced for employees and students at the universities served by a given library. In several cases, though, fees were required for the material used and/or per hour of printing. For others, there were entry fees, and one even charged a minimum fee of \$3. In some spaces, a fee was charged for preparing the equipment and the file for printing (calibration) or for removing supports (\$2 for 10 minutes of work). Some institutions indicated that projects consuming up to 50g of filament per project or 150g per month did not require fees, while other institutions did. There were no fees for prints of a certain size, but several charged a fee for printing larger items.

Printouts for scientific and research work were free of charge, while personal printouts required fees. There were limits for non-academic projects and the amount of filament required, e.g., up to 150 grams of material used per month or semester.

The printing time was also limited. Some libraries allowed printing during the opening hours of the makerspace only. In most cases, however, no such limits were introduced. It was pointed out that printouts should be used only in non-commercial activities, such as prototyping, and not for mass production of items. Mostly, users were allowed to print one item at a time and only on one printer at a time.

Legal aspects were clearly addressed in all libraries. Users were informed that they were responsible for the printed objects, regardless of whether they printed them themselves or commissioned them to the library. Therefore, it was always emphasized that all printouts must comply with applicable law. Sometimes, it was even required to prove the right to

print a given object, i.e., that it was one's own creative work, the object was in the public domain, or it was part of scientific/research work conducted at a university, etc.

Moreover, it was forbidden to print any weapons; dangerous items; objects that violate applicable local, state, federal, internal university, and library ordinances; or items that violate intellectual property rights. Ultimately, it was up to the library to decide whether to print a given object or not. Libraries could also refuse to print items without giving reasons.

None of the libraries provided a guarantee that the printed objects would meet the users' expectations because the users took full responsibility for the printing and subsequent use of their works.

4. WORKFLOW

The collected research material often confirmed the bulleted way of organizing work with 3DP. Of course, it took various forms, because of the different ways 3DP services were offered at specific libraries (free or paid, independent or performed by staff). The analyzed regulations included a description of the entire 3D printing process, i.e. workflow. Familiarization with the workflow regulations available in the policies allowed to develop the following scheme. The research enumerated the phases of object creation in several points:

- familiarization with the regulations, course, applicable work rules, etc.;
- preparation of a 3D design (CAD program, downloading from free databases, etc.);
- delivering an STL file to the library or reserving equipment (selecting a printer and possibly selecting a filament) — if the user printed alone and fees were required, he had to pay them in advance;
- checking the correctness of the project and preparing a printout;
- printing;
- notifying the user that the item is ready to be collected;
- the user checks the printout and collects the item;
- failure to collect the item and/or lack of information from the user results in the forfeiture of the item.

5. ADDITIONAL INFORMATION, TIPS, SUGGESTIONS, IDEAS, INSPIRATIONS

First of all, specific online resources were recommended for downloading 3D models for printing. Second, it was encouraged to create 3D models. Third, there were programs offered for checking the correctness and possible repair of projects. Fourth, users were provided with slicers. Fifth, programs supporting the three-dimensional digitization process

were generally related to specific devices, so they will not be mentioned here. Finally, in a few cases, photogrammetry programs were offered.

Tips were included on how to prepare the project so that it was correct, how to print, what filling to use, how to remove supports, what to pay special attention to, how to identify the most common problems with designs and prints, and various lists of books introducing the secrets of 3DP.

In some cases, projects using 3D printing were presented in the form of photos and descriptions in order to inspire library patrons to make their own. These were either projects conducted in a given facility or external ones. Three-dimensional printing was especially recommended for student projects, research projects, class assignments, classroom learning aids, and object prototyping.

CONCLUSION

Research on the regulations for 3D printing, obtained by studying content from 86 libraries of American public universities and 34 libraries of American private universities, allowed the identification of five thematic areas. These included: 1. introductory data, entry requirements, general work rules, and occupational health and safety; 2. equipment, equipment availability, location, FAQ, and contact information; 3. limits, restrictions, fees, laws, and warranties; 4. workflow; 5. additional information, tips, suggestions, ideas, and inspirations.

The table below (Table 1) presents the obtained research material, the components and the frequency of these components in the regulations of both public and private universities. The percentage of public and private university libraries that had the given records was also indicated separately. The table also separates the five thematic areas selected above to highlight specific provisions for each of them. Only the most common ones were indicated, i.e., those recorded in at least 12 library regulations, which constitute 10% of all 120 libraries selected for research.

Table 1. Components of the regulations for working with 3D printing in academic libraries of public and private universities in the United States, along with the frequency of occurrence (data from July 2023)

Component of the regulations	Libraries of public universities (86)	Libraries of private universities (34)	Total
1. INTRODUCTORY DATA, PRELIMINARY REQUIREMENTS, GENERAL WORK RULES, OCCUPATIONAL HEALTH AND SAFETY			
explanation of what 3D printing is	27 (31%)	14 (41%)	41 (34%)

entry requirements – completing the course	19 (22%)	8 (23,5%)	27 (22,5%)
staff only	11 (13%)	16 (47%)	27 (22,5%)
available tutorials	19 (22%)	8 (23,5%)	27 (22,5%)
need to reserve printers	11 (13%)	4 (12%)	15 (12,5%)
prints only for non-commercial use	6 (7%)	6 (17,5%)	12 (10%)
2. EQUIPMENT, EQUIPMENT AVAILABILITY, LOCATION, FAQ, CONTACT INFORMATION			
available 3D printer models	56 (65%)	23 (68%)	79 (65%)
contact information	33 (38%)	16 (47%)	49 (41%)
location of 3D printers	35 (32,5%)	10 (29%)	45 (36,5%)
opening hours and working/printing hours	27 (31%)	10 (29%)	37 (31%)
available filaments	25 (29%)	7 (20,5%)	32 (27%)
3. LIMITS, RESTRICTIONS, FEES, LAWS, AND WARRANTIES			
prints in accordance with the law	34 (39,5%)	14 (41%)	48 (40%)
no dangerous items can be printed	33 (40,5%)	14 (41%)	47 (39%)
3DP intended only for students and employees	33 (38%)	11 (31%)	44 (37%)
information about fees	25 (29%)	9 (26%)	34 (28%)
maximum print size	21 (24%)	13 (38%)	34 (28%)
prints for free	12 (14%)	14 (41%)	26 (21%)
possibility to refuse to print	9 (10%)	10 (29%)	19 (16%)
4. WORKFLOW			
workflow	12 (14%)	5 (15%)	17 (14%)
5. ADDITIONAL INFORMATION, TIPS, SUGGESTIONS, IDEAS, INSPIRATIONS			
recommended software	30 (35%)	20 (59%)	50 (42%)
indication of repositories with 3D models	28 (32,5%)	13 (38%)	41 (34%)
various printing tips	7 (8%)	7 (20,5%)	14 (12%)

In each library, the components indicated above were formulated slightly differently. Each library provided the 3DP service on its own, and therefore the design and structure of regulations in each facility were different. The indicated points were subject to individual modifications in line with the implementation of the assumed goals of the library. Therefore, this study does not indicate which libraries contained which regulations or the extent of those regulations. This work was intended to show more generally what is included in the regulations for making 3D printing available, along with the frequency of occurrence. It offers guidelines for what one should pay attention to when developing rules for working with 3DP in an academic library. Each library planning to purchase 3D printers should, therefore, consider whether and to what extent to apply individual guidelines in the regulations it creates for its own needs. Quantitative data may prove helpful in determining those components.

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Artykuł w wersji poprawionej wpłynął do Redakcji 29 lipca 2024 r.

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ZASADY UŻYTKOWANIA DRUKAREK 3D W BIBLIOTEKACH AKADEMICKICH

KEYWORDS: Druk 3D. Biblioteki akademickie. Uniwersytety publiczne i prywatne. Zasady współużytkowania drukarek 3D.

ABSTRAKT: **Teza/Cel** – celem artykułu jest przedstawienie głównych składowych treści regulaminów dotyczących udostępniania drukarek 3D w bibliotekach akademickich. **Metody badań** – w ramach badania przeanalizowano treść regulaminów dostępnych w 86 bibliotekach uczelni publicznych oraz 34 bibliotekach uczelni prywatnych w Stanach Zjednoczonych, które oferowały usługi druku 3D. **Najważniejsze wyniki** – końcowa analiza wyróżniła pięć grup tematycznych wskazanych w regulaminach: 1. dane wstępne, wymagania wstępne, ogólne zasady pracy, bezpieczeństwo i higiena pracy; 2. sprzęt, dostępność sprzętu, lokalizacja, FAQ, dane kontaktowe; 3. limity, ograniczenia, opłaty, przepisy prawne, gwarancje; 4. przebieg pracy; 5. dodatkowe informacje, porady, sugestie, pomysły i inspiracje. **Wnioski** – nie istnieje jednolity szablon tworzenia regulaminów, jednak większość analizowanych treści odwołuje się do kategorii wskazanych powyżej. Każda z bibliotek uwzględniała te kategorie w różnym stopniu w swoich regulaminach. Ponadto najczęściej wskazywanymi elementami regulaminów były informacje o: dostępnych modelach drukarek (65%); odpowiednim oprogramowaniu (42%); sposobach kontaktu z personelem biblioteki (41%); ostrzeżeniach, że można drukować tylko obiekty zgodne z obowiązującym prawem (40%); oraz obiektach, które nie stanowią zagrożenia (39%).