ASPECT OF RELIABILITY IN AIRPORT BUSINESS CONTINUITY MANAGEMENT

ASPEKT NIEZAWODNOŚCI W ZARZĄDZANIU CIĄGŁOŚCIĄ DZIAŁANIA PORTU LOTNICZEGO

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Abstract: *The paper presents the issue of ensuring the continuity of the operation at the airport. Requirements and objectives relating to business continuity management have been defined in accordance with ISO 22301 international standard. Conducted a study of reliability issues operation of the airport. Defined the function of the reliability and operational readiness of the airport. Presented the concept of using function of operational readiness in the risk assessment for the continuity of the airport.*

Keywords: *airport, business continuity, operational readiness*

Streszczenie: *Tematem publikacji jest zagadnienie zapewnienia ciągłości eksploatacji portu lotniczego. Określono wymagania i cele oraz międzynarodowy standard zarządzania biznesową ciągłością działania – ISO 22301. Przeprowadzono studium zagadnienia niezawodności funkcjonowania portu lotniczego. Zdefiniowano funkcję niezawodności i gotowości operacyjnej portu lotniczego. Przedstawiono koncepcję wykorzystania funkcji gotowości operacyjnej w ocenie ryzyka dotyczącego ciągłości działania portu lotniczego.*

Słowa kluczowe: *port lotniczy, ciągłość działania, gotowość operacyjna*

1. Introduction

According to the definition [14] airport is a public use aerodrome used to operate commercial flights (air carriage of passengers, baggage, cargo or mail).

The aim of the operation of the airport is handling aircraft operations in the aerodrome traffic and commercial air transport. At the airport, the operations consist of processes associated with: the operations (departures and arrivals) aircraft ground handling air transportation and special processes to ensure the safety, security, continuity and quality of operation of the airport. These processes are subject to the influence of numerous (in the majority of cases, random) factors, the sources of which include: environment, the failure of infrastructure, human factors, air traffic flow management.

Ensuring the safety and continuity of air transport is a legal obligation [14], the airport operator obligations for the provision. Operational safety and continuity of operations of the airport is also operational and business goals airport managing body. The objectives of security are achieved by bringing infrastructure parameters, procedures, and personnel from legal specifications and implementation of Safety Management System – SMS [15]. Objectives relating to business continuity are achieved through the introduction of an organization or coordination of flights schedules [10] or the implementation of Business Continuity Management System – BCMS [12].

2. The airport business continuity management system and reliability structure

Continuity of operations at the airport depends on the reliability and operational status elements of the infrastructure. Interruption or lower level of airport operation processes are the results of resources lack. The result will be a delay or cancellation of flights [11]. Law requirements and business objectives are the cause of the implementation of the BCMS at airports.

ISO 22301 [12] is an international standard of BCMS. This standard is widely adopted, inter alia, by airport operators (eg.: Warsaw Frederic Chopin Airport, New Delhi Indira Gandhi International Airport, Bangalore International Airport Ltd.). Implementation of BCMS as a good practice is also recommended by Airports Council International – ACI [1] as asupport and complement efforts to manage pandemic crises at airports [13].

Business continuity management is defined as a holistic management process that identifies potential threats to an organization and the impacts to business operations those threats, if realized, might cause, and which provides a framework for building organizational resilience with the capability of an effective response that safeguards the interests of its key stakeholders, reputation, brand and value-creating activities [12].

The key components and requirements of BCMS are:

- business continuity policy (intentions and direction of an organization as formally expressed by its top management),
- business impact analysis (process of analyzing activities and the effect that a business disruption might have upon them) and risk assessment (overall process of risk identification, risk analysis and risk evaluation),
- business continuity plan (documented procedures that guide organizations to respond, recover, resume, and restore to a pre-defined level of operation following disruption),
- business continuity programme (ongoing management and governance process supported by top management and appropriately resourced to implement and maintain business continuity management),
- resources (all assets, people, skills, information, technology (including plant and equipment), premises, and supplies and information (whether electronic or not) that an organization has to have available to use, when needed, in order to operate and meet its objective).

Methods used in the continuity risk assessment are based on the identification of critical resources (resources, the lack of which interrupts or lowers processes). For the identified critical resources assets identified potential causes (events), their status unfitness and an evaluation is the probability of their occurrence and analyzes the impact on the continuity of the operational processes. Widespread practice to perform a risk assessment is the use of expert and heuristic methods, and therefore the results obtained are subject to a factor of subjectivity and do not guarantee their complexity.

Critical processes in airport are aircraft operations and ground handling – business processes and special processes to ensure the safety, security and continuity of the operation of the airport (eg .: technical maintenance of infrastructure, protection of civil aviation against acts of unlawful interference, protecting the state border, rescue and firefighting).

In technical reliability theory sense, BCMS is a system for managing the risk of continuity and widespread practice in the performance of the BIA and risk assessment, the principles and methods set out in ISO standards [8, 16]. BCMS at the airport include both security application (technical, organizational, procedural) business continuity risk mitigation, including planning and taking action in case of incidents. An example of such action was the removal in a very short time, 24 hours from the maneuvering area [2] at Warsaw Chopin Airport disabled (as a result of an emergency landing on 01.11.2011) Boeing B-767. Realized for this purpose a procedure for removing a disabled aircraft, which constitutes an integral attachment to (legally required [14]) Warsaw Chopin Airport Operations Manual is a particular example of a business continuity plan.

In the business continuity plans are defined priorities and objectives, and:

- recovery time objective – *RTO* (period of time following an incident within which product or service must be resumed, or activity must be resumed, or resources must be recovered),
- maximum tolerable period of disruption – *MTPD* (time it would take for adverse impacts, which might arise as a result of not providing a product/service or performing an activity, to become unacceptable),
- maximum acceptable outage – *MAO* (time it would take for adverse impacts, which might arise as a result of not providing a product/service or performing an activity, to become unacceptable).

In the case of the airport (in which, in particular, cannot be create inventories of products) it can be assumed that the values of *RTO*, *MTPD* and *MAO* times are equal and determine the acceptable time-out operation of the airport – T_{AB} :

$$RTO = MTPD = MAO = T_{AB} \quad (1)$$

BCMS effectiveness depends on the correct (adequate to the objectives and requirements) determine the value of *RTO*, *MTPD*, *MAO* times. This is the basis to set priorities, criteria and structure of the BCMS. This implies the need to use mathematical methods from the theory of technical reliability. The issue of ensuring continuity of operation of the airport in terms of technical reliability theory is an issue to ensure the operability. Reliability and operational status of airport infrastructure elements determine the operational readiness of the airport [3, 4, 7].

Operational readiness of the object (or system) – $GO(t, \tau)$ is expressed as a probability of events involving that object (or system) is ready (in the operational suitability) at the time – t at least for a time – τ will perform the tasks:

$$GO(t, \tau) = P(t, \tau) \quad (2)$$

To the airport infrastructure include:

- movement area (that part of an aerodrome to be used for the take-off, landing and taxiing of aircraft, consisting of the manoeuvring area and the aprons) [2],
- visual and radio navigation aids and facilities [14],
- centralized infrastructure (airport infrastructure used for the supply of groundhandling services whose complexity, cost or environmental impact does not allow of division or duplication, such as baggage sorting, de-icing, water purification and fuel-distribution systems) [9].

Elements of airport infrastructure can be described as an ensemble of elements – x , cardinality – N .

Each i -th element of this set can be described as k -element feature vector whose values determine the operational status of the airport.

The relationships between the values of the characteristics of elements (time varying), and the operational status of the airport determine the reliability structure of the airport. Result analysis of the reliability structure of the airport is to identify the critical elements. Feature values are time varying depend on the reliability and operational status of infrastructure elements and are described using reliability measures.

The results of the conducted study [4, 5, 6] indicate that airport is a complex, continuous operation, renewable, reusable technical system with a dynamic, mixed (serial-parallel) reliability structure – S , whose formal description is as follows:

$$S = \langle X, R \rangle \quad (3)$$

where:

$X = \{x_1, x_2, \dots, x_{N-1}, x_N\}$ – ensemble of the airport infrastructure elements,

R – relationships connecting the elements – x between themselves and the surroundings environment.

Probabilistic functional characteristic is a reliability function – $R(t)$, defined as the probability of a correct implementation of tasks for a certain period – T , expressed as follows:

$$R(t) = P(T > t) \quad (4)$$

Basic measure of reliability is the expected value of a random variable – T , expressed as follows:

$$E(T) = \int_0^{\infty} R(t) dt \quad (5)$$

Functional characteristics of random variable – T is a function of the intensity of damage – $\lambda(t)$, expressed as follows:

$$\lambda(t) = -\frac{1}{R(t)} \frac{dR(t)}{dt} \quad (6)$$

Function of the intensity of damage – $\lambda(t)$ is given by the conditional probability of occurrence of the failure status of the object in a time interval $(t, t + \tau)$, provided that the time moment t failure has occurred, that is, determines the risk of damage to the object in each subsequent (after t). For this reason, the function of the intensity of damage – $\lambda(t)$ is called as a function of risk.

The solve of equation (6) is the reliability function – $R(t)$, expressed as follows:

$$R(t) = \exp \left[- \int_0^t \lambda(\tau) d\tau \right] \quad (7)$$

where: τ – the time the time after which element failure occurred.

All elements of airport infrastructure have very high reliability. This is due to the law specifications requirements. Operational unfitness state is a consequence of exclusion from operational use item on time scheduled maintenance or emergency repair [4, 6]. Runs operation of airport infrastructure elements are so alternately strings of using – T and servicing – To , which are random variables with probability density function: $f(t)$ and $g(t)$. To ensure continuity (operational readiness) operation, specify the expected value of uptime using the facility since the last service, which in theory operational reliability is expressed as a function of the average seniority object – $\psi(t)$. The reliability function of the recoverable element, understood as operational readiness, expressed as follows:

$$GO(t, \tau) = R(t, \tau) = \exp \left[- \int_{\psi(t)}^{\psi(t)+\tau} \lambda(\tau) d\tau \right] \quad (8)$$

Reliability N -element technical system is expressed as follows:

$$RS(t) = \sum_{i=1}^k P(S_i) \quad (9)$$

where:

$RS(t)$ – reliability of the system,

S_i – i -th ability status of the system

k – cardinality of a sub ensemble of the ability states of the system.

Taking into account the significant cardinality – N of the set (digital) infrastructure elements and the resulting multiplicity of reliability states – LSN airport system, of:

$$LSN = 2^N \quad (10)$$

in practice, it is advisable airport management in terms of ensuring the continuity of operation using the methods of the minimum ability paths and minimum cross sections nonoperational [5]. The minimum ability paths is a minimal subset of system components whose presence in a state of ability is a prerequisite for finding a system able suitability, and the transition of any element of this subset to a state of nonoperational causes the system to a nonoperational state [3, 4]. Minimum cross section of nonoperational is the minimum subset of system elements whose presence in a state of nonoperational causes the system is in the nonoperational

status, and the transition to any element of this subset to ability state causes the system to an operational state [3, 4]. Application of these methods allows the identification of critical resources in airport BCMS, the designation of their functional reliability measures and to estimate the reliability of the airport system "from below" and "from above":

$$\prod_{i=1}^{LMPN} R_{pi}(t) \leq RS(t) \leq 1 - \prod_{j=1}^{LMSZ} (1 - R_{sj}(t)) \quad (11)$$

where:

- $RS(t)$ – reliability of the system,
- $LMPN$ – number of the minimum cross section of nonoperational,
- $LMSZ$ – number of the minimum ability paths,
- $R_{pi}(t)$ – reliability of the i -th minimum cross section of nonoperational,
- $R_{sj}(t)$ – reliability of the j -th minimum ability path.

3. Summary and Conclusions

Ensuring continuity of operation of the airport is a legal obligation and operational and business purpose of the airport operator. The recommended [1, 13] and widespread practice is to implement the BCMS according to ISO 22301 [12]. BCMS is based on a risk assessment nonoperational elements of airport infrastructure. The risk assessment is carried out expert and heuristic methods, resulting in poor quality and credibility of the results. The issue of ensuring continuity of operation of the airport, can be considered as a matter of operational readiness complex technical system, using numerical and functional reliability measures (and operational readiness), which will ensure proper quality and reliability of the results as a basis for decision-making processes relating to risk management concerning the continuity of the operation of the airport. This requires the corresponding device of the actual data and operational information, to define a numerical reliability measures (e.g.: number of failures per unit time, time between service) and functional reliability measures (e.g.: reliability function, the function of failure rate, the mean internship). These data must be collected in certain procedures (e.g.: surveillance, diagnosis, genesis [3]) and appropriately documented, which is compatible with ISO 22301 [12] and ISO 31000 [16]. A collection of actual operational data is input data to the forecasting process, ie. determination of future operating states based on an analysis of past and current operating states, dimensioned function of the operational readiness of the airport. Identify the form and function parameters of reliability make it possible to formulate conditions, such as:

$$E(T_o) \leq T_{AB} \quad (12)$$

$$GO(t, \tau) > T_{AB} \quad (13)$$

implemented to airport BCMS, using real data and functions of the reliability. This will increase the effectiveness and efficiency of BCMS.

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