BIOLOGICAL RISK ASSESSMENT FOR AIRCRAFT PASSENGERS

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Abstract. The operation and sustainability of a serviceable condition is a complex and demanding process from both a managerial and maintenance perspective. During maintenance, it is necessary to ensure a number of processes that follow each other and have an impact on the time and economy of the company's operation. Each process has its own time values and associated unit labor costs. These unit labor costs, together with the material, which often forms a separate component of invoices for the customer and is sometimes charged as a flat rate, generate profits for the vehicle maintenance organization.The pandemic disrupted all established and used conditions and learned procedures at work. The pandemic caused the processes to be suspended and workers in all spheres of industry to be more or less affected by pandemic commission orders to change their approach to work without these procedures being verified. Managers responsible for implementing individual steps from measures ordered by the commission or higher by the statutory body are faced with a difficult task. Due to the short time when it is necessary to accept and put the task into operation, it is sometimes not possible to avoid financial losses. Losses caused by staff or supply chain failures have a clear impact on evaluation indicators, either for the company as a whole or for individual departments.

Keywords: risk; risk assessment; passenger

1. INTRODUCTION

Transport is characterized as an industry offering the transport of people and goods. The pandemic of the new Corona virus has affected transport to a considerable extent. Restrictive measures and regulations of governments in the transport of passengers and goods caused disruptions in transport in a large volume, and this factor also affected the economy, both at the micro-regional level and at the national level. Like all countries and providers of transport of people and goods, they have been hit by a decrease in sales due to epidemic measures that include work from home professions that do not necessarily require the performance of the essence of work from the workplace. The rate of decrease in transported persons was in some cases up to 90% of the volume of transported passengers compared to previous periods before the pandemic situation.

Most respiratory diseases, as well as the new SARS CoV2 virus causing the disease COVID-19, are transmitted through the air, which is a direct route of infection. This direct path is formed by microscopic particles that are exhaled by an infected person and inhaled by a person nearby. The transmission distance is up to several meters during a normal conversation. When sneezing, it can be more than just a few meters [1-2].

The carriers reduced the spread of the disease by various measures. The main measures were taken from government regulations. Several European carriers had almost unified requirements for passengers in vehicles. The setting of the measures was in accordance with the regulations of the governments so that the highest rate of elimination of the infection of passengers and personnel in means of transport was provided and ensured.

However, despite the measures introduced in transport and on-board aircraft, the risk of infection is still high. We are currently facing the 4th wave of the COVID19 pandemic. Restrictive measures can no longer be introduced in a repressive form of hard lockdown, due to the economic impact. According to the study, the measures are converted to the economic coefficient of an active year of life.

In some parts of the world, the corona virus has spread by underestimating the risk resulting from its reproductive number and its virulence. The first on-board transmission to be documented was a flight from London to Hanoi, Vietnam. This is flight VN54. At that time, there were 217 passengers on board. During the incubation period of 2-14 days, 16 cases of infection were detected on board this flight. Of these, 12 people sat directly in the same class with patient "zero". Other reports also assume transmission in the plane during the flight. [3-5]

2. RISK ANALYSIS AND ASSESSMENT

The main key and primary goal in working with risks that reduce security is to prevent threats and the resulting risks. It is necessary to reduce these risks or to limit adverse reactions which cannot be eliminated by technical, organizational, or other measures. The basis is the search for hazardous elements, the subsequent identification of their causes and sources and the evaluation of possible risks. In such a case, it is not necessary for us to act in accordance with already similar certified procedures according to the relevant standard, for example ISO 45001 or ISO 31000 [6,7]. A set of interconnected procedures and regulations is much more effective. These will define the clear steps / activities that will need to be followed during the performance of the activity. For effective prevention, it is necessary to know the possible risks, where and under what circumstances they may occur. It is also necessary to know the weight assessment of risk and how it is possible to prevent them. That is why they are carried out by risk assessment [8].

The starting point for risk assessment is the identification of sources of danger. It is about finding all possible effects and influences that can endanger life, human health, property, or the environmental aspect of the environment. In this step, it is necessary to carry out a thorough inspection of the sites, which will be subject to an assessment of the emergence of possible risks. Very often we will suffice with a common overview of risks, for which we need sufficient records of accidents at the workplace. For each identified source of risk, it is further assessed what damage may be caused and how it may occur.

The generally applicable risk assessment procedure is specified in several technical standards, such as EN 31010, EN ISO 12100 or IEC 300-3-9. The risk assessment itself consists in assessing, resp. comparison of our expressed (calculated value) with the set criteria.

The result of the risk assessment is thus an expression of the size (degree) of the risk and their prioritization, enabling further focus on the largest (most serious) risks. Because risk is essentially a two-dimensional quantity (probability - consequence), it is advantageous to use a system of two x and y coordinates to express it. It is common for the x-axis to express severity and the y-axis to express probability. We enter the amount of risk of each identified source of risk into this system. This figure is expressed as the intersection of the probability and severity values of the relevant source of risk. This will give us a clear overview of the distribution of risks in the area that we defined at the beginning of the analysis. In addition to the purely graphical way of expression mentioned, a similar expression can be used using a risk matrix, where its vertical elements form probability scales and the horizontal elements express severity. The risk assessment itself consists in assessing, resp. comparison of the values expressed by us (calculated values) with the set criteria.

Table 1 [12]

Probability of occurrence	Frequency (number of cases per year)	Severity of consequence			
		Disastrous	High	Considerable	Low
Common	>1	V	V	V	M
Supposed	$1 – 10^{-1}$	V	V	M	L
Occasional	$10^{-1} – 10^{-2}$	V	V	M	L
Low	$10^{-2} – 10^{-4}$	V	M	M	L
Unlikely	$10^{-4} – 10^{-6}$	V	M	L	N
Almost impossible	$<10^{-6}$	M	M	N	N

V = very high risk; M = medium risk; L = low risk; N = negligible risk.

3. ASSESSMENT OF RISKS FROM EXPOSURE TO BIOLOGICAL AGENTS

In the field of occupational health and safety and industrial hygiene, several methods are used to predict and detect chemical, physical and biological hazards in the workplace. The purpose is to assess the potential exposure, to determine the level of risk to health and to propose measures to protect workers' health against these risks. Biological risk assessment is relatively challenging due to the significant variability of exposure, limited information on the overall level of environmental contamination by a biological agent, the high individual likelihood of transmission of the agent from an infected individual, and the possible consequences. For many biological agents, including coronavirus SARS-CoV-2, there are no hygienic limits that could be used to assess the severity of exposure. However, the US NIOSH identified four risk groups of biological agents (RGs), which can be used as a starting point for risk assessment [9].

4. RISK ASSESSMENT PRINCIPLE

The European Agency for Safety and Health at Work (EU-OSHA) recommends the Online Interactive Risk Assessment (OIRA) tool for risk assessment. It is based on a qualitative risk assessment and can also be used to assess the risks posed by biological agents. The scales set out in Tables 2, 3 and 4 are used to assess the level of risk. Then, by comparing the level of risk obtained with the criteria set out in Table 5, priority interventions can be identified.

The method is based on a risk matrix based on knowledge of the likelihood of exposure to the biological agent and consideration of the possible consequences that may result from this exposure. Where these values intersect at the coloured areas of the matrix, the level of risk is assessed [10].

Table 2 [11]

Probability of occurrence of danger	Hazard description
Practically impossible	Occurs only in exceptional circumstances
Not very common	This is unlikely to happen in the foreseeable future
Possible	May occur in the foreseeable future, sporadic exposure is possible
Probable	Likely to occur in the foreseeable future, routine exposure, if likely
It can be expected	Almost certain consistent exposure is highly likely to occur in the foreseeable future

Table 3 [11]

Severity of damage to health	**Description of consequences**
Insignificant	No treatment is required.
Small	Minor injuries not requiring medical treatment.
Medium	Injuries requiring medical treatment.
Significant	Serious injury requiring professional medical treatment or hospitalization.
Critical	Death or permanent disability or multiple serious injuries.

Table 4 [12]

	Severity of damage to health				
Probability of occurrence of danger	Insignificant	Low	Medium	Significant	Critical
Practically impossible	**N**	**N**	**L**	**L**	**M**
Uncommon	**N**	**N**	**L**	**M**	**H**
Potential	**L**	**L**	**M**	**H**	**H**
Liable	**L**	**M**	**H**	**E**	**E**
Expectable	**M**	**H**	**H**	**E**	**E**

E = extreme risk, H = high risk; M = medium risk; L = low risk; N = negligible risk.

Table 5

Risk level	**Description**
Negligible risk	If this situation occurred, there would rarely be an injury
Low risk	If this situation occurred, it would be unlikely that an injury would occur
Moderate risk	Should this situation occur, there would be some chance of an injury requiring first aid
High risk	If this situation occurred, an injury requiring medical treatment would occur
Very high risk (Extreme risk)	Should this situation occur, there is likely to be such damage to health that would require difficult treatment, or would lead to permanent consequences, or even death

5. PROCEDURE FOR RISK ASSESSMENT IN A MEANS OF TRANSPORT

The methodology aiming to one selected group of people:

Passengers - persons who stay in the potentially contaminated environment inside the car for various lengths of time. A journey lasting several hours is no exception. Passengers get in and out of the car on an ongoing basis, which increases the risk of transmitting the infection.

The principle of risk assessment for both groups of people is based on the assessment of 3 independent parameters, which are assessed separately using a sub-scale of 1 to 4. The data needed for their assessment are easily identifiable and do not require additional measurements. As the COVID-19 pandemic is a highly dynamic process that changes over time as the coronavirus permeates the population, this must be reflected in the risk assessment performed. For this reason, in addition to the above six "static" parameters, information on the current epidemiological situation is also included in the risk assessment. Another important parameter that affects the resulting risk of spreading the disease within railway wagons is the type of railway wagon. From the point of view of the spread of the disease, the fundamental difference is whether it is an open space, or a space divided into many

separate closed cells. The number of seats is also important, which implies how many people can be in the car at the same time (the method does not assume the presence of standing passengers). This information is necessary to calculate the probability of hazardous contact with the infected person inside the transport compartment.

The first step is to determine the places in the vehicle. We count on restrictions when it was recommended to occupy a maximum of the number of seats.

The second step is to calculate the probability of the occurrence of an infected person in the transported environment, which we chose according to the number of places.

$$RK = \frac{N * S_V}{10^5} \tag{1}$$

With N - the current incidence per 100,000 inhabitants and S_v - the number of seats in the vehicle.

The third step is the analysis of risk factors for sufferers. The analysis is performed by assigning a weight of 1-4 to each of the risks. According to the severity of the increasing coefficient.

Passengers			
Parameter (P)		**Value**	**Coefficient (*K*)**
1	Probability of occurrence of an infected person (RK)	Less than 1.10^{-2}	1
		Less than 4.10^{-2}	2
		Less than $1{,}6.10^{-1}$	3
		More than $1{,}61.10^{-1}$	4
2	Occupancy while driving	25 %	1
		50 %	2
		75 %	3
		100 %	4
3	Adherence to social distance between passengers (min. 2 meters)	Yes	1
		Partially	3
		No	4

The fourth step is to determine the degree of risk of coronary infection with SARS COV 2 in the vehicle for each target group. The determination of the degree of risk is calculated as the decimal logarithm of the products of the individual coefficients

$$R = K_1 * K_2 * K_n \tag{2}$$

$$M\,R = \log R \tag{3}$$

The tables below use an algorithm to assess the level of risk for passengers (table above) and for the cleaning service (table below). As can be seen in the table selected from the risk assessment application, criteria have been selected that directly affect the risk assessment. Some of the factors are the same but have different weight values assigned. This is due to time exposure and the use of other protective equipment. As can be seen, both situations - passengers, cleaning service are simulated at the same incidence and the same occupancy of the aircraft. The value of the risk is much higher for

passengers than for cleaning staff. This is due to the extra work equipment and then the time spent on board the aircraft and the disinfection applied after the aircraft landed.

For passengers, the risk value is 1.68, which means high risk.

In comparison for the same time but another boarding condition, we can see decreasing the risk level.

Number of passengers in the aircraft 180, incidence 150/100 000

Analysis of risk factors for aircraft passengers

Case 1

The probability of the occurrence of an infected person on an aircraft based on the current epidemic situation K1:	3	1 – less than 0.01 2 – less than 0.04 3 – less than 0.16 4 – more than 0.16
Aircraft occupancy K2:	4	1 - 25% 2 - 50% 3 - 75% 4 - 100%
Adherence to the social distance between the passengers (min. 6 ft) K3:	4	1 - yes 3 - partially 4 - no

Risk evaluation

Risk level:	1,68	0 to 0,451 low risk 0,451 to 0,9 moderate risk 0,9 to 1,35 high risk 1,35 to 1,8 very high risk

Case 2

The probability of the occurrence of an infected person on an aircraft based on the current epidemic situation K1:	3	1 – less than 0.01 2 – less than 0.04 3 – less than 0.16 4 – more than 0.16
Aircraft occupancy K2:	2	1 - 25% 2 - 50% 3 - 75% 4 - 100%
Adherence to the social distance between the passengers (min. 6 ft) K3:	3	1 - yes 3 - partially 4 - no

Risk evaluation

Risk level:	1,25	0 to 0,451 low risk 0,451 to 0,9 moderate risk 0,9 to 1,35 high risk 1,35 to 1,8 very high risk

6. CONCLUSION

From the tests known and performed so far, the pathogen of the virus is transmitted by droplet infection. However, this does not mean that it must be a direct route of infection. It can also be a secondary infection where a virus that is ultimately neither alive nor dead can enter the host's body in another way. It is a well-known fact in the laboratories that the virus can hit the host even after several hours of surface contamination from a previous host or an infected person.

For this reason, it is necessary to find out how the fight against invisible disease will continue in the coming periods. As can be seen from the comparisons in the calculations in the tables, the values of the risk of contracting the virus depend on the current incidence and occupancy of seats on board the plane. When the number of passengers is reduced to half the occupancy of the aircraft, the risk is reduced from very high risk to high risk. In the sum up compared values from case1 and case2 is visible decrease of the biological risk.

In the future, the number of evaluation criteria will increase, and it will be possible to determine the value of the risk in the current situation during the pandemic. The system set up in this way will be able to reduce the risk of infection for both passengers and on-board or maintenance staff.

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