The role of prevention supported by innovations and implementations in increasing the safety of people staying in water areas

Andrzej Ostrowski[1] Arkadiusz Stanula[2] and Zbigniew Małodobry[3]

[1]University of Physical Education, Krakow,
Poland

[2]Academy of Physical Education, Katowice,
Poland

[3]University of Rzeszów,
Poland

***Abstract*— The most common causes of drowning are the attitudes and behavior of people swimming, drinking alcohol, not following the rules of safe bathing, disregarding regulations, regulations, prohibitions and orders, as well as low level of swimming skills, insufficient risk assessment skills and thoughtlessness.**

With the above in mind, it was decided to make some considerations about the role of prevention and prevention supported by innovations and implementations in increasing the safety of people staying in water areas.

The research material included legal acts in the field of safety in water areas, drowning statistics, subject literature and publications on the Internet about investments in the functioning of water sports in Poland, and the method was the reading of official documents (acts, regulations, orders), subject literature in the field of rescue water and analysis of investments in swimming and bathing facilities. It was found that:

1. **There are numerous drowning accidents in Poland. Efforts should be made to keep reliable statistics that constitute the basis for proper diagnoses of threats and accidents in water.**
2. **In order to reduce the number of drownings, appropriate preventive measures have been introduced in Poland through legal regulations regarding the organization and operation of rescue services. They need to be updated and developed, because in relation to the smaller number of accidents in other European countries, these actions are insufficient.**
3. **Lack of respect for legal regulations is another cause of accidents on the water, which is why the Police and other state authorities conduct preventive activities both among the organizers of water recreation and their participants.**
4. **An example of increasing the sense of safety in water areas and the functioning of rescue services are numerous innovations that are increasingly appreciated by the world of science.**
5. **Cooperation between the scientific community and industry results in the construction of increasingly modern and safe places to stay in water areas, which are secured using innovative rescue measures.**

Keywords— safety, prevention, innovation, implementation.

I. INTRODUCTION

The most common causes of drowning are the attitudes and behaviors of swimmers, including a low level of relaxation by the water, alcohol consumption, non-compliance with the rules of safe bathing, disregard for regulations, rules, prohibitions and orders, as well as a low level of swimming fitness, insufficient risk assessment skills and thoughtlessness (Stanula, et al. 2015). The causes of drowning may also be independent of humans at a given moment, being natural or civilization-related. The former, i.e. natural causes, occur primarily in open water areas with suddenly changing weather conditions, increased waves, sudden water turbulence, fast currents, changes in the shape of the bottom of the water body, etc. (Halik et al. 2014).

Civilization threats that may also occur in the aquatic environment include disasters, failures, environmental pollution, but also armed conflicts and acts of terrorism. They have a social basis and result from all human activities.

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However, the most common The cause of water dramas is not the lack of swimming skills - but their overestimation and loss of strength and hypothermia as a result of staying in the water for too long. Drowning is classified by the WHO as one of the deaths that can be avoided as a result of preventive and educational activities (Wiesner 2017).

The most objective and at the same time the most diagnostic indicator allowing to assess the quality of the water safety system are statistical publications regarding the number of drownings. Statistics provided by the World Health Organization (WHO) indicate that approximately 372,000 people die in water every year. This means that on average 40 people drown every hour. Drownings are classified among the top ten unnatural deaths. Far more men than women drown. The most serious risk factor in most countries is being in water under the influence of alcohol, in Poland every fourth drowning victim was under the influence of alcohol (www.who.int).

The threat to life resulting from drowning in Poland is much higher than the average in the European Union - the standardized mortality rate in 2012 in Poland was 2.2 per 100,000 population, and 1.2 in the EU (https://www.newsweek.pl). Data from the Police Headquarters show that in 2011, before the introduction of new legal regulations in Poland, 396 people drowned, and the average for the previous five years was 432.8 drownings per year (www.statystyka.policja.pl).

Over the following years (2012–2018), i.e. since the new legal order began to operate in Poland, the average number of drownings increased to approximately 600 per year. The final number of drownings is influenced by many variables, primarily weather conditions, location, time of the week, day, etc., because they determine the number of people using the bath.(Stanula, et al. 2015).

The relatively high risk of drowning can be minimized by following the logic of the risk management procedure. The analysis of the risk of a tragic accident is preceded by the identification of possible threats. For each type of threat, it is necessary to prepare appropriate strategies of behavior when it occurs. Risk management includes activities involving:

- risk identification,
- risk analysis,
- planning ways to deal with risk,
- risk tracking (Goszczyńska 1997, Kaczmarek 2008).

Identifying the risk of drowning involves recognizing the factors that can lead to a tragedy. Preparing such a list implies all subsequent actions in the process of broadly understood safety education. Mastering risk management skills allows you to effectively control the negative effects of threats occurring over water (Wiesner 2017).

Deaths due to drowning can be avoided or reduced as a result of prevention and prevention, therefore activities in this area should be permanently implemented and supported, including through innovations and implementations.

Basic goal considerations in this study is to determine the role of prevention supported by innovations and implementations in increasing the safety of people staying in water areas.

Specific objectives:

1) Determining which units and to what extent should carry out preventive activities to increase safety in the aquatic environment?
2) Indication of the extent to which the results of innovative activities supporting prevention can increase safety in the aquatic environment?
3) Indication of what implementations from various fields of technology and social activities supporting prevention can increase safety in the aquatic environment?

II. Material and methods

The research material included legal acts on safety in water areas, drowning statistics from the Police, literature on the subject and publications on the Internet about investments in the functioning of water sports in Poland. To analyze the material, the method of reading official documents (acts, regulations, orders, training programs) and subject literature in the field of water rescue and investments in swimming and bathing facilities was used (Korzeniowski 2013). The functioning and construction of innovative water sports facilities, devices and equipment for potential rescue operations and safe recreation by the water were subjected to hermeneutical analysis and interpretation, searching for new solutions in the effective prevention of accidents by the water in order to safely practice water sports and recreation ().

III. Results

A. Characteristics of drowning accidents in Poland

In order to determine the role of prevention in increasing the safety of people staying in the aquatic environment, it is necessary to diagnose the current situation regarding drowning accidents in Poland. Statistics kept by state authorities, including the Police, are helpful here.

TABLE 1. NUMBER OF DROWNINGS IN POLAND

Age Year	Until 7 years	8–14 years	15–18 years	19–30 years	31–50 years	Area 50 years	Together
	N(%)	N (%)	N (%)	N (%)	N (%)	N (%)	N
2018	2 (0.3)	14 (2.6)	17 (3.1)	91 (16.7)	171 (31.2)	244 (44.8)	545
2017	3 (0.6)	66 (14.4)	22 (4.8)	62 (13.6)	122 (26.7)	238 (52.1)	457
2016	11 (2,2)	5 (1.0)	20 (4.0)	58 (11.5)	141 (28.0)	241 (47.8)	504
2015	11 (1.9)	13 (2,3)	23 (4.0)	126 (22.0)	148 (25.8)	229 (40.0)	573
2014	6 (0.9)	10 (1.5)	24 (3.7)	119 (18.4)	190 (29.3)	270 (41.7)	648
2013	14 (1.9)	18 (2.5)	45 (6.3)	115 (16.2)	178 (25.1)	285 (40.2)	709
Mean	**7.8 (1.3)**	**21 (4.0)**	**25.2 (4.3)**	**95.2 (16.4)**	**158.3 (27.7)**	**251.2 (44.4)**	**572.6**

Source based on: policja.pl statistics.

The number of drownings in Poland is presented in Table 1, which shows that between 457 and 709 people drowned annually in 2013–2018. The largest group that died in water were people over 50 years of age (44.4%), and the smallest group was children up to 7 years of age (1.3%). It is worth noting that children and adolescents under 18 years of age accounted for 1/10 of all water accidents.

Social campaigns conducted so far to raise awareness of the dangers associated with staying by the water have had limited effects on the scale of society as a whole. However, it is worth paying attention to the low number of victims among children and teenagers, to whom most social campaigns related to safe recreation by the water were directed, which may prove their effectiveness. What is disturbing is the very high number of victims among adults, including the oldest, who died in water three times more than children and adolescents. Therefore, actions and campaigns for staying safely by the water and at the same time indicating how to do it safely should be addressed to all social groups, including seniors (https://rcb.gov.pl/utoniecia/).

TABLE 2. PLACES OF DROWNINGS IN POLAND

Place Year	River	Lake, Lagoon	Joint	Sea	Other	Together
	N %	N %	N %	N %	N %	N
2018	133 24.4	162 29.7	9 17.0	39 7.1	120 22.0	545
2017	117 25.6	142 31.1	81 14.8	14 3.1	103 22.5	457
2016	123 24.4	156 30.9	97 19.2	22 4.4	106 21.0	504
2015	154 26.6	197 34.4	110 19.2	16 2.8	96 16.7	573
2014	190 29.3	196 30.2	112 17.3	22 3.4	128 19.7	648
2013	203 28.6	186 26.3	125 17.6	43 6.1	152 21.4	709
Mean	153 26.5	173 30.4	103 17.5	26 4.5	117 20.5	572

Source: police statistics.pl.

The locations of drowning accidents are presented in Table 2. Most drowning accidents occurred in open areas of inland waters, i.e. lakes (30.7%) and rivers (26.5%). Relatively few drowning accidents were reported at sea (4.5%). Based on the above, it can be concluded that areas of marine waters were better protected by rescue services than areas of inland waters. It should be borne in mind that in many water areas, such as ponds or rivers, where 44.0% of drowning cases were recorded, there are no bathing areas or designated places for swimming and bathing. Moreover, every fifth drowning incident occurred in an unspecified area of water. It is not expected that bathing areas and other guarded places will be created in the above areas, therefore, intensified preventive measures should continue to be carried out, including, among others, the obligation for fishermen to stay in individual safety or rescue equipment on vessels and near the shore, anglers, workers in hydrotechnical facilities, navigation, etc., regardless of the type of activities related to being by the water.

TABLE 3. CAUSES OF DROWNING

Reasons Year	Bath in the city unguarded.	Bath in the city forbidden.	Defocus above water	Defocus while fishing	Other	Toget her
	N %	N %	N %	N %	N %	N
2018	80 14.7	64 11.7	44 8.1	29 5.3	328 60.1	545
2017	55 12.0	34 7.3	28 6.1	36 7.9	304 66.5	457
2016	68 12.6	32 6.3	38 7.5	27 5.3	368 73.0	504
2015	100 17.4	54 8.7	44 7.7	41 7.1	334 58.3	573
2014	104 15.4	36 5.5	56 8.6	41 5.9	411 63.4	648
2013	128 18.0	67 9.5	55 7.7	37 5.2	422 59.2	709
Mean	89 15.5	44 7.7	44 7.7	35 6.1	361 63.1	572

Source: police statistics.pl.

The causes of drowning are presented in Table 3. The results in the table above do not present clear causes in most cases, as as many as 63.1% of the total number were given in the other category. Of those listed in the table - Bathing in unguarded or prohibited places accounted for 23.2% of accidents, and carelessness while staying near the water - 13.8%.

It should be assumed that as a result of increased education and prevention, many bathing-related misfortunes could be avoided, and many accidents could be avoided if, additionally, people staying in water areas used commonly available individual safety or rescue measures. It is also necessary to conduct a detailed analysis of the causes of drowning, on the basis of which more effective social interventions could be applied.

TABLE 4. ALCOHOL CONSUMPTION AS A CAUSE OF DROWNING

Reasons Year	After ingestion alcohol	Not found alcohol	Together
	N %	N %	N
2018	126 23.1	419 76.9	545
2017	97 21.2	369 78.8	457
2016	111 22.0	393 78.0	504
2015	136 23.7	437 76.3	573
2014	157 24.2	491 75.8	648
2013	156 22.0	553 78.0	709
Mean	130 22.7	442 77.3	572

Source: police statistics.pl.

One of the main causes of accidents in the aquatic environment is being under the influence of alcohol. This seems to be right, but the statistics seem to be ambiguous. According to them, only every fifth person who had a fatal accident in water was under the influence of alcohol. It is not known whether the remaining people (77.3%) who were not found to

have alcohol were tested for this condition. Moreover, in people who were found to be under the influence of alcohol, the concentration of alcohol was not provided, which does not fully justify the cause of drowning. Similarly to assessing the causes of drowning a detailed analysis of the role of sobriety on the number of drownings should be carried out, on the basis of which more effective social interventions could be used.

B. Social prevention as a determinant of safety in the aquatic environment

Social prevention is a set of activities to prevent undesirable behavior of people in order to protect them. Preventive and, inextricably linked with them, educational activities aimed at increasing safety in the aquatic environment are aimed directly at the issue of dealing with situations of direct and indirect threat. Act on the safety of persons staying in water areas of August 18, 2011 in Art. 14 section 1 point 2 imposes on entities authorized to perform water rescue the obligation to conduct preventive and educational activities. They mainly involve giving lectures in kindergartens, primary schools, junior high schools, high schools and other institutions. Moreover, in the summer, as part of prevention, rescue teams that are members of rescue entities are obliged to patrol rivers and lakes with motorboats.

Each rescue entity, in accordance with the above Act, should have:

- a center/office where there is constant, 24-hour duty, communication with the Police, Fire Department and Emergency Medical Service,
- an intervention team consisting of water rescuers equipped with passenger cars, off-road vehicles, motor boats and specialized rescue equipment needed for water rescue (www.ratownictwo-wodne.com.pl.).

As part of preventive and inextricably related educational activities, entities authorized to perform water rescue are obliged to cooperate with water area managers and the Police and supervise dangerous places, including places customarily used for bathing (i.e. not formally a bathing area or a place used for bathing), as well as to participate in the risk analysis carried out by water area managers referred to in Art. 4 section 1 point 1 of the Act.

The obligation to conduct preventive and related educational activities regarding safety in water areas is independent of the obligations arising from contracts concluded with the managers of designated water areas and cannot be at the expense of ensuring readiness to perform water rescue services.

Education is a set of processes and interactions whose aim is to change people, especially children and young people, in accordance with the ideals and educational goals prevailing in a given society(https://pl.wikipedia.org/wiki/Edukacja).Safety education as an inseparable part of prevention is particularly important where the greatest threats exist. It begins with the identification of threats and ends with the development of contingency plans related to risk (Wiesner 2011). Education for safety is implemented through school and social education. The first, formal one, takes place at the stage of preschool education, school and studies. The second one - informal, lasts throughout life and shapes a person's attitudes, values, skills and knowledge based on various experiences and the environment, especially mass media. Examples include: educational competitions, projects, films, radio plays, multimedia and simulation games, as well as entertainment. It takes place in the workplace, as part of activities in non-governmental organizations, youth organizations, trade unions, sports clubs, etc. and in the place of residence, spending free time as self-education or accidental education, i.e. resulting from everyday situations that were planned, happened unexpectedly and became source of knowledge or experience.

Education for safety is implemented through:

- swimming education,
- legal education,
- education for physical culture,
- rescue education.

An example of preventive safety activities is, among others, the construction of indoor facilities for safe bathing and swimming, such as swimming pools and water parks. In Poland, in 2014, there were 736 swimming pools consisting of at least one pool with a length of at least 16 m. These were: 12 Olympic swimming pools, 66 sports swimming pools (25 x 16 m), 489 swimming pools with dimensions of 25 x 12.5 m and 169 training and recreational swimming pools (Ministry of Sport and Tourism, 2015). Apart from swimming pools, water parks are becoming more and more popular among the public. Facilities of this type are relatively young, because Mr The first indoor water park was built in 1985 in Edmonton, W Canada. Water parks are large facilities characterized by:diversified infrastructure, which includes swimming pools of various depths, sizes and with different water temperatures, often with artificial waves and in places to surfing. Additional attractions of the Aquaparks include: slides, artificial rivers with rapid current, fountains, water jets and water geysers. The water parks also offer treatments hydrotherapeutic,saunas,solariums, sometimes also baths brine. Water parks are often built in places where they occur thermal, enabling year-round use of facilities, including those located outside built-up facilities(www.wikipedia.org/wiki/Aquapark). It can be concluded that thanks to the construction of new facilities that provide attractions and comfort, more and more people use swimming pools and water parks, which makes them more willing to learn swimming and at the same time spend their free time safely in the aquatic environment.

In Poland in 2019, there were 443 facilities recognized as water parks(https://infobasen.pl/aquaparki.html).The largest water park is located in Poznań–Termy Maltańskie, which was put into operation in 2011. This complex with a cubature of 253,659 m3 and a swimming pool area of 2,420 m2 is the second largest Aquapark in Europe(www.webcitation.org.).The most frequently visited water park in Poland is the we water park Wrocław– it is visited by over a million people a year. The water park in Krakow is visited by half a million people, and Fala in Łódź by 250,000(http://biznes.onet.pl/mamy-boom-aquaparkow).The real gem of water investments is open 2020Suntago Water World, Stage I of the huge Park of Poland investment. The water park was created in the village of Wręca

near Mszczonów, approximately 40 km from Warsaw and 70 km from Łódź. It is the largest water park in Poland, as well as the largest roofed facility of this type in Europe. It can accommodate 15,000 people at the same time, with 67,000 m² of space at its disposal.

The organization of bathing and swimming in swimming pools and water parks, where specific regulations, regulations, safety standards and rescue equipment are introduced, promote safety. This is confirmed by the results presented in Table 5. Even though the number of facilities of this type is rapidly increasing in Poland, the number of drowning accidents does not increase, it is small and amounts to an average of 3 people per year, which constitutes 0.5% of all drowning accidents.

TABLE 5. NUMBER OF DROWNING ACCIDENTS IN POLAND AT SWIMMING POOLS IN RELATION TO ALL EVENTS IN 1998–2012

Year	Total number drowning accidents	Number of drowning accidents in indoor swimming pools
1998	892	7
1999	828	4
2000	525	6
2001	675	3
2002	741	1
2003	661	7
2004	564	4
2005	585	3
2006	564	2
2007	479	0
2008	452	1
2009	468	0
2010	369	2
2011	396	1
2012	449	5
Mean	576	3

Source: www.statystykipolice.pl

C. Legal prevention as a determinant of safety in the aquatic environment

Legal prevention is action aimed at preventing violations of legal norms (https://sjp.pwn.pl/slowniki/prewencja.html)and is divided into general and specific.

General legal prevention is one with directives, which the goal is to influence society by administering punishment.

What stands out here is:

- general negative legal prevention - it involves deterring potential ones perpetrators by the fact that certain acts are prohibited, and also because they are measured penalties behind crimes,
- general positive legal prevention - shaping the legal awareness of society by administering justice in cases crimes. This is facilitated by a public naturema in hearing, public announcement judgments, as well as the possibility of making their content public through the mass media.(https://pl.wikipedia.org/wiki/Prewencja_ogolna).

Special legal prevention this is one of purposes of punishment and at the same time a directive its. Its goal is to prevent it from happening again deed By perpetrator.

What stands out here is:

- specific negative legal prevention - preventing (or even hindering) the perpetrator from committing a crime in the future (e.g. by being imprisoned), which reduces the likelihood of recidivism at least for the duration of the sentence,
- special positive legal prevention, clearly preferred by the Polish legislator - what should be understoodresocialization(https://pl.wikipedia.org/wiki/Prewencja_szczegolna).

In terms of safety in the water environment and limiting the occurrence of potential drowning accidents, preventive activities of state authorities, rescue services, the Police and other authorized units boil down to the introduction of legal regulations and their respect by both the organizers of water recreation and their participants. Legal regulations precisely define sanctions for the negative effects of tortious acts. Responsibility of both groups is treated as bearing the consequences of their own actions, primarily legal ones.

Along with social development, behavioral changes occur, most often forced by the development of technology. That is why new legal regulations are constantly being introduced. In the case of participants relaxing by the water, the following suggestions should be considered:

- obligation for persons staying on vessels up to 5 m in length to wear and fasten lifesaving equipment in the form of life jackets or lifejackets - depending on the swimming area,
- the obligation of anglers to wear life-saving equipment in the form of life jackets or life jackets, regardless of the method and place of fishing,
- the obligation to have and use a device for emergency shutdown of the engine in watercraft by attaching it directly to any part of the body or the helmsman's clothing,
- the obligation to report leaving the port, marina and the expected cruise route by making an entry in the port book, along with providing the method of contact, regardless of the size of the vessel and the swimming area,
- obligation to report arrival at a port or marina by making an entry in the port book and providing the method of contact,
- the obligation to familiarize yourself with local weather conditions and adapt to them, in accordance with the recommendations of the port/marina regulations.

D. Innovations as a determinant supporting prevention and safety in the aquatic environment.

Innovation is the result of all scientific, technical, organizational, financial and commercial activities that are aimed at implementing changes in products, processes, organization and marketing. Innovation is defined as a novelty, a purposefully introduced change both in technology and organization, business activity or in another sphere of human life, therefore, within the definition of innovation used in European Union directives, organizational innovation and process innovation were introduced separately (https://www.funduszeeuropee.gov.pl/media). Innovation may also involve transforming an invention into a marketable product or process.

In a broad approach, innovations can be considered positive changes that are effective from the point of view of economic and financial calculations. A concept very closely related to innovation is innovation. By the innovativeness of economic entities, he means "their ability and motivation to constantly search for and apply in practice the results of scientific research, research and development work, new ideas, concepts and inventions" (Janasz 2002).

An example of innovation in water rescue are the activities of the Management Board of the Silesian WOPR, which established the Committee for Technical and Technological Innovation in water rescue, KITT for short. This commission is an advisory and opinion-forming body operating at the Management Board of the Silesian WOPR. The aim of the committee's work is:

- searching for new hardware solutions used in rescue; implementation of new rescue and rescue techniques,
- conducting research in the area of new technologies and devices in rescue,
- verification of new solutions introduced to the rescue market,
- scientific activities in the field of rescue, safety, physical recreation and sports,
- activities supporting the scientific development of members of the Silesian WOPR,
- development of scientific publications related to rescue, safety and physical recreation and sports,
- development of teaching in universities and public education in the field of rescue,
- dissemination of knowledge in the field of new techniques and technologies in rescue environments (http://www.slaskiewopr.pl.).

Another example of innovation is the management of the Water Rescue Coordination Center in Sopot, the main coordination center accepting 24-hour calls from the nationwide Water Rescue Number 601 100 100. The operation of the CKRW system is based mainly on: Water Rescue Intervention Groups, Water Rescuers securing sea and inland bathing areas and in cooperation with other services such as: Maritime Search and Rescue Service SAR, State Fire Service, State Medical Rescue, Police and many others. The main task of the CKRW Dispatcher is to answer emergency calls, locate the injured person, collect information, provide first aid by phone, and then dispatch and coordinate activities. Currently, there are six Water Rescue Coordination Centers in Poland, they are:

- Szczecin – West Pomeranian Voivodeship,
- Giżycko – Warmian-Masurian Voivodeship,
- Legionowo – Masovian Voivodeship,
- Kruszwica – Kuyavian-Pomeranian Voivodeship,
- Suwałki – Podlaskie Voivodeship,
- Sopot – Pomeranian Voivodeship and the rest of the voivodeships not mentioned above.

Using technology and innovative management, the system is unique on a global scale. Unique solutions and effects were presented at the International Lifesaving Federation - an international organization bringing together national water rescue organizations from around the world (http://www.sopockiewopr.pl/ckrw).

On similar principles as in Sopot, the coordination of rescue teams, receipt of reports and management of systems for those practicing water sports on inland waters is handled by the Dispatcher at the Water Rescue Coordination Center in Giżycko. After an accident occurs and is reported to 997 (Police) or 112 (CPR) or 998 (Fire Service), the information is redirected to the Water Rescue Coordination Center. It is also possible to report directly to the CPRW by calling 984 or 601 100 100. The CPRW dispatcher, based on the location of the reported accident on the water, notifies the appropriate, nearest headquarters of the rescue team and the emergency service. The headquarters of the rescue teams are: Harsz-Składowo, Sztynort, Mikołajki, Ryn, Wierzba, Pisz-Łupki, Ruciane Nida (https://www.zeglarski.info/).

The RATUNEK application, installed in smartphones running Android, also has an innovative character. The Plus Paga Solutiuns network operator, in cooperation with GOPR, TOPR, WOPR and MOPR, has developed and introduced a specialized application that is intended to make it easier for rescuers to find and reach the injured more quickly, thus increasing their safety on water and in the mountains. The accuracy of locating the interlocutor is from 3 to 20 m. GPS must be turned on for the application to work. After tapping the icon three times, a telephone conversation is initiated with the nearest Water Rescue Coordination Center (CKRW), from where the interlocutor's GPS position is sent, as his position and telephone number appear on the digital map in CKRW (http://divemed.pl/aplikacja-na-ratunek/).

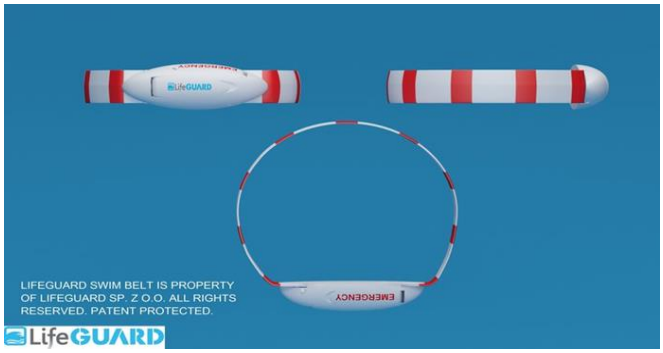
Another example of innovation that increases safety in water is the Lifeguard Swim Belt. This intelligent lifebuoy invented by Artur Kamiński from Poland. His project may contribute to improving safety in many water areas and swimming areas in the future. The idea of a traditional lifebuoy and a car airbag is combined here. When folded, the Lifeguard Swim Belt looks like a normal belt (Photo 2). The Lifeguard Swim Belt is equipped with a canister of compressed gas which, in the event of an emergency, is pierced by a needle triggered by pulling the buckle. Gas from the punctured tank inflates the flexible material that forms the strap, turning it into a lifebuoy. To

reduce the risk of failure, the belt is equipped with two buckles. The first one moves the head, which pierces the gas tank and fills the wheel (Photo 1). However, if for some reason it does not work, the second, emergency buckle is used to move the gas tank itself so as to load it onto the immobilized head. This solution is very similar to the emergency cord in parachutes. (https://www.spidersweb.pl).

PHOTO 1:LIFEGUARD SWIM BELTAFTER FILLING WITH AIR

Source: https://www.spidersweb.pl.

PHOTO 2:LIFEGUARD SWIM BELTFRONT, BACK, TOP VIEW.



Source: https://www.spidersweb.pl.

The innovative Laura multi-functional boat, designed by Andrzej Ostrowski (Protective Certificate for utility model No. 67456), can be used for more comfortable and safe work of rescuers and quick transport at the swimming area. The hull of the multi-purpose boat "Laura" is 426.7 cm (14 ft) long and 198 cm (6.5 ft) at its widest point. Thanks to these parameters, the boat has high longitudinal and, above all, transverse stability. The bottom of the boat is 20 cm thick at the front and slopes gently towards the stern, where it is 15 cm thick. If the boat is flooded, the water spontaneously flows out of the cockpit through the open stern, where the bottom is 5 cm lower than in the bow part. The lack of a transom, in addition to the natural possibility of water outflow, facilitates communication, both from the shore and from the water. This is especially useful when you need to pull a person in need of help into the boat (Photo 3). The person is pulled into the boat from the water, not pulled out, as in the case of units with a transom at the stern. The wide and flat cockpit allows a person/people to be placed freely in the cockpit and provided with qualified first aid by one or two water rescuers (Photo 4). The cockpit area is not limited because the rower's seat is mobile, and in the case of using an outboard engine, the mobile transom is also not a major limitation, as it takes up little space compared to the 2 m wide stern. Watertight chambers and bulkheads ensure the stiffness of the hull and the boat's buoyancy of approximately 800 l. The total weight of the boat, depending on the equipment, is 80-120 kg. allowing it to be transported, among others, on the roof of a passenger car.

Additional Features of a multi-functional boat related to a higher level of safety include:

- unsinkability, thanks to the tightness of the joints of the lower and upper parts of the hull and the buoyancy means glued to the internal parts of the hull,
- high longitudinal and transverse stability of the hull enabling safe communication of the crew in the cockpit,
- easy boarding after capsizing,
- the ability to turn the boat around independently after capsizing, with simultaneous automatic drainage of water from the cockpit through the open stern,
- use of anti-slip surfaces on the entire surface of the cockpit and deck,
- fastening equipment and ropes to holes and handles located in the hull outline, no metal fittings protruding from the hull,
- possibility of emergency swimming using the upper limb drive after lying down in the cockpit in the event of loss of the previously used drive,
- securing the oars against falling out of the oarlocks or breaking.

The features of a multi-purpose boat related to higher swimming speed result from:

- the flat-bottomed shape of the underwater part of the hull in the central part of the bottom and with slants within 12° in the remaining parts, which limit hydrodynamic resistance, and the undercut bottom of the stern part reduces turbulence and "sticking" of water.

Justification: The parameters of the hull, especially its underwater part, determine many different features, such as the speed or initial stability of the vessel. They constitute the basis for calculating movement resistance in various water conditions. One of the most important parameters in assessing the efficiency of the underwater part of the hull is the waterline, i.e. the theoretical plane intersecting the hull at the waterline. The shapes of the underwater part of the hull are expressed in the so-called cylindrical (prismatic) coefficient resulting from the buoyancy curve and have a clear relationship with the total hull resistance (Pieśniewski 2015a, 2017). The least favorable in this respect is the triangular cross-section (sharpie), and the most favorable is the round-bottomed one. Smaller ratios of the wetted circumference of the station to its immersed surface are generated by a shape similar to a rectangle. However, by far the most favorable shape is semi-elliptical, and with larger ratios of waterline width to draft - trapezoidal, characteristic of a skipjack hull (Pieśniewski 2012). Fairly good results occur in rectangular sections with rounded corners. The desired minimum resistance for almost all shapes is achieved when the waterline width is twice as large as the draft (Pieśniewski 2015b). The total resistance to hull movement is: frictional resistance, resulting from the basic property of water, which is viscosity, and residual resistance, especially wave resistance, resulting from the movement of water molecules during hull

movement. Residual drag is, in practice, wave drag, responsible for generating waves on the water surface by the hull (Pieśniewski 2012, Krężelewski 2017).

- low sides, which reduce lateral drift caused by wind pressure on the hull (Berkowski et al. 2007, Świdwiński, Kolaszewski 2015),
- low hull weight compared to other units of similar size, which results in less effort when rowing,
- an effective oarlock fastening system enabling the use of lifeboat oars.

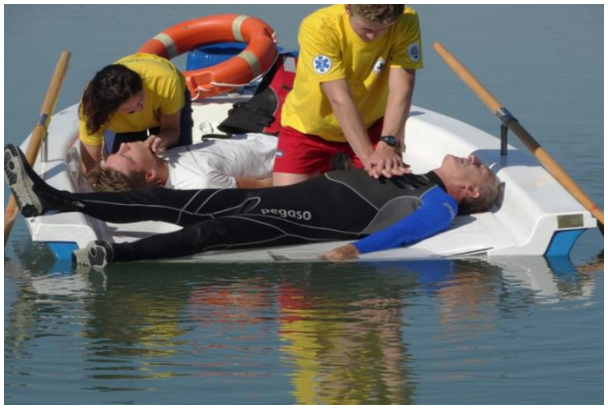
The advantages of a multi-functional boat related to the convenience of use include:

- spacious (250 cm x 160 cm), comfortable cockpit for the crew,
- flat bottom of the cockpit enabling comfortable stay and communication,
- small draft enabling you to swim to the shore and pull the boat ashore on your own,
- profiled bow and sides ensuring "dry" sailing,
- small dimensions and weight facilitate transport and storage of the boat,
- possibility of using a locker with a self-draining water system,
- possibility of securing the boat against theft by using holes in the hull,
- spontaneous flow of water from the cockpit and locker after rainfall, flooding or after washing the deck.

PHOTO 3. INNOVATIVE LIFEBOAT WITH AN OPEN STERN AND A WIDE DECK.

Source: from the archives of A. Ostrowski

PHOTO 4. AN INNOVATIVE RESCUE BOAT WITH THE ABILITY TO PROVIDE IMMEDIATE ASSISTANCE TO INJURED PEOPLE.



Source: from the archives of A. Ostrowski

In the near future, it is expected that social needs, development of science and technology, and the importance of the problem related to the large number of drownings not only in Poland but all over the world may constitute the basis for further exploratory searches to save human health and life in water.

E. Implementations as a determinant supporting prevention and safety in the aquatic environment

Implementation is the beginning of using something in practice (https://sjp.pwn.pl.).The implementation may concern many areas of science, industry and life, e.g.: IT system, technology, product, exercises, skills, management, etc. Implementation may take place as a result of appropriate adaptations or through research and implementation works. Work simple mentation constituting the basis for implementations depend primarily on the adopted methodology, length of the schedule or scope of the project, and the strength of their impact on the implementation process depends on the size of the project (http://www.ptzp.org.pl.).

Implementations are most often the result of research and development work and are aimed at realizing an original design, construction or technological achievement and before they are considered ready, they are subjected to a series of assessments, usually in accordance with a scale called Technology Readiness Levels - TRL (Banke). 2010).

The key element of implementation from a legal perspective is introducing it to an organization, company or institution by transferring licenses, copyrights, and in particular property rights (https://pl.wikipedia.org/wiki/Wdro%C5%BCenie_systemu).

In terms of increasing safety in the aquatic environment, technology implementation seems to be primarily important, created as a result of scientific and technical activities carried out in practice, e.g. by commissioning new technologies or modifications of existing technologies. **Research and implementation work** consist in developing methods and techniques for applying research results in production; they are the final stage of the research cycle from discovery invention for its practical application. These include transferring scientific research results from laboratories to industry, from the model phase prototypes to phase mass production. The results of this research are called innovations, because implementation research is closely related to development work, consisting in adapting the methods and achievements of implementation research to the production conditions in a given country and in a given plant, as well as adapting the product to the requirements of the recipient of that country and its market(https://pl.wikipedia.org/wiki/Badania_naukowe).

Implementation work (Implementation work) are made on the basis of the company's decision to apply the results of research and development work, including the use of inventive projects, both its own and those acquired in the form of licenses, related to the launch of the production of new products or modernization of manufactured products and the introduction of new manufacturing methods that precede starting production

on an industrial scale.

Implementation work, including author's supervision, includes in particular work related to:

- preparation of full technical documentation,
- developing draft standards and documentation in the field of typing,
- making an industrial prototype, the first set of tools and equipment, and assembling technological devices,
- making a trial series of a new product, conducting tests and introducing corrections after tests.

The implementation work is completed when the production of a new or modernized product or the implementation of a new technology is launched on an industrial scale (https://stat.gov.pl/metainformacje/slownik-pojec/).

An example of implementation to increase the level of safety in water areas is the use of increasingly popular unmanned ships called drones.

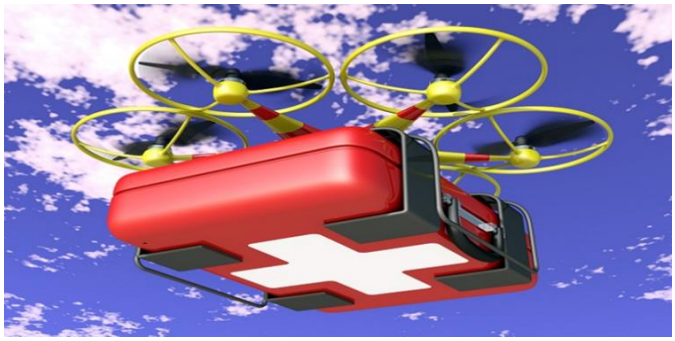
PHOTO 5. PARS "IRANIAN DRONE SAVING LIVES"

Source: www.swiatdronow.pl.

The unmanned aerial vehicle (UAV) dedicated to use in water rescue is Pars–Iranian drone,based on quadrocopter,designed to provide lifebuoys to drowning people (Photo 5).Pars has attached lifebuoys that are dropped near the drowning person. Pars can also operate at night - it is equipped with a thermal camera to detect the human body in the water. It is lit with LED lamps, has a camera with a live view from the drone's deck, autopilot, GPS, and is stabilized with a three-axis gyroscope, barometer and compass. Parsit flies with a forward speed of approximately 7.5 m/s and hovers in the air for approximately 10 minutes, which gives it a range of 4.5 km. Real tests were also carried out, in which Pars competed with a real lifeguard. Efficacy tests showed that from the moment of calling to the injured person located 75 m from the shoreline, Pars delivered a lifebuoy in 22 seconds, and the rescuer - in 91 seconds (http://www.swiatdronow.pl/pars-iranski-dron-ratuje-tonacych).

Another adapted drone, the "Flying Defibrillator", also serves a rescue function (Photos 6, 7). The prototype of a drone transporting a defibrillator - Defikopter - was created by the German organization Definetz. The deficopter's task is to quickly deliver the AED to a designated place, defined by a dedicated application.

PHOTO 6.UNMANNED AERIAL VEHICLES (UAVS)–"FLYING DEFIBRILLATOR".



Source www.http://www.swiatdronow.pl/defikopter-dron-wyposalony-defibrylator-aed

PHOTO 7. "FLYING DEFIBRILLATOR" IN ACTION.

Source: www.http://www.swiatdronow.pl/defikopter-dron-wyposalony-defibrylator-aed

The defibrillator can be delivered to any place in the area where it is stationed based on GPS coordinates. ""Flying defibrillator"is to increase the safety of the population, because AEDs are available only in key places, i.e. airports, main city promenades, offices, sports facilities. In places that are not large population centers, delivering defibrillators to an injured person takes hours, while only the first minutes after a cardiac arrest count in saving lives. Therefore, the Defikopter can help - a multi-rotor aircraft that will quickly deliver the AED to the right place on the map by air.(http://www.swiatdronow.pl/defikopter-dron-wyposalony-defibrylator-aed).

It is also worth mentioning that a floating robot, EMILY (Emergency Integrated Lifesaving Lanyard), was designed and manufactured in Switzerland to save people drowning in water (Photo 8). It is powered by a battery-powered rotor engine and operated by remote control after being launched from the shore, boat, pier or helicopter.

PHOTO 8. EMILY ROBOT

Source: https://www.emilyrobot.com/

The robot was first tested in early 2010, and in 2012, rescuers made the first rescues of people using EMILY. The robot is powered by NOAA EMILY, enabling multi-day operation time. In 2016, EMILY was used to help refugees reach land safely on the island of Lesvos in Greece. EMILY is currently equipped with the Hellenic Red Cross, the Hellenic Coast Guard and rescue teams from Turkey(https://www.emilyrobot.com/).

Monitoring and analyzing the scene of an accident or searching for missing people in the mountains are another of many examples of the use of unmanned aerial vehicles in rescue. Even more advanced is traversing the sky using a drone equipped with FPV, thanks to which you can observe a designated water area "through the eye of a drone" in real time.

A drone with a rope and a buoy used to retrieve drowning people from the water is the idea of Polish rescuers. The above set was created in the Science and Technology Park in Gdynia. In addition to monitoring hard-to-reach places during searches, the drone can also help a drowning person get out of the water. There are cameras on board of the unmanned vehicle that record images with a ten-fold optical zoom, thanks to which water rescuers can determine, without risking health and life, whether the person they are interested in is a free swimmer or requires assistance. A rescue buoy with a tow rope can be thrown to a drowning person, and the aiRPAS Machines drone can even tow it to a safe place with the help of a rescuer operating the camera remotely. In the case of wanted and missing persons in difficult-to-reach areas, it is possible to drop a signaling buoy which, using a sound, light and GPS signal, will indicate the location of the missing person to the rescue services (http://www.superstacja.tv/wiadomosc/2019-05-31/).

The greatest risk of drowning occurs on hot summer days, especially on weekends. A large crowd of people wanting to relaxin attractive places in limited beach areas, despite the efforts of organizers and rescue services, poses a great threat. The solution to the above problems may be the swimming pool in Jurków in Małopolska, where near the beach and the place designated for swimming and bathing, a complex of swimming pools was built (Photo 9) adapted to the expectations of vacationers, with a separate paddling pool for the youngest with parental supervision (Photo 10) and 50 m swimming pool with designated areas of water with a depth of 40 to 120 cm. Those relaxing by the water more often used swimming and bathing places that were better developed and therefore safer than the adjacent designated swimming and bathing places located on the lake (Photo 11). The above example is worth considering in the development of the Baltic Sea quays and attractive water resorts, frequently visited in the summer.

PHOTO 9. AN EXAMPLE OF A COMPLEX OF SWIMMING POOLS BUILT NEXT TO THE BEACH AT THE LAKE TO ENSURE SAFE SWIMMING AND BATHING.

Source: A. Ostrowski archive

PHOTO 10. A SEPARATE PADDLING POOL FOR CHILDREN NEXT TO THE SWIMMING POOL AND THE BEACH BY THE LAKE AS AN EXAMPLE OF INCREASING THE SAFETY OF SWIMMING FOR CHILDREN UP TO 7 YEARS OLD.

Source: A. Ostrowski archive

PHOTO 11. A SMALL NUMBER OF BATHERS AND SWIMMERS IN THE LAKE AS A RESULT OF THE POSSIBILITY OF SWIMMING AND BATHING IN THE POOLS ADJACENT TO THE LAKE.

Source: A. Ostrowski archive

The implementation of the achievements of technology used in sea navigation and other areas of life in water rescue seems natural and desirable. An example is the lifeboats owned by some rescue entities.

For example, in the R-1, R-7, R-12, R-14, R-15 boats intended to provide assistance in the area of the Great Masurian

Lakes, thermal imaging cameras with the possibility of quick installation were installed. They also have an integrated navigation system, which includes: – GPS system – radar – digital map – echo sounder. From the R-2 NAWIGATOR II boat, the image from the camera with the GPS/GPRS location system in the PLUS network is directly transmitted to the Water Rescue Coordination Center in Giżycko via the water rescue number 601 100 100 (https://www.zeglarski.info/assets/Pliki-PDF/).

The future of water rescue implementations seems to be electric floating boards, which are more and more commonly used by vacationers (Photo 11). Many private companies already rent the above equipment for recreational use. The advantage of floating electric boards is their mobility, ease of transport and maneuvering in the water, and the ability to safely reach the injured person. A lifeguard operating on the board in a prone position can easily swim to the injured person, slide into the water if necessary, or pull an unconscious person or person with limited mobility onto the board. It can also participate in rescue operations, having additional vessels of a similar type in tow at its disposal.

PHOTO 12. ELECTRIC FLOATING BOARDS USED BY VACATIONERS.

Source: A. Ostrowski archive

IV. CONCLUSION

Despite rapid technical progress and the introduction of new solutions and products, at the moment, due to the specificity of innovations and implementations, it is difficult to indicate what and how preventive activities will be supported in the future to increase safety in water areas. We should expect a turbulent development in many areas of life, and above all, the adaptation of achievements in various fields of technology, new technologies, management and IT.

Based on the analysis carried out, it was concluded:

1) There are numerous drowning accidents in Poland. Efforts should be made to keep reliable statistics that constitute the basis for proper diagnoses of threats and accidents in water.
2) In order to reduce the number of drownings, appropriate preventive measures have been introduced in Poland through legal regulations regarding the organization and operation of rescue services. They need to be updated and developed, because in relation to the smaller number of accidents in other European countries, these actions are insufficient.
3) Lack of respect for legal regulations is another cause of accidents on the water, which is why the Police and other state authorities conduct preventive activities both among the organizers of water recreation and their participants.
4) An example of increasing the sense of safety in water areas and the functioning of rescue services are numerous innovations that are increasingly appreciated by the world of science.
5) Cooperation between the scientific community and industry results in the construction of increasingly modern and safe places to stay in water areas, which are secured using innovative rescue measures.

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