Zeszyty Naukowe ASzWoj nr 2(115) 2019
War Studies University Scientific Quarterly no. 2(115) 2019
ISSN 2543-6937, e-ISSN 2545-1650

RISK MANAGEMENT IN AIR NAVIGATION SERVICES

Dolores Gracja PIWEK, MSc

Institute of Civil Aviation Management
Faculty of Management and Command
War Studies University, Warsaw

e-mail: d.piwek@akademia.mil.pl
ORCID: 0000-0002-3083-6015

Abstract

The need to develop and adopt legal standards for safety management was identified at the Conference of General Directors of Civil Aviation dedicated to the global strategy of aviation safety (Montreal, March 20-22, 2006) and additionally supported by the recommendations of the Safety Conference (Montreal, March 29 - April 1, 2010). The year 2006 saw the introduction of issues related to the safety management system to the Convention's annexes. The existing fundamental rules related to SMS were included in the annexes: 1 - *Personnel licensing*, 6 - *Operation of Aircraft*, 8 - *Airworthiness of Aircraft*, 11 - *Air Traffic Services*, 13 - *Aircraft Accident and Incident Investigation*, and 14 - *Aerodromes*. In addition, due to the dynamic development of aviation and, at the same time, the growing need to create the highest standards in the field of safety management systems, the Air Navigation Commission established the Safety Management Panel (SMP) to develop the content of Annex 19. After several years of reconciliation and consultation, this document was finally adopted by the ICAO Council in 2013. It has become the ipso facto document that provides the basis for creating an effective safety management system, as it is compatible and also adapted to the most effective practices indicated in the ICAO Doc 9859 Safety Management Manual. Annex 19 sets out the responsibility of States, the safety management system and the collection of information related to safety. The National Civil Aviation Safety Programme and the structure of this system were also dealt with. The whole idea is to support states in the process of hazard identification and risk management.

The purpose of the article was: to highlight selected elements of the risk management process in a practical dimension, to present the principles for assessing the degree of risk by an air navigation service provider, and to identify ways of improving this process.

Searching for an answer to the main research problem contributed to achieving this goal. **The research problem was expressed in the form of a question**: How does the air navigation service provider manage the risk under the air traffic safety management system in order to achieve compliance with regulatory requirements and to achieve the assumed parameters (indicators) in the area of safety?

With regard to the main research problem, the following research hypotheses were formulated:

1. I believe that an air navigation service provider undertakes an assessment of the degree of possible danger in civil aviation to identify hazards in air traffic as part of a safety management system.
2. I suppose that the air navigation service provider manages the risk in a manner consistent with the provisions of law and by using procedures included in normative documents.

Key words: safety management, risk management, air navigation services providers

Concept of risk

Risk is an integral part of the existence of any aviation organisation. It can also be stated that risk is a byproduct of aviation activities. Each action taken is at risk of failure, not only because of incorrect forecasts or incorrect methods of action, but more often because independent of contractors, there are hostile factors in the aviation operations environment. Risk must be identified and controlled. The activities of organisations responsible for legislative processes in the field of aviation go deeply into the phenomenon of risk and set out rules that even allow risk management.

Before discussing the risk management process in ANSP in detail, the term "risk" itself should be somewhat clarified as the basis for consideration in this article. Risk is most often intuitively associated with a threat, situation or dangerous and adverse factors. However, generally speaking, threats are all probable events that can threaten life, health or property, but the "risk" term is much more periphrastic. The word 'risk' comes from the Latin *risicum* meaning the possibility of a positive or negative event, and from the old Italian *risicare* meaning 'dare' or 'face'. We learn from Spanish and French that *ar-risco* is both courage and danger, and the "language of aviation" in English defines *risk* as a situation that causes danger. While the risk is associated with danger, it is definitely more associated with making a decision or a choice than with the intended use[1]. A common mistake in defining concepts is to replace a specific term with its defintion. The same happens with "risk". Diversity in defining risk can also result from a significant diversity of names assigned to risk when defining their ambiguity. Terminological diversity in the area of various scientific fields is natural; however, too much diversity in one discipline may cause communication difficulties. For example, in the context of aviation, in Annex 19 *Safety Management* to the Convention on International Civil Aviation, risk is defined as follows: *safety risk - predicted probability and the severity of the consequences or effects of the threat*. Risk is, therefore, only associated with probability and the severity of consequences. These two definitions clearly do not exhaust the meaning of risk. Another way of defining risk is to identify it with uncertainty, example, e.g.

1 G. Pietrek, *System zarządzania kryzysowego – diagnoza i kierunki doskonalenia*, Warszawa 2018, p. 40.

according to ISO norm 31000: 2009 "risk is the effect of uncertainty in pursuing a given goal". In the above definition, the risk was treated as a random consequence without specifying whether it should be measured. The term risk is associated with future and prospective measures and the result is an end state. It is important to clarify the difference between risk and uncertainty[2]. Uncertainty is associated with a deficit of information necessary for forecasting and decision making, while risk can be characterized by having the information, goal, task and knowledge of the random nature of the forecast implementation. In the opinion of this author, the most reasonable definition of risk, proposed by P. Makowski, is as follows: *risk is a peculiar feature of a situation whose forecast random development can only have negative effects either negative or positive and the probability distribution of these effects is known and identified with acceptable accuracy*[3].

However, I would like to draw attention to another important issue arising from the cited definition of risk according to Annex 19 *Safety Management*. Not the risk itself but the risk related to safety, as in the definition of safety (also from Annex 19 of the Chicago Convention) we find the term "risk": *safety - a condition in which the risk associated with various types of aviation activities, related or directly supporting air operations are reduced to an acceptable level and controlled*. In ANSP, the concepts of risk and safety cannot exist without each other. Safety is managed because there is a risk of negative events. Risk is managed because an acceptable level of safety is being sought. Risk management therefore involves setting safety goals and identifying threats to finally "deal" with the risks. I describe how to deal with it later in the article.

Risk management

If one would like to reach an ambiguous definition of the term "risk management" or "safety risk management" in the documents regulating ANSP activity, then this would not be an easy task. On the other hand, the easily available information regulating the subject of the Safety Management System (SMS) and referenced in the documents is that risk management is one of the elements of the SMS and covers two areas. An SMS is defined as *a systematic approach to managing safety, including the necessary organisational structures, accountabilities, policies and procedures*[4]. It is used as a tool for the management of safety by an organisation. The four generic processes included in the ICAO SMS requirement (identification of hazards, implementation of remedial action to address the safety risks of the consequences of hazards, continuous

2 P. Makowski, *Konsekwencje regulującego charakteru ryzyka*, w: *Risk management 2015,Zarządzanie ryzykiem w Siłach Zbrojnych Rzeczypospolitej Polskiej*, red. Z. Redziak, M. Strzoda, AON 2016, p. 14.

3 Ibidem, s. 15.

4 ICAO Doc 9859 - *Safety Management Manual* (SMM), ed. 3, Montreal 2013, p. 116.

monitoring and continuous improvement) encompass the four basic safety problem-solving activities that support delivery of services by an organisation. According to the SMS concept, risk management areas are:

- Identification of threats - refers to formal activities aimed at identifying threats to the conducted activity. It is done using a combination of reactive, proactive and predictive methods.
- Risk assessment and mitigation - it concerns research, estimation and monitoring of risk in the course of business.

Risk management is, therefore, a process of identifying threats related to the provided services, based on a combination of reactive, proactive and prognostic methods in the field of safety data collection and provides analysis, assessment and control of risk related to identified threats in the field of safety.

Pursuant to Commission Regulation (EU) No. 1035/2011[5], air traffic service providers in the European Union have a safety management system (SMS) as an integral part of their services management. This system, among other things, is meant to ensure that when providing air traffic services, the main safety objective will be to reduce the risk of an air accident caused by the services to a practically feasible extent. In addition, institutions are required to ensure that risk assessment and mitigation are carried out at the appropriate level and all aspects related to ATM provision are taken into account. As previously mentioned, risk management involves setting safety goals. Setting goals in the field of safety, in turn, is associated with the following activities:

- identification of probable threats and circumstances of failures related to the ATM system (the effects of existing situations should be included here);
- assessment of potential consequences and the severity of these consequences in relation to aircraft safety (this assessment is based on the appropriate severity classification system);
- definition of an acceptable level of hazards in relation to the highest probability of hazard occurrence.

This "appropriate classification system" will be examined later in the article. Severity classification should be based on a detailed description indicating the most probable consequences of threats in the most pessimistic scenario of developments.

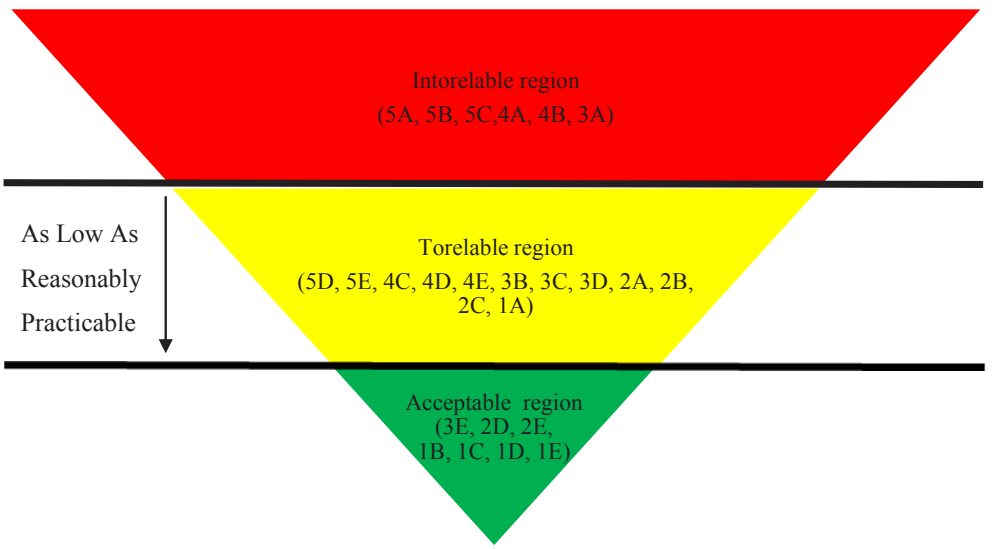
It should be taken into account that safety management, first of all, is one of the functions of air navigation services and, therefore, guarantees the indication, assessment and reduction of various safety hazards. Secondly, the approach to safety management is based on comprehensiveness, formalisation and systemic perception of safety issues. Safety management consists of several elements interrelated that form a whole in pursuit of the assumed safety goals. Hazard identification and risk assessment are just two of them.

5 Commission Implementing Regulation (EU) No. 1035/2011 of 17 October 2011 laying down common requirements for the provision of air navigation services and amending Regulations (EC) No. 482/2008 and (EU) No 691/2010.

Risk classification scheme

Safety risk management is a generic term that encompasses the assessment and mitigation of the safety risks of the consequences of hazards that threaten the capabilities of an organisation, to a level as low as reasonably practicable (ALARP). The objective of safety risk management is to provide the foundation for a balanced allocation of resources between all assessed safety risks and those safety risks the control and mitigation of which are viable.

Figure 1 depicts a broadly adopted generic visual representation of the safety risk management process. The triangle is presented in an inverted position, suggesting that aviation (just like any other socio-technical production system) is "top heavy" from a safety risk perspective: most safety risks of the consequences of hazards will be assessed as initially falling in the intolerable region. A lesser number of safety risks of the consequences of hazards will be assessed in such a way that the assessment falls straight into the tolerable region, and even fewer will be assessed in such a way that the assessment falls straight into the acceptable region.



Source: ICAO Doc 9859 - Safety Management Manual (SMM), ed. 3, Montreal 2013.

Figure 1. Safety risk management

The scope of the risk classification scheme in an air navigation service provider takes into account the relationship between the ATM system or changes in its characteristics and air traffic safety. This relationship results in the need to provide the classification of the impact of ATM system elements or changes introduced in it on the level of air traffic safety. It is carried out according to the expected impact of occurrences with the participation of the ATM system and the probability of

the consequences of these occurrences. According to the ICAO classification, the severity of occurrences is classified into five categories:

- Cat. 1 catastrophic (e.g. equipment destruction, many fatalities);
- Cat. 2 hazardous (e.g. big reduction in safety margin, physical discomfort or workload for operators to such an extent that there is no certainty that they will perform further tasks);
- Cat. 3 major incidents (e.g. significantly reducing safety margins, weakening operators ability to cope with adverse conditions due to increased stress level);
- Cat. 4 minor incidents (e.g. nuisance, operational restriction, use of emergency procedures);
- Cat. 5 negligible (e.g. minor consequences).

The frequency of occurrences within the scope of the air transaction management system was classified as:

- extremely improbable - this effect should not occur throughout the life of the system;
- improbable - this effect can occur, but only in large amounts during the entire lifetime of the system;
- remote - possibility of occurrence during the whole period of the system's operation;
- occasional - the effect will occur several times during the whole period of use;
- frequent - the effect will often occur in the life cycle.

With reference to the five classifications, one can point to to a specific example of occurrence that describes its overall impact on safety, direct impact on the air traffic management system, and the exemplary effects of the event.

If there is a first category occurrence (catastrophic), the services lose their ability to carry out their duties safely. Inability to provide a safe air traffic management service means that it is not possible to conduct the service in accordance with the procedures and requirements that arise from safety regulations. The reason for this is the high level of stress or workload to the extent that the air traffic controller or crew is not able to perform further tasks, there is a loss of functional ability which results in an inability to deal with negative conditions resulting from the occurrence. When the catastrophic event happens, the possibility of introducing preventive procedures or systems is also significantly reduced, intervention is limited and operators are not prepared to implement remedial actions. The reasons for such situations are plane crashes, aircraft collisions in flight, aircraft collision with the ground in a controlled flight, loss of aircraft control functions. This situation can lead to many accidents or serious incidents.

To compare the descriptions of the existing situations and their effects with the previously described category, if there is a fourth category occurrence (minor incidents), the situation is as follows: the provision of the service remains secure but the service is weakened. As a result of stress or specific environmental conditions, the activities of the controller or crew are slightly disturbed. In this case, it is possible to automatically take reliable countermeasures to eliminate the effects of the occurrence. Examples of causes may be: a slight reduction in separation so that both

the crew and controllers have full control over the situation and are able to restore proper flight separation minima immediately; another effect may be the workload of the controller or crew, which may lead to an incident. Therefore, the risk was defined as a combination of estimated weights of the effects of events in the air traffic management system with the frequency of their occurrence. Using the described risk classification scheme, an air navigation service provider may conduct appropriate measurements of the impact of ATM system components on air traffic safety. This is the basis for accepting the likely severity of threats and their probability (frequency of occurrence).

Once the safety risk of the consequences of an unsafe event or condition has been assessed in terms of probability and severity, the next step in the process of bringing the safety risks of the consequences of the unsafe event or condition under organisational control is assessment of the tolerability of the consequences of the hazard if its damaging potential materialises during operations aimed at delivering services. This is known as assessing safety risk tolerability. It is necessary to obtain an overall assessment of the safety risk and this is achieved by combining the safety risk probability and safety risk severity tables into a safety risk assessment matrix, an example of which is presented in Table 1.

For example, a safety risk probability has been assessed as occasional (4). The safety risk severity has been assessed as hazardous (B). The composite of probability and severity (4B) is the safety risk of the consequences of the hazard under consideration. Extending the discussion to the described risk severity categories, it can be seen in this example that a safety risk is just a number or alphanumerical combination and not a visible or tangible component of the natural world. The color coding in the matrix in Tab. 1 reflects the tolerability regions in the inverted triangle in Figure 1.

Table 1

Safety risk assessment matrix

	Catastrophic A	Hazardous B	Major C	Minor D	Negligible E
Frequent 5	5A	5B	5C	5D	5E
Occasional 4	4A	4B	4C	4D	4E
Remote 3	3A	3B	3C	3D	3E
Improbable 2	2A	2B	2C	2D	2E
Extremely improbable 1	1A	1B	1C	1D	1E

Source: ICAO Doc 9859 - *Safety Management Manual* (SMM), ed. 3, Montreal 2013.

The risk matrix formed in this way allows the level of risk occurring and its consequences to be accurately estimated, constituting the basis for further actions in the field of risk management in an air traffic service provider.

System for reporting and investigating occurrences in air navigation services

In accordance with international regulations and Eurocontrol[6] requirements, the occurrence reporting system at the institution responsible for providing air traffic services should be supplied. It includes occurrences reporting methods both as part of the mandatory procedure and as part of voluntary notification. In addition, this system defines the rules for preparing reports in relation to the service and the methods of reporting occurrences to the air accident investigation commission. The provisions governing the scope of the procedure also determine the rules for reporting occurrences, to Eurocontrol[7]. Occurrences related to the operation of air traffic management (ATM) and communication, navigation and surveillance (CNS) services are treated as the subject of the process. Under the mandatory reporting system, the units required to take action are:

- crew operating the aircraft;
- personnel monitoring continuing airworthiness, technical service - those directly related to the airworthiness certificate or authorisation for operation;
- air traffic services staff;
- flight information services personnel;
- personnel related to aircraft maintenance (conducting repairs, renovation, installation);
- personnel conducting in-flight checks or inspections of air navigation service facilities.

With regard to the voluntary reporting system, employees of every air navigation services provider's cells are required to use this system. Directors of individual safety cells directly interested in the reporting process are responsible for supervising the process (including directors competent in the cells for: safety and crisis management, air traffic services, air space management, technical services, training of ATS personnel, investigation of aviation events, and employees of the mentioned departments and technicians duty). The occurrence reporting system run by the entity must be consistent with the safety policy in force in the institution

6 European Organisation for the Safety of Air Navigation (EUROCONTROL) - international organisation working to achieve safe and seamless air traffic management across Europe and is headquartered in Brussels, Belgium.

7 T.M. Markiewicz, *Podstawowe zagadnienia zarządzania ruchem lotniczym*, wyd. AON, Warszawa 2010, p. 80.

and the "just culture"[8] policy. This system is additionally designed to increase the level of safety of the institution. This happens by specifying incompatibilities or deficiencies in the air traffic management system and implementing appropriate corrective measures and preventive actions.

In the scope of reporting occurrences under the mandatory and voluntary system, the first and basic step is to submit a form about the occurrence to the appropriate unit for safety and crisis management in air traffic or the unit for investigation and inspection of ATM / CNS. After receiving the notification, the head of the appropriate unit prepares a report on the occurrence, which is then presented to the safety and crisis management unit in air traffic, the cell responsible for air traffic services, the cell competent for air space management, the cell competent for technical services and the deputy president of the institution. After analysing the report at the above-mentioned levels, actions are taken in accordance with the occurrence described in the report. As part of the analysis of the occurrence, an investigation is conducted inside the organisation, followed by the registration and archiving of the occurrence.

The condition for undertaking activities in the field of investigation of an occurrence related to air traffic management services and communication, navigation and surveillance services is a decision issued by the air investigation authority[9] designating the air navigation service provider to conduct an investigation of the event. The authority decision includes:

- qualification of the incident (i.e.: air accident / incident / non-aviation situation);
- institution responsible for conducting the investigation process (air accident investigation committee / air navigation service provider / air operator / airport authorities);
- person responsible for supervising the explanatory process.

Investigation may be conducted by the entity to which the occurrence relates, but in accordance with the decision issued by the air investigation authority competent in a given country. If the authority investigates the occurrence, it is necessary to complete the appropriate documentation and other materials, as well as to archive them. If, however, the subject concerned conducts the proceedings on their own, the obligation to investigate the occurrence is charged to the appropriate organisation's investigation cells depending on the classification of the aviation occurrences.

The person designated for the undertaking representing the occurrence investigation and inspection unit is responsible for the occurrence investigation process within the organisation. In order to take action, the designated employee is obliged to:

8 Just Culture is a concept related to systems thinking which emphasises that mistakes are generally a product of faulty organisational cultures, rather than solely brought about by the person or persons directly involved. In a just culture, after an incident, the question asked is, "What went wrong?" rather than "Who caused the problem?"

9 In Poland: State Commission of Aircraft Accident Investigation (SCAAI).

- complete and save submitted reports;
- secure the messages of the air traffic services of the aircraft that participated in the event;
- secure and save recordings of radio and telephone correspondence;
- protect and save radar imaging recordings;
- prepare printouts of the flight trajectories of aircraft that participated in the event;
- perform all other analyses, expert opinions and recordings necessary to conduct the investigation of the occurrence[10].

The inspector appointed by the occurrence investigation and inspection cell is responsible for conducting the procedure, (guided by the personal knowledge and experience gained during the process), and is also authorised to collect any additional materials necessary to investigate the occurrence. During the course of the investigation, the inspector interviews the participants of the occurrence and at the request of the personnel of air traffic services. After collecting evidence, the inspector conducts an analysis to determine occurrence causes and determine the degree of danger. Next, an initial report containing the exact course of the occurrence, initial analysis, event classification and conclusions is prepared. This report is sent to the head of the incident investigation and inspection unit and to the appropriate air investigation authority.

After the examination of the occurrence and approval of the final report, safety recommendations are issued in relation to the conducted proceedings. The last step is the entry of the event data into the occurrence log as well as archiving and storage of materials from the analyses carried out. In this way, the occurrence investigation process allows to accurately classify the occurrence, describe the reasons for it and the entire course. It also contributes to the formulation of appropriate safety guidelines and recommendations to support institutions in implementing corrective actions and to create a database used during safety training.

Conclusions

Verifying the hypotheses made it possible to solve the adopted research problem and, as a consequence, achieve the assumed goals of the work. Identification of hazards and risk classification is the first step after determining the safety policy to establish the severity and probability of threats that may occur in the future and those that have already occurred (possible repetition). In accordance with the adopted classification scheme, an air traffic service provider may determine the consequences of events, their impact on the air traffic management system and the repeatability of the

10 Regulation of the Minister of Transport of 18 January 2007 *on aviation accidents and incidents*, Journal of Laws No. 35, item 225.

event in the future. Adjusting the severity of the event's effects to the probability of its occurrence enables accurate diagnosis of the consequences (i.e. the degree of "paralysis" of services, the impact on other service provider cells and control of other sectors, the ability to continue the service or damage to the systems used by ATS). In addition, a risk matrix is developed that in turn indicates the level of acceptability (or lack thereof) of a given risk. The risk classification process carried out in this way gives a clear view of each event and its impact on future safety.

Investigation of aviation occurrences is primarily used to determine the causes and determine prevention in this regard. However, another equally important result of research is the creation of databases on specific occurrences that are to serve the proper preparation of training programmes for the personnel concerned. The organisation is required to investigate occurrences covered by this process, but may also conduct investigations as part of a voluntary reporting system. It is very important that, apart from mandatory reporting, staff are aware of the importance of voluntary reporting. Any situation that has taken place or may take place should be controlled, even slight misconduct can lead to a serious occurrence. The organisational climate should affect the willingness to voluntarily report events and make employees aware of the most important reason for pursuing this policy, which is prevention of unwanted occurrences and care for maintaining safety at the highest level.

Safety regulations require constant updating and adapting management models to the ever-changing environment that places demands on aviation institutions and organisations. With air transport in growing demand, ensuring the highest possible level of safety is a necessary condition for the dynamic development of the air transport market on a global scale.

Abbreviation index

ALARP - As Low As Reasonably Practicable
ANS – Air Navigation Services
ANSP – Air Navigation Service Provider
ATM – Air Traffic Management
ATS – Air Traffic Services
CNS – Communication Navigation Surveillance
EUROCONTROL – European Organisation for the Safety of Air Navigation
ICAO – International Civil Aviation Organisation
SMS – Safety Management System
SMP – Safety Management Plan

References

Legal Acts:

ICAO Doc 7300 – *Convention on International Civil Aviation*, the 7th of December 1944.

ICAO, ANNEX 11 *Air Traffic Services* to the Convention on International Civil Aviation Air Traffic Services, ed. 13, July 2001.

ICAO, ANNEX 19 *Safety Management* to the Convention on International Civil Aviation Air Traffic Services, ed. 1, July 2013.

ICAO Doc 9859 - *Safety Management Manual (SMM)*, ed. 3, Montreal 2013.

Commission Implementing Regulation (EU) No 1035/2011 of 17 October 2011 *laying down common requirements for the provision of air navigation services and amending Regulations* (EC) No 482/2008 and (EU) No 691/2010.

EUROCONTROL, ESARR 4 - *Risk Assessment and Mitigation in ATM*, April 2001.

Rozporządzenie Ministra Transportu z dnia 18 stycznia 2007 r. *w sprawie wypadków i incydentów lotniczych*, DzU Nr 35 poz. 225.

Science publications:

Makowski P., *Konsekwencje regulującego charakteru ryzyka*, w: Risk management 2015, Zarządzanie ryzykiem w Siłach Zbrojnych Rzeczypospolitej Polskiej, red. Z. Redziak, M. Strzoda, AON 2016.

Markiewicz T.M., *Podstawowe zagadnienia zarządzania ruchem lotniczym*, wyd. AON, Warszawa 2010.

Pietrek G., *System zarządzania kryzysowego – diagnoza i kierunki doskonalenia*, Warszawa 2018.