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Review paper

What is a Risk of Increased Traffic in Boka Bay?*

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Abstract: Boka is undeniably one of the most beautiful destinations in the world. This may be a subjective opinion, however being included in UNESCO's world heritage list may be an objective proof of such a statement. This is recognized by the Government, and nautical tourism has been set as one of the main development strategies for this area. The economic growth, on the other side brings problems that our limited sources can hardly cope with. Increased traffic i.e. number and size of vessels (boats/yachts/ships) that are visiting Boka Bay, enormous fuel quantities burnt by giant engines on mega cruisers, by-products of every day processes such as garbage and sewage cause many side effects that could be hidden. These are all risks that could create catastrophic consequences if not handled properly, and in long term, may turn one of the finest destinations into a place to be avoided.
Navigation is a skill. Years of experience are required to become professional navigator. It is not a sport and it is risky to treat it like that. Risk management concept will be utilized for assessing mentioned risks and for establishing controls that will definitely reduce them.
After short introduction of the concept, priority will be given to analysis of all factors that must be taken into account for successful risk assessment. Special attention will be paid for database that must be established for Boka Bay area. Next step in the process is identification of all hazards related to visits of different types of vessels. Setting the criteria and matrixes that are relevant for this special area is essential before final part of the research focused on risk assessment.

Keywords: Risk assessment, Hazards, Increased traffic, Boka Bay.

1. Introduction

Boka Bay is precious jewel among all other beauties. Apart its enormous cultural and traditional value this diamond has very important economic effect on Montenegrin budget. This has been recognized in the latest

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National Strategy for Substantial Development until 2030 [1]. Large number of seaman compared to its population [2], influential income based on maritime economy, and development of maritime tourism are the benefits that cannot be ignored. Furthermore, same should be developed and brought to its optimum, what is also recognized as priority by Montenegrin government [3].

However, the questions that cannot be avoided and should be emphasized on the top level are: How much are we aware of the risks involved in maritime economy that could endanger our coast? Are we aware of the effect that only one accident could make to our precious jewel? Simply, could Figure 1 lead to Figure 2?

Fig. 1 – *Cruiser "Crown Princess" photographed in close proximity of coast of Prcanj affected by strong wind and anchor dragging [4].*

Fig. 2 – *Cruiser "Costa Concordia" after disaster [5].*

Safety of navigation within Montenegrin coastal waters is implemented throughout many statutory and obligatory acts [6], [7], [8]. It is well established and many parties are contributing towards its improvement. However, without implementing all available techniques and technologies and with increased traffic on the other side, it is very difficult to keep designated path.

Risk Management is very helpful technique in identification of potential risk, and an excellent tool in reducing such a risk. Supported with adequate tools it would create such environment where making decision by appropriate personnel would be easy, quick and risk-based [9].

The aim of this research is to assess the risk of increased traffic in the Boka Bay area. Beside the introduction, the article contains following sections:

- RISK MANAGEMENT TECHNIQUE – this section describes benefits of using Risk Management concept in the specific area of interest, along with the importance of precise database and criteria for successful assessment.
- RISK ASSESSMENT – gives detailed procedure for identification of hazards related to navigation in Boka Bay, and analysis of the risk caused by these hazards.
- DISCUSSION AND CONCLUSION – this part presents the analysis of data gained by the research and summary of the obtained results.

2. Risk Management technique

2.1. Risk management concept

Risk management is not pretty new technique. It has been in use for years. Its essential use started with introduction of ISO Standards. Thus, ISO 9001 (Quality Management System) stipulates that every decision made within an organization must be risk based. What makes this standard more stringent than others is that any process related to decision making must be well recorded and provable. In simple words, an organization must, on request, be able to prove that risk management has been strictly followed. Risk Management is an excellent concept used for improving quality of any process or service rendered.

Even if it is obligatory, and although numerous organizations comply with it, many accidents in everyday life indicate that there is plenty space for improvement [4], [5].

Risk Management is very comprehensive and well-structured concept, consisting of many stages. For the purpose of this article, main focus will be

given on Risk Assessment as just part of this concept. The principle is well explained in many studies [10], therefore it won't be explained in this article.

Risk is often expressed in terms of a combination of the consequences of an event and the associated likelihood of occurrence [11].

Risk assessment may be completed by numerous techniques. This research will be based on risk matrix technique due to its simple practical use in various spheres [12].

2.2. Relevant Risk Management database

Many studies and investigations should be completed in order to make Risk Management 'alive'. Purpose of such studies is to create valid database that will be used for assessing the risk and consequently to set the risk criteria [13].

For the purpose of assessing the risk and thus improving safe navigation in Boka Bay following studies should be performed as a minimum:

1. Study for numbers and interval of visits for all types of vessels.
2. Study of predominant weather in Boka Bay.
3. Study for probability of accident/failure on visiting types of vessels.
4. Possible consequence of accident/failure on visiting types of vessels.

Types of vessels and interval of their visit in Montenegrin Costal waters /Boka Bay

From 2006, Port of Kotor has been recognized and oriented for cruising tourism [14]. Apart from cruising ships, due to its nature and beauty, Boka Bay is well visited nautical-tourism destination. There is an evident tendency of increased number of boats/yachts and cruising vessels, as shown in Table 1 [15], [16].

Table 1 – *Number of foreign boats visiting Montenegrin Coastal waters.*

Year	Number of boats
2014	3,961
2015	4,018
2016	4,384
2017	4,598
2018	4,710
2019	4,775

It is interesting to point out that about 30% of these numbers were boats (yachts) with LOA above 20m, and that most of these visits took part in Boka Bay in summer time (for example in 2019, 2,995 boats have visited Montenegrin coastal waters in period June-August). Taking into account that

number of visitors is also increasing each year, risk of accident/incident will logically be increased.

Regarding cruising ships, the increase of 11.7% has been reported for Port of Kotor in 2019 (compared with 2018), with total 419 visits [17].

Year 2020 was omitted from the study, since the number of visits has drastically decreased, what was expected due to COVID-19 outbreak.

Nevertheless, increasing tendency is obvious, and same pattern is expected in the near future.

Predominant weather condition in Boka Bay

Geographical location and natural protection from strong winds make Boka Bay excellent destination regarding weather conditions. Currents are not affecting the surface navigation, and winds are rarely reaching gale force (28 knots or above).

Even if these parameters give excellent shelter to vessels visiting Boka Bay, the main concern should be given to anchored vessels. As per IACS Unified Requirement A1, Rev 6 [18], to which most Classification Societies refer to, anchor is not designed to hold a ship off fully exposed coasts in rough weather or to stop a ship which is moving or drifting. Anchor is primarily designed to hold a ship in good holding ground, with significant reduction of holding capacity in poor holding ground. In addition, holding capacity is based on an assumed maximum current speed of 2.5 m/s (4.86 kts) and maximum wind speed of 25 m/s (48.6 kts), with no wave. With the wave of 2m maximum significant height, holding capacity is applicable to a maximum current speed of 1.54 m/s (3 kts) and maximum wind speed of 11 m/s (21.4 kts) [18].

This kind of weather is rare in the Bay of Boka, but it still occurs. Therefore, appropriate regulatory act should be enforced, which will consider prohibition of anchoring when the weather prediction reaches above mentioned parameters.

Probability of accident/failure on different types of visiting vessels

Data from many sources must be used in order to calculate and predict probability of accident (or failure leading to accident) on type of vessels that are visiting Boka. However, collecting such data is extensive work, and sometimes uncertain. For example, research made by Maritime Injury Guide Organization states following: 'There has been little consistent and systematic gathering of data to explore cruise ship safety and accidents. Another problem with obtaining accurate safety statistics is the fact that

cruise lines are essentially outsourced. Most ships are incorporated and registered overseas, which means there is little oversight beyond the state under which the ship is operated' [19]. Their statistics shows that:

- Between 2005 and 2018, 448 major cruise ship accidents were reported.
- Between 2005 and 2011, 16 people died in cruise ship accidents.
- Since 2000, around 300 people on cruise ships have fallen overboard. There were 17 overboard incidents in 2017 alone.
- Between 1979 and 2013, 55 cruise vessels sank, with 15 of those occurring between 2010 and 2013.
- From 1972 to 2011, 98 cruise ships ran aground. Between 2005 and 2013, 66 passenger ships reportedly ran aground.

Data for boats/yachts are even more unobtainable, since most of the accidents stay unreported.

Long period of time will be required to create valid database for Boka Bay. Therefore, probability of failure or accident must be calculated based on data from other similar touristic areas. However, accidents that have already occurred in Boka Bay must be taken into account when assessing the risk.

Possible consequences of incident/accident related to visiting vessels' types

First three studies (explained before in section 2.2.) are aimed to determine likelihood i.e. possibility of hazard to happen. To assess the risk it is also required to determine possible consequence if hazard really occurs. Even if this consequence might be minor it should still be considered in the process of risk assessment.

Following consequences (negative effects) may be experienced [13]:

- To people – any accident/incident on board any type of the vessel could cause injury or fatality to humans. This consequence should be categorized based on the scale of injury or fatality.
- To property – collision, allision, failure, force majeure etc. would always cause property damage. It should be formulated upon the value of damage to the property
- To environment – even if very strict rules and regulations aim for zero pollution, it is still taking place. When determining consequence to the environment and its category, the long-term effect must also be considered. The cost of cleaning, bringing environment back to its natural balance, setting new rules etc. must be taken into account. The

impact of increased traffic to very delicate and precious environment should not be based on speculations and rumors, it should be based on facts obtained by concise and detailed studies. These studies should cover all possible pollutions i.e. oil spills, garbage disposal, ballast water treatment, use of inappropriate fuels, discharging sewage and gray water etc.

– To business – major accidents will always affect business, e.g. closure of ports, closure of channel, negative publicity, decreased interest in destination etc.

Setting the criteria

It is worth mentioning that objective of the Risk Management is not to reduce profit by acknowledgment that heightened risk exists. It is there to create safe environment and make such profit achievable. Unfortunately, many organizations are afraid to make realistic Risk Assessment because it may reveal weaknesses of their organization and thus reject potential customers. Since one accident can affect maritime economy for decades, neglecting the risk should be ceased by all possible means.

Another problem, in the use of this concept may be set criteria. This could be the main reason for creating gap between principles set in the context and those used in practice. Most of the organizations adopt ALARP (As Low as Reasonable Practicable) criteria as the main principle in their context [20].

Looking at ALARP principle, it can be noticed that distinctive risk regions are wide and there are no defined limits between each region.

One of the criteria that is more precise, comprehensive and easy to comply with is matrix set by New Zealand Maritime Authority used for Port and Harbour Risk assessment [13]. Frequency and likelihood is well defined by numbers and values, what can easily be referred to. Practical use of such criteria is clear, and assessing the risk is much easier. Another issue, worth mentioning is whether such criteria is statutory? If yes, than making decision is easy and cannot cause any doubt, i.e. if assessed risk reaches statutory defined unacceptable area, such operation/process/service should not be taken until risk is reduced.

Taking above into account, Risk Management may be defined not only as essential tool for risk identification, but excellent aid for setting legislative rules. These rules would assist in protection from potential negligence and intentional misconduct.

3. Risk Assessment

3.1. Hazard identification

First step of Risk Assessment is identification of hazards. Hazard is defined as potential source or situation leading to unintended event (incident/accident). Hazards that are related to navigation in Boka Bay are:

- Unsafe navigation;
- Failure of equipment;
- Bad weather condition;
- Insufficient control of shipboard operation;
- Lack of standards on the ships visiting Boka Bay;
- Lack of regulatory acts controlling navigation in Boka Bay;
- Lack of regulatory acts controlling discharge of sewage/garbage/grey water from ships including ballast waters;
- Lack of acts regulating use of high Sulphur fuels within Boka Bay.

All identified hazards are the common one and each of these consist of many minor hazards. In order to avoid analysis of numerous hazards, more convenient is to analyze unintended events which may occur due to above mentioned hazards. These include, but are not limited to:

- Collision;
- Allision (contact between vessel and fixed object, while collision is contact between two vessels);
- Anchor dragging (with or without consequently collision/allision);
- Grounding;
- Loss of stability;
- Power loss including propulsion loss, engine failure and propeller fault (for cruise vessels only);
- Fire on board;
- Man over board (MOB);
- Injury or fatality;
- Air pollution;
- Sea pollution;
- Mooring breakdown.

3.2. Risk analysis

Risk analysis is the core of the process. Risk is analyzed and evaluated based on data mentioned in section 2.2. Risk analysis may be quantitative or qualitative. Notwithstanding limited budget and time for this research, quantitative risk assessment is preferable. Quantitative risk assessment is very detailed and demanding process, and it is justified only if its use is unquestionable. Many software were developed to assist in quantitative research. One of these is IWRAP MK2 software for assessment of probability of collision and grounding in certain navigational area. Software has been developed by IALA and is even 'free of charge' to its members [21]. Sadly, Montenegro is not an IALA member. The cost of license, adequate training and navigational chart must be anticipated in order to use it within Boka Bay area. Without use of such software quantitative risk assessment cannot be unquestionably certain, but it will, still, give good overview of the risk in the area. It is worth mentioning that software is not giving probability of allision, which in sensitive area like Boka Bay must be considered. Another issue that makes quantitative method difficult to apply is missing data (explained in 2.2).

Following matrixes used for risk assessment in this article are combination of those used by New Zealand's Maritime Authority (and other eminent Port Authority such as UK); ISO; IMO and those based on personal professional experience. Same have been adapted to Boka Bay area and proportional to available budget (Tables 2-5). For example, the consequence is scored as catastrophic for the damage over 6 million € for port Wellington (NZ) and 4.28 million € for Long Beach (USA). Wellington has GDP of about 2 billion € [22], and port of Long Beach about 176 billion € [23], while Montenegro as state had 4.66 billion € in 2019 [24]. Total GDP for Boka Bay area is estimated to maximum 1 billion €. Therefore, categorization of the consequences will be based on values proportional to our budget, i.e. how much impact on our economy could such consequence make.

Table 2 – *Likelihood Matrix for Risk Assessment in Boka Bay.*

Category	Description	Definition
1	Rare	An event occurred once in industry
2	Unlikely	An event occurred several times in industry
3	Possible	An event occurring several times per year in industry or happened in Boka Bay
4	Likely	An event occurring once a year in Boka Bay
5	Frequent	An event occurring several times per year in Boka Bay

Table 3 – *Likelihood Matrix for Risk Assessment in Boka Bay.*

Scale	People	Property	Environment	Business
1	**Insignificant** Slight injury (bruise)	**Insignificant** (€0-5,000)	**Insignificant** Negligible environmental impact. (€0-5,000)	**Insignificant** (€0-5,000)
2	**Minor** Minor injury, Lost work case	**Minor** (€5k-50k)	**Minor** Small spill contained closely around vessel (€5k-50k)	**Minor** Bad local publicity (€5k-50k)
3	**Moderate** Serious injury or disability	**Moderate** (€50k-500k)	**Moderate** Spill, limited to immediate area around vessel (within 500m) (€50k-500k)	**Moderate** Bad widespread publicity, temporary navigation restriction in the Bay (€50k-500k)
4	**Major** Single fatality	**Major** (€500k-2M)	**Major** Pollution spread in wide zone (>500 m radius). Chemical spillage or small gas release, threatening to ecosystem and environmental amenity (€500k-2M)	**Major** Regional bad publicity. Temporary closure of a part of Boka Bay (€500k-2M)
5	**Catastrophic** Multiple fatalities	**Catastrophic** (€2M+)	**Catastrophic** Spill requiring support from international clean up funds. Widespread coast contamination or serious chemical/gas release. Significant threat to environmental amenity. (€2M+)	**Catastrophic** International media publicity. Port closure or navigation seriously disrupted within the Bay for an extended period. (€2M+)

Table 4 – *Risk Matrix for use in Boka Bay Risk Assessment.*

Consequence	5	5	10	15	20	25
	4	4	8	12	16	20
	3	3	6	9	12	15
	2	2	4	6	8	10
	1	1	2	3	4	5
Likelihood		1	2	3	4	5

Since there are mainly two types of vessels visiting Boka Bay (boats/yachts and cruising ships), and taking into account huge difference in likelihood and consequence of incident involving each type, two separate risk assessment will be carried out.

Table 5 – *Risk assessment for boats/yachts visiting Boka Bay.*

Identified hazard	Likelihood	Consequence	Control	Residual Risk
Collision	3/4	4	COLREG, STCW, Speed limit	12/16
Allision	3	2/3	COLREG, Speed limit	6/9
Anchor dragging	4	1	COLREG, STCW	4
Grounding	3	2	COLREG, STCW, Speed limit	6
Loss of stability	2	2	Register	4
Fire/explosion	4	3	SOLAS	12
MOB	4	2	SOLAS	8
Injury/Fatality	4	4		16
Air pollution	2	2	MARPOL	4
Sea pollution	3	3	MARPOL	9
Mooring breakdown	2	2	Port Control	4

Explanation:

Collision - In last few years, several collision accidents happened in the area and Montenegrin coastal waters (Table 6). In most of these accidents, fatality was present, therefore consequence was categorized as 4.

Allision/Anchor dragging – These incidents are rarely reported since consequence is thought to be under owner's budget, although dragging and allision may affect infrastructure and cause effect on ecosystem. Risk assessment is made on the experience of boat owners and personal practice.

Grounding – three incidents related to grounding were reported in Boka Bay, two in 2021,and one in 2019 [32]. Since there are no many reports for previous period likelihood is categorized as possible. Consequence is usually within the cost of yacht repair (up to 50k), i.e. score 2.

Loss of stability – Even if these incidents happen several times per year around the world, there are no many reported cases in Boka Bay. Likelihood is categorized as 2 and consequence similar to previous hazard (grounding).

Table 6 – *Comparison of collision/allision accidents in the Region and Montenegrin coastal waters.*

Region	Montenegrin coastal waters
• 16.08.2016 Greece, collision between fast and tourist boat, 4 fatalities [25] • 25.04.2017 Croatia, collision between SAR and taxi boat, 5 fatalities [26] • 22.06.2017 Croatia, collision between taxi and fast boat, 1 fatality [26] • 12.07.2017 Croatia, collision between two boats, 1 fatality [26] • 20.07.2017 Croatia, collision between sailing and fast boat, several injuries [27] • 04.08.2018 Italy, collision between fishing and recreational boat, 2 fatalities [28] • 22.08.2018 Croatia, collision between yacht and small passenger boat, injury [29] • 04.09.2018 Croatia, collision between taxi and recreational boat, several injuries [26] • 04.07.2019 Croatia, allision of catamaran and jetty, serious injury [27] • 03.08.2019 Croatia, allision of fast boat with unidentified object, total loss [27] • 10.08.2019 Greece, collision of two boats, 2 fatalities [30] • 02.08.2020 Croatia, collision between fishing and fast boat, injury [27] • 26.11.2020 Croatia, collision of two boats, serious injury [27] • 29.01.2021 Italy, collision between fishing and recreational boat, total loss [31] • 08.07.2021 Croatia, collision between two boats, serious injury [27]	• 01.05.2017 Montenegro, River Bojana, collision between ski-jet and boat, minor injury [32] • 24.07.2018 Montenegro, Ulcinj, collision between recreational and taxi boat, 2 fatalities and 2 injuries [32] • 30.07.2018 Montenegro, Open Sea near Lustica, collision between sailing boat and yacht, 2 fatalities [32] • 11.07.2020 Montenegro, Budva, collision between yacht and boat, 1 fatality, 1 injury [32]

Fire/explosion – Almost once/year there was an incident related to fire or explosion in Boka Bay:

– 22.04.2017 Montenegro, Boka Bay, Solila, fire on catamaran, property damage [32];

– 22.07.2017 Montenegro, Boka Bay, Tivat, fire on boat, property damage [33];

– 13.12.2017 Montenegro, Bar Marina, several boats on fire, property damage [32];

– 05.08.2018 Montenegro, Port of Bar, fire on patrol boat, property damage [34];

- 05.09.2019 Montenegro, Boka Bay, Tivat, fire on motor yacht, total loss [32];
- 26.06.2021 Montenegro, Boka Bay, Tivat, fire on fast boat, property damage [32];
- 14.09.2021 Montenegro, Sveti Stefan, fire on sailing boat, property damage [32].

Therefore likelihood is categorized as 4. The consequences in these incidents were slight to serious injury, but with just small difference in circumstance it could lead to serious injury or total loss including oil spill. Due to potential consequence it will be categorized as 3.

MOB – Almost all incidents with grounding and fire ended up with MOB, defining this incident as likely to happen. However the consequence could be minor injury what is the reason to be scored 2.

Injury/fatality – Risk to injury/fatality rises from many other accidents such as collision, fire, grounding, and MOB. Unsafe navigation and misconduct may also lead to this danger, what is shown through following examples [32]:

- 20.07.2018 Montenegro, Budva, recreational boat accident, 1 severe injury;
- 07.08.2018 Montenegro, Boka Bay, Prcanj, rubber boat hits swimmer, injury;
- 16.06.2019 Montenegro, River Bojana, fast boat hits swimmer, injury;
- 19.08.2019 Montenegro, Open sea near Traste, fast boat hits diver, injury;
- 22.08.2019 Montenegro, Plava Spilja, boat sunk, several person over board, minor injuries;
- 01.09.2019 Montenegro, near Albania border, 2 person rescued after sailing boat sunk;
- 27.07.2021 Montenegro, Becici, ski-jet recreation accident, moderate injury;
- 05.08.2021 Montenegro, Oblatno, contact between towing object and swimmer, severe injury.

Taking into account all of the above, this hazard is classified as likely to happen and possible consequence is unfortunately single or multiple fatality. This is the highest risk among all related to yachts' visits to Boka Bay.

Air pollution – Relatively small engines on boats/yachts and better quality of fuels used on them, make air pollution unlikely to occur with minor consequence.

Sea pollution – Since there were no major accidents reported for the area, risk assessment against this hazard is made based on data and experience from similar regions. Additional explanation is included in conclusion.

Mooring breakdown – Weather conditions in Boka Bay are such that both possibility and consequence for this hazard are low, but still noticeable.

Table 7 – *Risk assessment for cruising ships visiting Boka Bay.*

Identified hazard	Likelihood	Consequence	Control	Residual Risk
Collision	2	4	COLREG, STCW, Speed limit, Company policy	8
Allision	3	3	COLREG, STCW, Speed limit, Company policy	9
Anchor dragging	3	3	COLREG, STCW, Company policy	9
Grounding	2	3	COLREG, STCW, Speed limit, Company policy	6
Loss of stability	2	2	Register, Class, Company policy	4
Power loss	3/4	4	Register, Class, Company policy	12/16
Fire/explosion	3	3	SOLAS, Company policy	9
MOB	3	4	SOLAS, Company policy	12
Injury/Fatality	3/4	4	Company policy	12/16
Air pollution	2	3	MARPOL, Company policy	6
Sea pollution	3	3/4	MARPOL, Company policy	9/12
Mooring breakdown	2	2	Port Control, Company policy	4

Explanation:

Divergent approach has been established for cruise vessels (Table 7). Number of accidents that happened on ships visiting Boka Bay was taken into account instead of number of accidents that happens in Boka Bay area. Apart from data in section 2.2, made available by Medical Injury Guide Organization's own research, there is no transparent database or site where related info could be found and collected. For that purpose, personal research has been made based on scheduled ship visit to Kotor in 2019 and 2021 (planned schedule from 01st Oct till 31st Dec).

Accident database for scheduled vessel has been found on internet [35]. Although database is not official and its content is not approved by relevant authorities, it is justifiable for these purposes. Even if 1.6 million visits to the referred site (in August only) does not give scientific credibility, it clearly indicates that common people rely and trust it. Related to schedule for 2021, records for 19 ships have been found. There were no accident history for 7 ships. Data for these 7 ships must be taken carefully, as 4 ships are new buildings, 2 are 5 years old and 1 with age of 10. Average age of remaining 12 ships is 12.6 years, newest being 2 and oldest 33 years.

Number of accidents for the particular risks occurring on cruising ships scheduled to visit Kotor in 2021 is shown on following diagram (Figure 3).

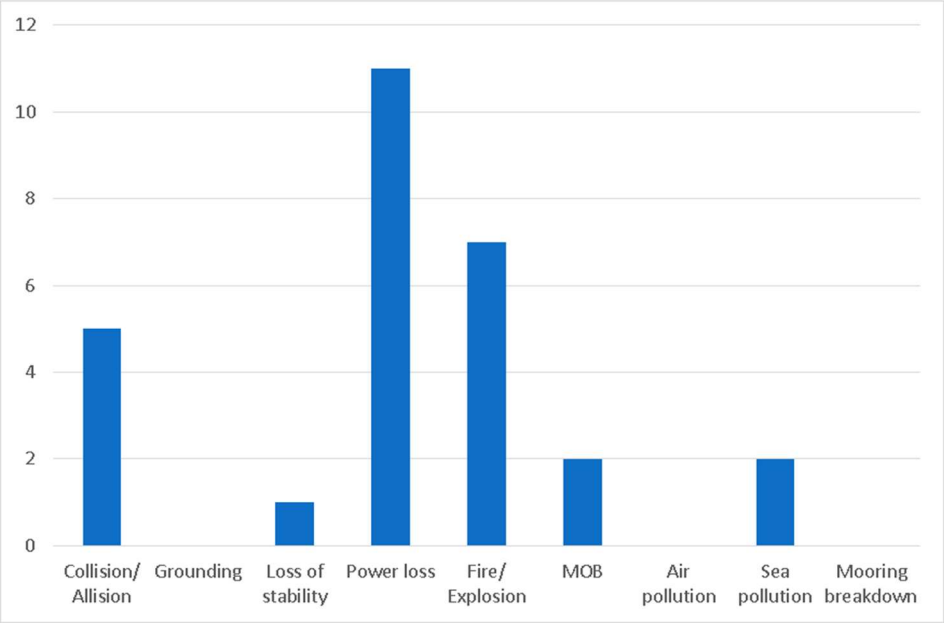

Fig. 3 – *Number of accidents for particular risk on board the vessel scheduled for visit in 2021 [35].*

Note: Anchor dragging is omitted since there is no recorded data. Data for injury/fatality is not shown since it is well above all other accidents, and includes medical cases that are not directly involved with navigation.

Schedule for 2019 should be considered even more, since these vessels were actually visiting Kotor in 2019 for several times. Records for 33 ships have been found. Four ships didn't have accidents (newest has 8 and oldest 30 years). Remaining 29 ships have average 18.7 years (newest 4, oldest 37 years). One of the ships has been scraped, however records are included in research.

Following diagram in Figure 4 shows the number of accidents, for particular risk, occurred on ships that have visited Kotor in 2019.

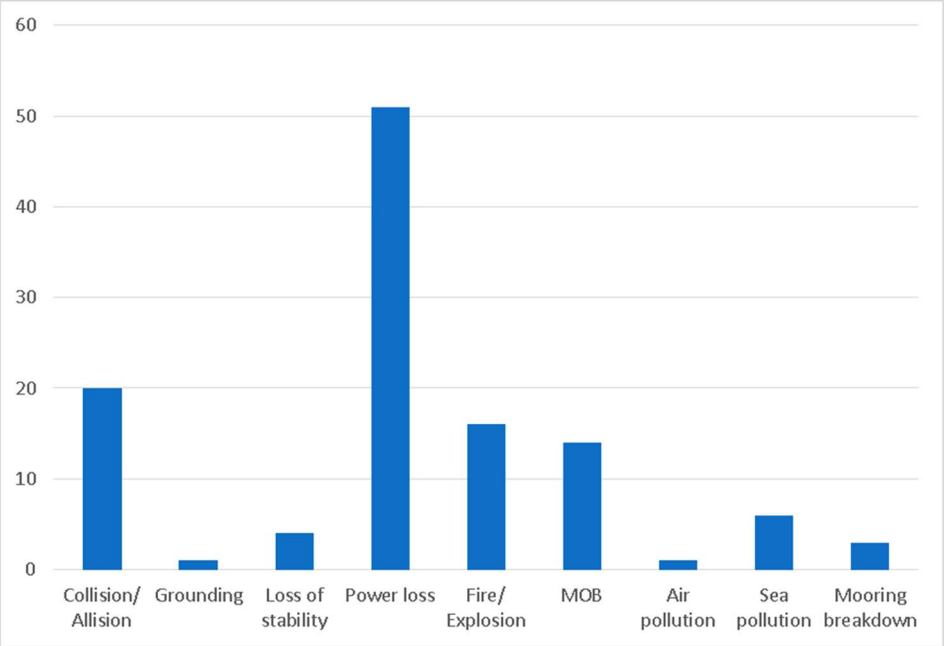

Fig. 4 – *Number of accidents for particular risk on board the vessel visited Boka Bay in 2019 [35].*

Collision – Total 6 collisions (out of 20 incidents related to collision/allision in the fig.4) have been reported for listed vessels both in 2019 and 2021. Therefore, likelihood is categorized as 2. Potential consequence of collision, what was the case in most of these accidents, is large damage and occasionally multiple fatalities. That is the reason why it is scored 4.

Allision – Most of the cases stated in the figures 3 and 4 are allisions. Likelihood is 3, and consequence is serious injury or damage within 500k euros, i.e. 3.

Anchor dragging – Similarly to boats/yachts, these accidents are rarely reported. For example, accident involving cruising ship 'Viking Star' [35] that almost run aground due to anchor dragging cannot be found in above database. Same is with 'Crown Princess', ship from Figure 1. Same is remembered, just because it happened in Boka Bay. Since there were two such accidents in Boka Bay in few years, likelihood is than categorized as 3, consequence is 3. This risk should be well appraised, same as grounding

below, since it could lead to stranding, oil spill etc. what could really cause considerably bigger damage.

Grounding – This accident is one of those that should be assessed with great caution. As stated in above figures, it happened only once among ships visiting Kotor and the consequence was minor. However, everybody is well aware of the accident from Figure 2. One such accident could cause immeasurable damage to Boka Bay. Risk assessment is made on obtained numbers, but as mentioned it should be taken with utmost care. Likelihood is scored 2, consequence as 3.

Loss of stability – Listing is most often case of stability loss within cruising ship business. Possibility to have such incident is unlikely and consequences are either medium injuries or damages up to 50k.

Power loss – This is the accident mostly occurring in research. Power loss itself is not the accident that causes much headache. However, potential losses that derive from power problems are enormous. It could lead to grounding, stranding, stability loss, capsize of the vessel, oil pollution, fire. Therefore both likelihood (with score 3/4) and consequence (with score 4) of such hazard are high, and the risk from it is highest among all others.

Fire/explosion – considering relatively high number of fires, likelihood is scored 3, same as consequence. Most of the accidents have been extinguished by fixed system, or by appropriate reaction, and so the cost of damage was within tolerable limits (score 2). However, due to potential serious injury it is scored as 3.

MOB – Unfortunately, a lot of MOB cases are related to cruise ships. A lot of these accidents are not caused by the lack of standards or controls. Instead, these are usually result of felony or even intention. A lot of these cases were under crime investigation. Since majority of cases ended up with fatality, it is categorized as hazard with major consequence.

Injury/fatality – Taking into account that a lot of hazards end up with serious injuries and fatalities and with such high number of all other mentioned risks which could lead to such result this hazard is also assessed as high risk.

Air pollution – With certain acts regulating air pollution from ships, hazard is unlikely, and consequence may be moderate, especially if hidden (more details in conclusion).

Sea pollution – Number of reported accident (8 in total) might categorize this hazard as unlikely. However, considering the fact that it was repeated on same ship regularly visiting Kotor, makes it more possible to

happen. Claims for declared accidents were remarkable, why this hazard is scored with 3/4.

Mooring breakdown – Mooring breakdown occurred 3 times within all recorded accidents, what was the reason to define it as unlikely risk with minor consequence.

4. Discussion and conclusion

As explained in the article, risk assessment is useful and functional only if criteria is set. Based on professional experience and on many publications dealing with this topic [9], [10], [11], [12], [13], [20], residual risk with score 10 or above is treated as high risk in this research. Thus completed Risk Assessment revealed several hazards with high residual risk. High risk doesn't immediately insinuate that service should be ceased. Economical strategy of Boka Bay reposes on the further development of nautical tourism. As stipulated earlier, our strategy must be based on precise and detailed study, not causing even the slightest doubt in long term. Obtained high risks are pointing out that some of the hazards are not processed adequately. Simply, it could mean that some of the controls to reduce risk are not adequately addressed (as speed limit control, control for strict compliance with COLREG, SOLAS etc.).

Although the risk of pollution (both from yachts and cruising ships) is not within high risk category, it is recommended to carry out further investigation in the future. Montenegrin Government has ratified many conventions and there are numerous acts regulating pollution prevention [33, 34, and 35]. However, legitimate question is whether there is strict control of compliance. For example, responsible person should take fuel sample on 20% of all foreign vessels. Analysis should be completed in accredited laboratory. By following such procedure, it may be practically proved that foreign vessel is complying with measures for air pollution prevention. Another issue that may cause the problem is that taking of samples of sewage/gray water and ballast is justified only if there is doubt that vessel has caused sea pollution. In many sensitive areas, regular taking of samples is custom. Thus, measures to control pollution are made preventive. And finally, penalty policy is the key in successful implementation of the law. Knowing that there are strict rules and witnessing their compliance, navigators will be forced to think twice before making any misconduct.

Further corroboration of above statement could not be completed due to lack of relevant data (as number of fines charged for violation of Port Law i.e. penalty provisions for sea/air pollution; existence of accredited

laboratory for taking fuel sample; number of fuel samples actually taken and existence of beneficial policy for low risk vessels) although official request has been submitted to Ministry of Capital Investment [37-39].

Completed risk assessment may not be perfect and unquestionably reflect the real situation in Boka Bay, but should give good basis for further investigation. With availability of adequate software and data collected over certain period of time, more reliable and precise risk assessment could be made. This research revealed the following:

- There is high risk of collision, fire and injury/fatality on boats/yachts.
- There is high risk of power loss, MOB, and injury/fatality on cruising ships.

Further investigation could be directed towards generation of precise database for the subject area and setting appropriate controls in order to minimize the impact of obtained high risk hazards.

Several high risks call for attention that controls for these areas must be enhanced or established. Navigation in Boka Bay with so many boats, yachts and cruising ships requires special attention by all involved parties. Making risk assessment or just setting the rules is not enough. If the juveniles are allowed to steer the speed boats, ski-jets, if skipper can be any person passing COLREG exam without any practical knowledge, if there are no regulatory acts following best practice around the world (related to ballast water treatment, discharge of water from ships, use of low-sulphur fuels) then our mission will just be a dead letter on the paper. However, it is still not late to protect and preserve our diamond for many future generations.

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