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Recreational use of an artificial water reservoir in case of the Piechcin Diving Base

Abstract: The paper aims to present divers' opinions about the recreational use of the water reservoir in Piechcin with regards to four complex research areas. The study was conducted at the Diving Base in Piechcin located in the Żnin district, the Kuyavian-Pomeranian Voivodeship. The statistical data (divers' opinions) were obtained employing a direct interview method via a questionnaire. The data were analysed with statistical methods, and the results were verified by applying fuzzy logic relations. The research shows that the owner has adapted and developed a post-mining excavation for divers, allowing for the safe practicing of qualified tourism. The technical and organizational conditions were assessed in two groups of respondents, namely those who expect some changes at the Base, and those who believe that further improvements are unnecessary.

Keywords: qualified tourism, post-mining workings; sustainable development; diving; fuzzy logic; fuzzy aggregation norms

1. Introduction

Intensive mining of raw rock materials in Poland is predominantly concentrated in its southern areas. The exploitation of deposits, becoming aggressive, entails permanent transformation of the environment. Morphology, landscape, natural conditions, and nature of land use are all subject to radical changes. The most noticeable alterations are related to the transformation of land into opencast excavations (Kacprzak and Bruchal, 2011). An example of such a place is the Piechcin reservoir under analysis. The quarry originally served the extraction of limestone – a raw material for lime, cement, or soda production. In the 60s of the last century it was decommissioned, and a lake was built in its place. Since 2011, a year-round Diving Base has been operating there with a comprehensive surface infrastructure and an underwater training site. The investment was created as part of a project co-financed by the European Regional Development Fund (ERDF) – the Kujawsko-Pomorskie Voivodeship Operational Program, which is discussed in detail in the work of Cichowska (2019). The reservoir fits into the idea of sustainable development through its adaptation for diving recreation. The management of post-industrial areas can be diverse. However, the overriding goal is continual transformation of an exploited area while striving to maintain all its values and defining its new functional roles (Bąbalska et al., 2014). Industrial heritage is an interesting and growing area of study for several reasons, one being the awareness of the role of industrial heritage understood as a "niche market" (Edwards and Llurdes, 1996). The former opencast mine in the region of Pomerania and Kujawy has been repurposed into an innovative and environment-friendly site, which was confirmed by the research conducted by Cichowska et al. (2018) and Cichowska (2019).

Proper management of post-mining reservoirs, including inactive opencast workings, has been a significant research problem for many years (Sobala and Pukowiec, 2014). It is described in their works by: Pietrzyk-Sokulska (2010, 2015), Zawadzki (2013), Majgier et al. (2010) or Nita (2010). Similarly, Jawecki (2012, 2017) and Jawecki et al. (2014, 2015) also dealt with the reclamation and development of post-mining areas. He described five directions of adaptation of such areas (forest, water, natural, tourist-didactic, and cultural-recreational), indicating examples of proposed solutions for Poland and the world. In the case of Piechcin, an effective method proved to be submerging the excavation in a limestone quarry, and, in the longer term, adapting it for the specific needs of divers. Therefore, looking at Jawecki's (2012) proposals, the studied reservoir can be classified as suitable for tourist and recreational use. Such an approach is of importance, as currently the area of the Barcin commune, within which the reservoir is located, shows a large scale of anthropogenic transformations. These are multifaceted and concern a large part of its area (in practice, in the Kujawsko-Pomorskie Voivodeship there is no other commune where the scale of transformations regarding the total area would be as extensive). The changes primarily concern the earth's surface (both highly exposed workings and overburden landfills) (Studium uwarunkowań i kierunków zagospodarowania przestrzennego gminy Barcin, 2018).

In this study, the authors propose to confirm the statistical analysis results with the method based on fuzzy relations and the optimistic fuzzy aggregation norm. Zadeh (1965) pioneered the application of fuzzy logic in 1965. Many scientists, together with practitioners, develop methods for the theoretical and practical use of fuzzy logic. Very often, they can describe the problem using imprecise phrases such as "I rate the availability of the Base rather well" or "I rate the availability of diving equipment the highest". Fuzzy logic methods are used in technology to control devices (Mamdani and Assilian, 1975). They can also be used to manage systems in economics, for example, Rogowska (2011) developed a method for stock management using fuzzy sets, with which she described the volume of stocks and demand for products. Mreła et al. (2019) applied fuzzy logic methods in education to estimate levels of learning outcomes acquirement.

The paper aims to present divers' opinions about the recreational use of the Diving Centre in Piechcin with regards to four complex research areas. The foundation of the research is a survey consisting of simple statements rated using the Likert scale. The study involves statistical analysis of the received data and, additionally, establishing fuzzy relations to transform estimations of the simple statements to an assessment of the complex research areas. Based on these approaches this study intends to show the opinions pertaining to the functioning of the Diving Centre. The respondents were divided into two groups. Divers from the first of these groups want some changes at the Centre, whereas respondents from the other group do not require any modifications.

2. Study area

The Piechcin Diving Centre (PDC) is located in the Kuyavian-Pomeranian Voivodeship, Żniński County, the Barcin commune (Piechcin village) (Fig. 1). It is located 10.1 km from Barcin, 27.8 km from Żnin, 19.3 km from Inowrocław, and 43.1 km from the capital of the voivodeship, Bydgoszcz.

Piechcin is located on the north-eastern edge of the Gniezno Lake District (315.54). According to the physical and geographical regionalization carried out by Kondracki (1988), it is one of the two mesoregions covering the central and southern part of the Barcin commune. The northern part falls within the Inowrocław Plain mesoregion (315.55).

Both units are located in the macroregion of Greater Poland Lakeland (315.5), within the South Baltic Lakeland sub-provinces. The northern and southern area of the commune features a moraine plain, with the Noteć valley running in the middle. The Piechcin base is situated in the south part of the commune, distinguished by a highly transformed zone due to the exploitation and processing of raw limestone

materials. It is an area with several dozen meter deep workings and a waste heap that stretches over several kilometres. The topography of the limestone extraction area is entirely anthropogenic (Studium uwarunkowań i kierunków zagospodarowania przestrzennego gminy Barcin, 2018). The diversification of the terrain (especially on surfaces with high humidity, such as the Noteć valley) causes local climate shifts. The area of the commune of Barcin, according to the classification of climatic regions of Poland carried out by W. Okołowicz, lies in the "Kujawski subregion" (characterized by a large number of cloudy days, little rainfall, "transitional" climate) (Studium uwarunkowań i kierunków zagospodarowania przestrzennego gminy Barcin, 2018).

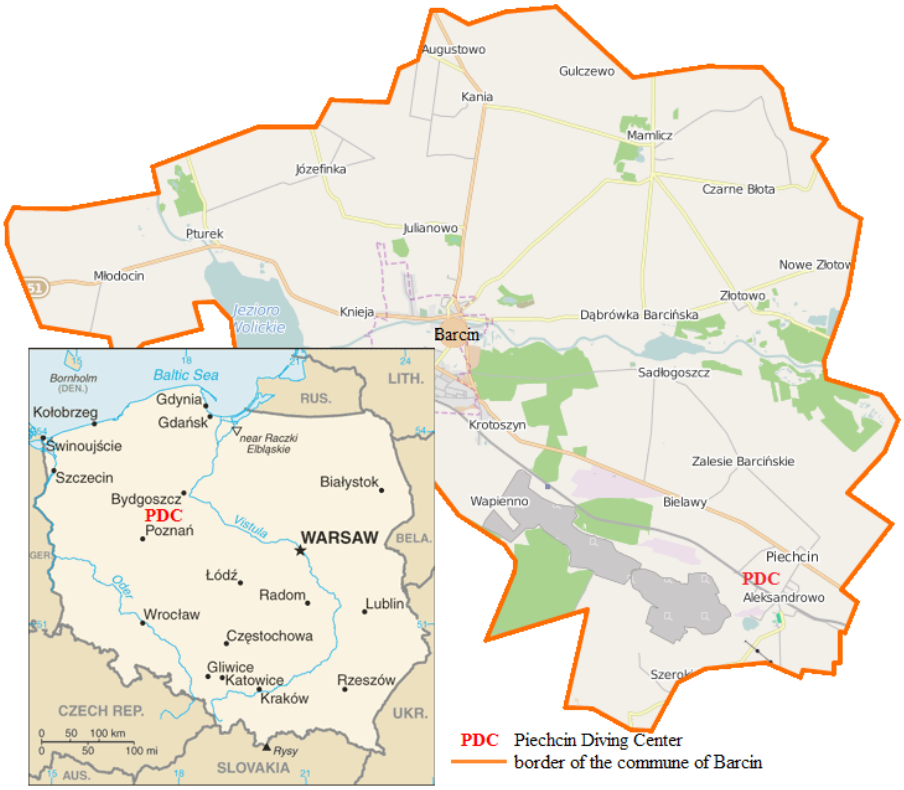

Figure 1. Location of the Piechcin Diving Centre (Source: prepared by the authors based on https://commons.wikimedia.org/w/index.php?curid=36899273: OpenStreetMap contributors – Barcin (commune), CC BY-SA 2.0; https://www.worldometers.info/img/maps_c/PL-map.gif)

An artificial water reservoir was built in a former limestone quarry. It has a varied ichthyofauna as well as underwater and coastal vegetation. The current owner has been systematically developing its surroundings since 2007, adapting the former mining site for diving purposes. In its immediate vicinity, the natural and landscape potential is limited to small forest complexes, mainly in the southern part of the commune. They are primarily fragmented island communities. Forest land covers a total of 8% of the commune's area (121.08 km^2). The structure of forest stands shows prevalence of pine (with an admixture of spruce, fir, birch, and larch). The hydrographic network is not extensive (Noteć is the most notable river in the commune, and the lakes include Wolickie, Kierzkowskie, and Sadłogowskie). There is one walking trail ("Pałucki"), two bicycle trails ("Pałuckie Landscapes" and "Barcin-Gołąbki"), and a paddling trail ("Stara Baśń") running through the commune. The area holds certain potential predispositions for the development of tourist and recreational functions. While exploring the reservoir, the PDC users can become acquainted with the natural values of the area and its tourist attractions (including the architectural layout of the old town in Barcin, churches, and the palace and park complex in Młodocin).

The Piechin water reservoir itself is also a kind of tourist destination in the commune. Due to its characteristic colour, purity, and transparency of water, it is sometimes called the "turquoise lake in the old quarry" (http://www.polskaniezwykla.pl/web/place/26620,piechcin-turkusowe-jezioro-w-starym-kamieniolomie.html), which attracts the attention and interest of potential tourists, especially divers. The facility owner has made an effort, following the principle of sustainable development, to contribute to the permanent enrichment of the region. As Paulo (2008) notes, he succeeded in establishing a new use for the post-mining area. Therefore, we can conclude that the facility in Piechcin is an exciting example of revitalisation of an excavation into a comprehensively prepared and developed reservoir for qualified tourism.

3. Materials and methods

3.1 Survey method

The survey was conducted using a diagnostic study involving 225 divers staying at the Piechcin Base from June to September 2018. The role of the researcher was to distribute and collect the questionnaire. This approach was dictated by the respondents' feeling of anonymity and thus also psychological readiness to provide honest answers, even to sensitive questions. The applied research technique enables faster and cheaper data acquisition and eliminates the influence of the interviewer in the course of an interview (Sołoma, 2002). To achieve the goal intended in the study, we chose people who had previously had contact with diving, and therefore already had some knowledge about the exploration of this type of water reservoirs, and thus could assess the Base objectively (Cichowska et al., 2018). The content of the survey was consulted with the owner of the facility.

The study aimed at finding out about the respondents' opinions on four research areas:

- A_1 – availability of the water reservoir for potential users during the year,
- A_2 – water safety in terms of infrastructure solutions,
- A_3 – quality level of the offered conditions of stay,
- A_4 – facilities as an essential advantage to staying at the Base.

The anonymous questionnaire consisted of 27 questions, but for the purposes of the study only 2 were used, the first of which (number 18) was used to divide the respondents into two research groups (A and B), and the second (number 19) consisting very detailed subquestions (prepared in tabular form) to analyse the opinions of respondents in the field of research areas A_1 – A_4. We chose 14 out of 20 the following subquestions:

- Q_1 – social rooms,
- Q_2 – underwater attractions,
- Q_3 – diving equipment rental,
- Q_4 – air quality in diving cylinders,
- Q_5 – parking space,
- Q_6 – organization of arrivals in terms of logistics,
- Q_7 – order in the Base and its surroundings,
- Q_8 – water safety,
- Q_9 – prices for the service,
- Q_{10} – the general atmosphere in the Base,
- Q_{11} – sanitary facilities,
- Q_{12} – lecture halls,
- Q_{13} – hardware storage,
- Q_{14} – Base availability during the year.

The questionnaire consisted of a series of statements, for which the respondents were expected to select one of six answers. ("Very good," "Good", "Average", "Poor", "Very poor", "I have no opinion"). The authors employed the Likert scale, as the divers were asked to what extent they agree (or disagree) with a given statement, similarly to Sołoma (2002). The analyses were carried out bearing in mind the division into two above-mentioned groups of respondents: users who are not expecting (A) and those who are expecting (B) the introduction of various amenities at the Base, allowing for an increase in the level of service quality and enhancing the comfort of underwater exploration. The statements included in the survey involved the assessment of material (surface or

underwater infrastructure) and non-material elements related to the quality of rendered services (e.g., assistance in organizing visits and the accompanying atmosphere), which play an essential role in developing a competitive advantage.

3.2 Description of the fuzzy logic method

The foundation of fuzzy logic is the concept of a fuzzy set. Let X denote a non-empty space. The fuzzy set A consists of pairs $\{(x, \mu_A(x)), x \in X\}$, where $\mu_A: X \rightarrow [0,1]$ is called a membership function that describes the level of belongings of x to set A. If X x Y is a Cartesian product of non-empty spaces X and Y, and if R is a fuzzy set, then R is called a fuzzy relation.

In this publication, we define three non-empty spaces:

1) the space of research areas $X = \{A_1, ..., A_4\}$
2) the space of questions $Y = \{Q_1, ..., Q_{14}\}$
3) the space of divers-respondents $Z = \{N_1, ..., N_{225}\}$

and three fuzzy relations:

1) R_1 – the relation between the research areas and the questions; value $R_1(A_1,Q_1)$ denotes the level in which question Q_1 is necessary to understand research area A_1; if $R_1(A_1,Q_1) = 0$, then, of course, this question is not connected with the research area A_1; if $R_1(A_1,Q_1) = 1$, then the question can be sufficient to compr ehend A_1; values of the membership function of R_1 are determined by experts – people who know the problem and formulate questions;
2) R_2– the relation between the questions and the respondents; value $R_2(Q_1,N_1)$ denotes the answer of respondent N_1 that was coded and transformed to interval [0,1];
3) R_3 – the relation between the research areas and the respondents; value $R_3(A_1,N_1)$ denotes the level in which respondent N_1 estimates research area A_1.

The introduction of three relations is necessary because it is easier for respondents to answer simple questions than to estimate their opinion on complex research areas.

The space of divers was divided into two subspaces, namely $Z = Z_1 \cup Z_2$, where Z_1 - $\{N_1, ..., N_{123}\}$ denotes group A and Z_2 - $\{N_{124}, ..., N_{225}\}$ – group B. The division into these two subspaces was made based on an additional question that was not included in the question range .

The values of the membership function of are estimated by the experts and the values of the membership of are the results of simple coding of the respondents' replies. However, values of the membership function of are calculated based on the formula for S-T-composition of fuzzy relations (comp. Rutkowski, 2012):

$$R_3(A_i,N_j) = S_{k=1,2,...,13}(T(R_1)A_i,Q_k), R_2(Q_k, N_j)) \text{ for } i = 1,2,3,4 \text{ and } j = 1,2,...,225) \quad (1)$$

Here, as S-operation we chose:

$$S(x,y) = x + y - x \cdot y \text{ for } x, y \in [0,1] \quad (2)$$

and as T:

$$T(x,y) = x \cdot y \text{ for } x, y \in [0,1] \quad (3)$$

In addition to statistical measures, we also use an aggregation method, using the optimistic fuzzy aggregation norm (Sokolov et al., 2018). The optimistic fuzzy aggregation norm is a function S: [0,1] x [0,1] → [0,1] such that, for each $x, y \in [0,1]$,

$$S_O(0,0) = 0 \quad (4)$$
$$S_O(x, y) = S_O(y, x) \quad (5)$$
$$S_O(x, y) \geq max\{y, x\} \quad (6)$$

One of the functions fulfilling these conditions is function $S(x,y) = x + y – xy$ defined by (2). Groups A and B are not equinumerous, so the authors divided each value of relation by the group size. The optimistic fuzzy aggregation norm was employed in view of the assumption that each respondent's estimation adds some value to assessing each research area.

3.3. Materials

Table 1 presents the values of membership function of relation established by the article authors.

Table 1. The values of membership function of relation (Source: Authors' own elaboration)

Question / Res. Area	Q_1	Q_2	Q_3	Q_4	Q_5	Q_6	Q_7	Q_8	Q_9	Q_{10}	Q_{11}	Q_{12}	Q_{13}
A_1	0.25	0.5	0.25	0	0.5	0.5	0	0.5	0.5	0.5	0	0.25	0.5
A_2	0.5	0.75	0.5	1	0.25	0.25	0.5	1	0	0	0.25	0.25	0
A_3	1	0.25	0.75	0.5	1	0.75	1	0.75	0.5	0.5	1	1	1
A_4	0.75	1	1	0.75	0.75	1	0.75	0.75	1	1	0.75	0.75	0.75

Resp. – Respondent, Quest. – question

For example, the value of $R_1(A_5,Q_3)$ of the relationship between research area A_1 and question Q is low (0.25). It is dictated by the fact that for divers who can explore the reservoir all year round, rental of diving equipment is not essential, as they typically come to the Base with their own gear. This option is justified mainly by people starting their diving course, or those whose equipment has deteriorated. In turn, the connection of area with question Q_2 is characterized by a more significant correlation (0.75), because the prepared underwater attractions must be marked in the water so that the exploration of the reservoir takes place in adherence to the safety rules. However, it should be noted that not all of these underwater attractions are used, especially by training groups. The value of the membership function for A_3 and Q_{11} was defined as because the sanitary facility is an essential element that translates into the quality of services offered. The facility owner provided said facility despite the lack water utilities and sewage systems in the area. However, there is no relation between research area A_1 and question Q_4 (0). Year-round service does not affect the air quality in cylinders. Good quality breathing gas must not endanger divers' health and must always be checked regularly by the organiser to ensure their safety.

Table 2 contains some values of the R_2 membership function. The values of this relation are determined based on the respondents' answers. For example, diver N_1 rated the social room as good (Q_1), which was coded with the value of 0.75. On the other hand, respondent N_2 assessed the air quality in the cylinders as bad, so $R_2(N_2, Q_4) = 0$.

Table 2. Part of the values of the membership function of relation R_2 (Source: Authors' own elaboration)

Resp. / Quest.	N_1	N_2	N_3	N_4	N_5	N_6	N_7	N_8	N_9	N_{10}	N_{11}	N_{12}	N_{13}
Q_1	0.75	0.75	0.75	1	1	1	0.75	0.75	1	1	0.75	0.75	0.75
Q_2	1	0.75	0.75	1	0.75	1	0	0.75	1	0.5	0.75	0.75	1
Q_3	1	0	0	1	0.75	1	0.75	0	1	1	0	0	0
Q_4	1	0	0	1	0	1	0.75	0	0	1	0	0	0
Q_5	0.5	0.75	0.75	1	0	1	0.5	0.75	0.75	1	0.75	0.75	1
Q_6	0.75	0	0	0	0.75	0	0	0.75	0.75	1	0.5	1	0.75
Q_7	1	1	1	1	0.5	1	0.75	0.75	1	1	0.75	1	0.75

Q_8	0.75	1	1	1	0.75	1	0.75	0.75	1	1	0.75	0.75	0.75
Q_9	0.5	0.5	0.5	1	0.75	0.5	0.75	0.75	0.75	0.75	0.75	0.75	0.5
Q_{10}	1	0.75	0.75	1	1	1	1	1	1	1	0.75	1	0.75

Resp. – Respondent, Quest. – question

3.4. Individual and groups' estimations

By formulae (1) – (3), we calculate values of the membership function of relation R_3. These values are in part presented in Table 3, and sample value $R_3(A_1, N_1)$ is calculated below:

$$R_3(A_1, N_1) = 1 - (1 - R_1(A_1, Q_1) \,.\, R_2(Q_1, N_1) \cdot (1 - R_1(A_1, Q_2) \cdot R_2(Q_2, N_1))$$
$$\cdot \ldots \cdot (1 - R_1(A_1, Q_{13}) \cdot R_2(Q_{13}, N_1))$$
$$= 1 - (1 - 0.25 \cdot 0.75) \,.\, (1 - 0.5 \cdot 1) \cdot \ldots \cdot (0.75 \cdot 1) = 0.973$$

Table 3. Part of the membership function of relation R_3 (Source: Authors' own elaboration)

Res. Area \ Diver	N_1	N_2	N_3	N_4	N_5	N_6	....	N_{124}	N_{125}	N_{126}	N_{127}	N_{128}	N_{129}
A_1	0.97	0.98	0.88	0.59	0.69	0.94	…	0.96	0.93	0.99	0.94	0.98	0.96
A_2	0.98	0.99	0.87	0.82	0.82	0.84	…	0.95	0.94	0.99	0.94	0.98	0.98
A_3	1.00	1.00	0.99	0.97	0.97	0.97	…	0.99	0.99	1.00	0.99	1.00	1.00
A_4	1.00	1.00	1.00	0.99	0.98	0.97	…	1.00	0.99	1.00	1.00	1.00	1.00

Res. area – research area

Table 4 presents simple statistical measures based on estimated values of relation R_3, representing the respondents' opinions about the research areas.

Table 4. Statistical measures of relation (Source: Authors' own elaboration)

Measure / Res. Area	Group A				Group B			
	Min	Max	Average	Standard deviation	Min	Max	Average	Standard deviation
A_1	0	0.991	0.933	0.107	0.250	0.991	0.922	0.105
A_2	0.186	0.990	0.944	0.092	0.250	0.990	0.909	0.142
A_3	0.375	0.999	0.983	0.066	0.186	0.999	0.946	0.177
A_4	0.375	1.000	0.988	0.066	0.375	1.000	0.965	0.125

Res. area – research area

Table 5 presents aggregated values of relation achieved by using the optimistic fuzzy aggregation norm (2).

Table 5. Aggregated values of relation (Source: Authors' own elaboration)

Divers' groups / Research area	Group A	Group B	Total
A_1	0.604	0.608	0.605
A_2	0.598	0.613	0.604
A_3	0.613	0.628	0.619
A_4	0.620	0.629	0.624

4. Results and discussion

The Piechcin reservoir is a lake with an area of approx. 5 ha and maximum depth of 25 m. After mining, the sunk pipes, steel plates, motor vehicles, a sailboat and a yacht all became potential attractions to the enthusiasts of underwater experiences. The Piechcin Diving Centre (also known as Base Piechcin) is the organiser of dives (Fig. 2). It conducts training and diving courses (introductory, specialization, advanced) and trial dives with qualified instructors. It also allows the use of the water reservoir, its surroundings, and infrastructure by people holding appropriate qualifications or come to the Base as instructors leading their own training/internship groups (diving certificates must be deposited during their stay). During the dives of organized diving groups, the organiser is the diving instructor. Each diver assumes full responsibility for the dive they perform. Divers are obliged to comply with the regulations governing the practice of recreational diving in Poland. They undertake to comply with the safety rules arising from the training standards of the federation they are affiliated with and from good diving practice. The detailed rules on diving in the Piechcin quarry are regulated by the provisions published on the organizer's website, which one must read while making a personal entry on the diving card (https://bazapiechcin.eu/regulamin).

Figure 2. Piechcin Diving Base (Source: photo by Robert Werner provided by the owner of the Piechcin Base)

Research has shown that people who believed that changes should be made at the Base comprised 45.3% of the total number of respondents (i.e., 102 people, B). Others (A, 54.7%) concluded that there is no need to improve the existing facilities or introduce entirely new solutions. The respondents from group B were less inclined to answer "Very good" and "Good" when evaluating elements of the above-water infrastructure (e.g. accommodation, sanitary facilities, parking spaces), which enhance the conditions at the Base (Fig. 3). They also assessed them more often as "Average" or "Poor" than the respondents from group A. Negative opinions, albeit incidental, related mainly to the organization of sanitary facilities and restrooms made available to divers. If a respondent refrained from sharing their opinion, it was most often due to the fact that they had no need to use such facilities or were otherwise at the Base for the first time.

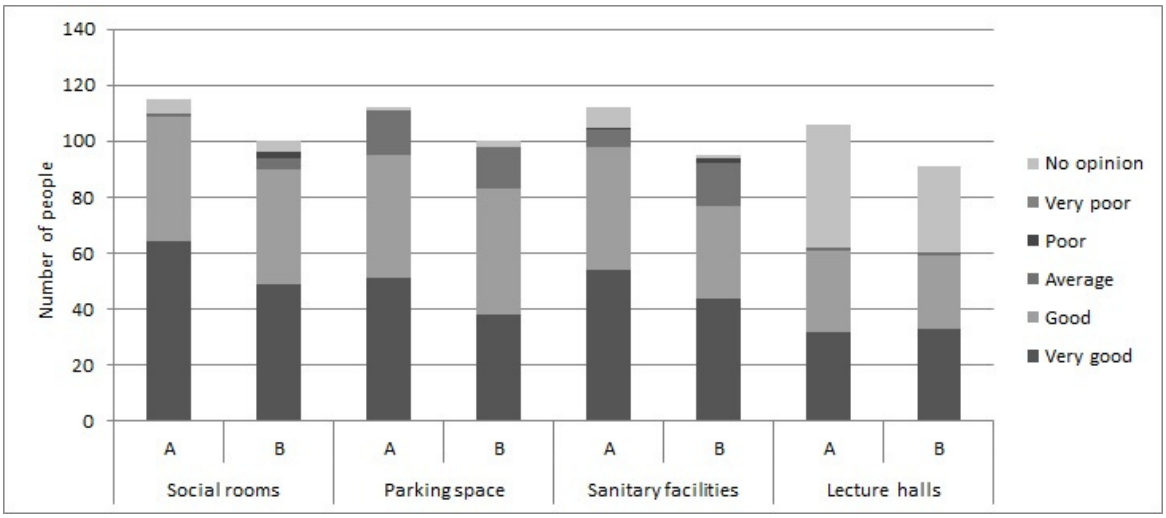

Figure 3. Opinions of respondents (in groups A and B) on basic services related to the stay at the Base (Source: Authors own study)

Similar research results were obtained in the analysis of factors that primarily determine Piechcin as a destination of choice among divers (Fig. 4). Said factors are directly related to the organizational and economic activities pursued by the owner of the facility. The respondents who saw shortcomings in the Centre (B) less often than the satisfied ones (A) rated these aspects high ("Very good"). Interestingly, group A included people who (despite the general positive attitude to the offer) were more often dissatisfied with the fee charged for the stay, the organization of arrivals in terms of logistics, and the disorder at the Base and its surroundings ("Average" and "Poor" rating) (Fig. 4). Nevertheless, group A treated these elements of the offer as a secondary issue, since the destination tends to be prioritised primarily for the underwater attractions prepared for divers. This is confirmed by positive opinions ("Very good" and "Good") in relation to the assessment of the reservoir itself (Fig. 5).

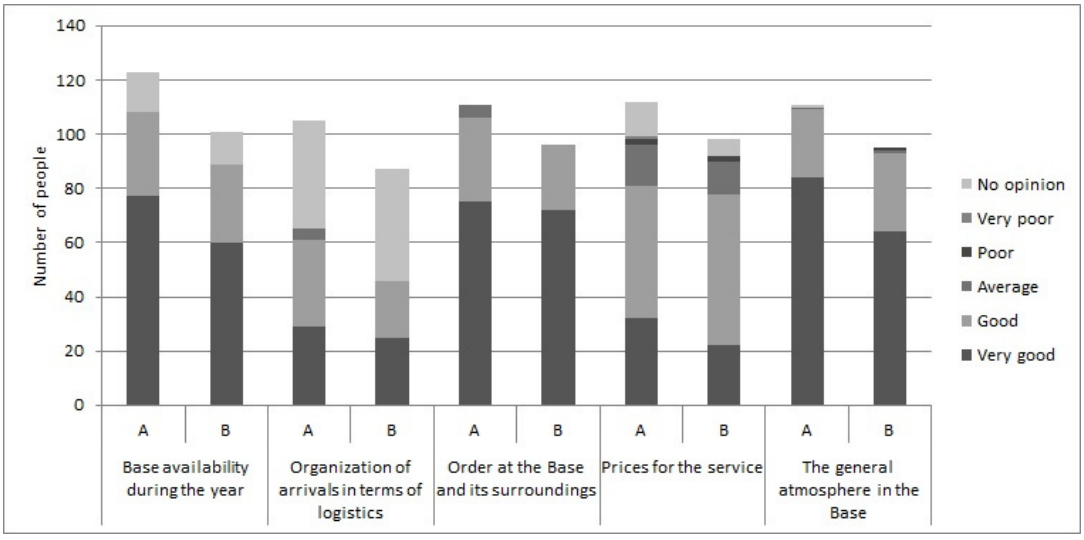

Figure 4. Opinions of the respondents (in group A and B) on the management of the facility (Source: Authors' own study)

However, we noticed that group A assessed the safety of the reservoir lower than group B, which declared that the facility required improvements. These respondents also rated the organizational activities in the field of hardware storage as low (Fig. 5). Therefore, regardless of their generally positive feedback, the divers in question appear to prioritize solutions that would improve their safe use of the reservoir. Thus, they focused predominantly on changes in the underwater development that would make navigation easier. Namely

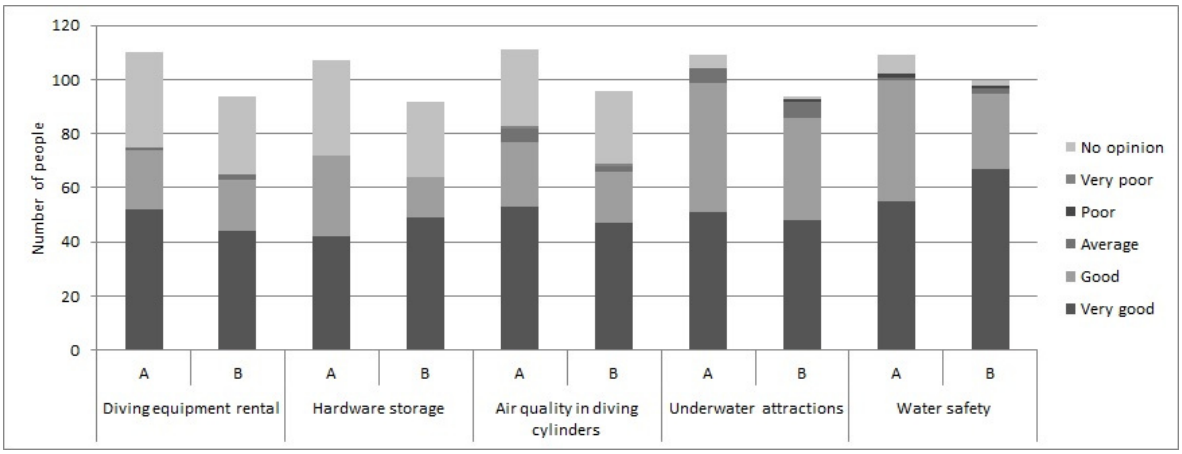

Figure 5. Opinions of the respondents (in group A and B) on the quality of services in water exploitation (Source: Authors own study)

introducing markers on the fixed guide lines to know which direction one is heading (e.g., LED signposts) and towards which attractions. They also expressed requests to create additional water entry points (including high benches), preparation stands, a track for practicing skills with diving reels and lines, and water availability for rinsing the equipment. In terms of underwater infrastructure, they proposed making the reservoir more attractive with new exhibits (plane, pipes, and wrecks) (Cichowska, 2019). Based on the obtained research results, it can be observed that the respondents of groups A and B may have different premises for visiting the diving site and hold different expectations for the owner. Undoubtedly, all respondents come to Piechcin to explore the reservoir. Group A comes mainly for training reasons, whereas group B for tourist and training reasons. The latter are more likely to bring along their friends or families with children and expect changes in the field of infrastructure oriented towards leisure activity (including a playground for children, shading from intense sun, a pier for people accompanying divers, changes in sanitary facilities or introduction of catering facilities). Group A is focused in particular on adequately securing the Base for diving activities for people who come here to improve their skills and qualifications or are just start their adventure with diving.

Regardless of the declarations made earlier in groups A and B (whether changes at the Centre should be introduced or not), the Piechcin Base is perceived by users as a friendly and safe place. This is confirmed by very high marks given to it ("Very good" and "Good" opinions), which are a testimony to the proper organization of the service and trust towards the owner of the facility.

The obtained results of statistical research were confirmed using the fuzzy logic methods. When researchers decide to analyse problems, they might distinguish some research areas and prepare the questionnaire to collect data. The research areas are often too complicated and complex to be expressed as questions, so the researchers prepare simple questions connected with the research areas. Our method requires the exact relation between the research areas and questions (Table 1). Analysing values of relation , we can see more clearly whether there are enough questions to get sufficient information.

Moreover, there is no need to prepare separate questions for each research area, as every individual question can be connected with more than one research area. During the survey the data are collected, and then coded in such a way so as to obtain numbers belonging to interval [0,1] as presented in Table 2. Once values of relations and are established, we can use a method of fuzzy compositions to get the values of relation , which represent the estimations of respondents' opinions on complicated and complex research areas (Table 3). The main advantage of this method is the capacity to obtain accurate estimation of opinions on complex issues based on simple question sets.

The analysis of results (Table 3) shows that the respondents generally assess the Piechcin Centre as good. Table 4 provides the values of simple statistical measures: the minimum value (Min), the maximum value (Max), the arithmetic mean, and the standard deviation. Based on the data in Tables 3 and 4, a conclusion can be drawn that that the respondents' ratings for each research area were high and usually ranged from 0.7 to 1. Low values of standard deviation also seem to confirm generally high estimates on the part of respondents. Moreover, research area , i.e., the facilities offered by the Centre in Piechcin, was given the highest rating.

Obtaining opinions of individual respondents is valuable, but exploring the opinions of entire respondent groups may prove more informative. In the paper, the authors employed one of the optimistic fuzzy aggregation norms, based on an assumption that each estimated value of relation increases the value of groups' opinion. Because the distinguished groups differed in size, a decision was made to divide each value of relation by the group size. Comparing data presented in Table 5, one can yet again observe that divers estimate all facilities and services of the Base as high and similarly across all research areas under consideration. Despite the respondents' declarations regarding the need for changes at the base or lack thereof, their responses very convergent. From and the analysis of their answers and the research results one can conclude that the need for changes did not concern the current equipment or amenities offered by the Centre. More likely, divers simply expect an extension of the Centre's offer.

In the context of the above considerations, it seems advisable to examine how users perceive investments regarding the management and development of qualified tourism. The obtained research results may become a learning material on how to protect areas so that they function, as Nita (2010) emphasizes, in harmony with the landscape. At the same time, such investments play an essential role in eliminating the likelihood of crises related to infrastructure deficiencies. Specialist tourism requires appropriate material preparation for the facility owner and personal qualifications (qualified tourist), i.e., unique psychophysical practice, the ability to use diving equipment, or proper behaviour underwater in challenging cases.

5. Conclusions

The conducted analysis allows for the formulation of the following conclusions:

1. Creating an artificial water reservoir in Piechcin and its development for recreational purposes fits perfectly into the concept of sustainable development, aimed at minimizing the impact of the investment on the natural environment through reclamation and adaptation to specific goals (qualified tourism).
2. The functioning of the Diving Centre was positively assessed by the respondents from groups A and B, albeit the respondents in group B, who indicated the need for additional amenities at the facilities, evaluated research statements lower than the other respondents.
3. Negative opinions ("Poor" and "Very poor") were rare, which confirms the owner's ability to organize, develop and professionally prepare the-reservoir for divers.
4. The fuzzy relations used in the article allowed for the analysis of research areas that would otherwise be too complex to be expressed as questions in a survey. Establishing the link between the questions and the research areas and the use of fuzzy relations allowed the authors to formulate simple questions for respondents to answer, which were then analysed to investigate the attitudes of divers to complex issues representing the research areas.
5. Estimations of the relation between the research areas and the respondents indicate that the divers assessed the services and facilities very well. Both the respondents declaring the need for changes and those who expressed no demand for such alterations regarded the Centre similarly.

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