# THE DECISION MODEL OF AN AIRCRAFT CREW IN SAFETY SYSTEM

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*Abstract* — **This publication presents the decision-making process conducted by an aircraft crew in safety system. The decision model has influence on the safety system in aviation operations and is also connected with correct service and aircraft operating. Function of this system is help to select essential information and enable to conduct analyses of current flight data of an aircraft, which subsequently allows to the crew to progress in quick and efficient planning of tasks and activities, also recommends steps of technical nature. Model of decision is a very good indicator of the crew's performance and should be used like that by pilots and crew members for maintenance and operation of an aircraft.**

*Key word: information in safety system, maintenance, diagnostics, project management, safe system of aircraft.*

## I. INTRODUCTION

The practical ability of an aircraft company to satisfy of aircraft crew will require simultaneous selection of suitable factors e.g. human behavior which are based on the latest scientific results.

As we all know, many factors of human behavior can interfere employee's ability to effectively perform actions. These factors include inadequate skills, reactions, training, work knowledge, discipline, organization factors, employee attitude and behavior. Sometimes ignorance is cause of air crashes. For example we can quote history of a Polish Air Line, aircraft IŁ-62 M was on a route from International Airport in New York to Warsaw International Airport on 9th of May, 1987. When one of engine was broken, plane was fired down while pilot (crew) investigated that problem. After about a few minutes the plane crashed in South populated area called the Kabacki forest. The distance from the Kabacki forest to ray way of domestic airport Chopin was 5700 meter, direction 33. In this air crash were killed 183 passengers and crew, everyone on board.

The National Transportation Safety Board determined that the probable reason of this air crash was the failure shaft of engine during service by employee (human mistake) from Russian Aviation Factory. During flight the shaft tears out and crack turbine of engine. This cracked turbine of engine destroyed control surface elevator of aircraft. This resulted, this aircraft was emergency landing as soon as possible.

According to NASA information, almost 75% of accident to year 2010 which happened in International Airports are caused by human mistake. There are two types of human mistakes in airside:

- active failure,
- passive failure.

The active failures (standard procedures) performed by poorly, violation of law. Active failure complies with written instructions to the aircraft cabin mismanagement and laziness. Whereas passive failure are associated by the ignorant real situation, misunderstandings, errors in communication, lack of support in an unexpected situation, distraction, fatigue and quality meal before flight. Moreover there are also distinguishes errors from pilot (crew) skills, behaviors or their absence related to an incorrect assessment of the situation, wrong decisions, lack of experience and knowledge, not enough training (e.g. simulator) and do not understand the flight task.

In order to prevent dangerous situation and better organizations needs to lower risk as low as possible. There are things which organization can do to maintain safety culture:

- workers need to have training on consequences of dangerous behavior,
- inform (communication) all aviation employees how information is disseminated,
- realistic rules addressing hazards, safety, security and latent conditions that may cause damage,
- reduce risk of the accident.

The investigation process should be developed as a logical method of analyzing factual information in order to identify root causes.

The safety recommendations based on the findings of the investigation it should be developed to prevent reoccurrence by corrective actions [7].

In developing an investigation procedure, the following elements should be included:

- analysis the every essential information,
- reaching conclusions and finding main root causes,

- formulating safety and operational recommendations based on the conclusions and true causes,
- gathering of factual information with including photographs, maps and plans,
- each incident or accident should be thoroughly investigated. The form of the investigation will depend on the circumstances of the incident or accident.
- after reviewing the information contained in the incident or accident report,
- further investigation of the incident or accident may be required.

Further investigation is suggested if one of the following situation is present:
- aviation company policy requires an safety investigation,
- the incident resulted in the cancellation of the flight or a delay of more than 4 hours,
- during cases where there is a threat of recurrence,
- during cases where the incident was a recurrence,
- during cases involving injuries or fatalities to passengers, pilots, crew, ground staff or third parties,
- incidents or accidents not investigated by state or aviation company accident investigators.

The existence of an integrated support of an airline should correspond with a crew's support management in aircraft cabin [8]. Unfortunately, sometimes an aircraft crew's makes situation difficult to proceed with any ordered decision process during their flight. Presumably, it might be the main reason of blocking up their proper decision-process and therefore, the main cause of their lack of success in this respect. The above mentioned problem can be solved by applying a logical approach and the morphological method. However, it has to be remembered that still this approach cannot fully solve an aircraft crew's problems. It happens, because it is quite often difficult to construct a fully dependable system during an analysis of mental decision processes of an aircraft crew. That is also why the above mentioned problem refers to any one system that will be supported by pilot and the crew experience [4].

## II. THE DECISION-MAKING PROCESS IN SUPPORT OF THE NEEDS OF AN AIRCRAFT CREW

An integrated assistance of aircraft carriers should cause transformation of knowledge for any aviation company (fig.1). In this context the knowledge on essential technical tools should improve the activities of any aircraft company.

Furthermore, the economic analysis of the aircraft market shows financial sphere. By the fact above refers to the acquisition of skills, capacities enhancement, what is significant perceived in the light of proper organization of a particular aircraft company's financial structure.

One of the important elements of this system is also the prophylaxis of professional diseases, contracted by pilots and crew members. This is important for finding various measures, to prevent workers' bad accidents. This policy definitely influences the efficiency and quality of aircraft services.

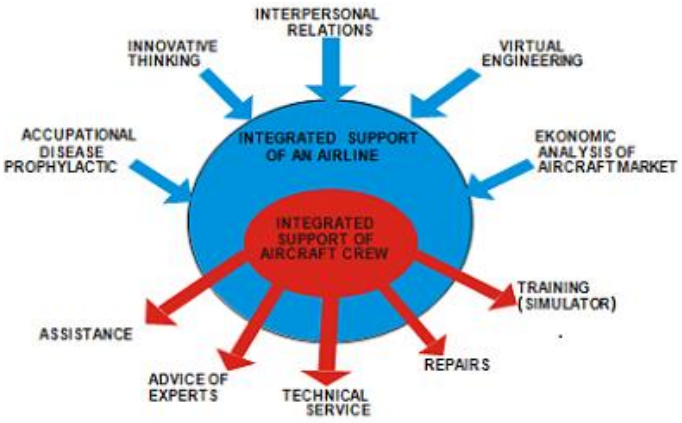


Figure 1. Integrated support for aircraft crew [2]

The decision-making system, using measures of informative support (e.g.: computer simulations), allows to solve a lot of decision-making problems with a high coefficient of risk related to aircraft safety. Additionally, examination of interpersonal relations concerning mutual human dependence and personality relationships allows to obtain important observations which relate to the needs and work of aircraft companies, which might contribute to future innovations.

Taking into account innovations in creating new methods, we will be able to work out a system to facilitate the development of aircraft carriers in terms of satisfying its crews' needs.

It is exactly the role of the integrated support for an aircraft crew in their decision-making process that helps the development of an airline. Organizational transformation of knowledge contributes to increase efficiency of the productive activities. It ensures the success of high-quality production and air equipment repairs of an aircraft with regard to optimization of costs as well as safety rules [6].

## III. THE DECISION-MAKING MODEL OF AN AIRCRAFT

The philosophy of decision-making model, as it is used with the application of new technologies, offers the best solution for ensuring safety and efficient operations during the flight of an aircraft. The model-making process means that human factors are correlated with the new technologies. Their function is to upgrade air equipment making use of already existing aviation program taking advantage of the most modern knowledge in this respect (e.g. procedures of ground handling and operation plans). What is also important as the knowledge and experience used in the system design which provides interpretation of an aircraft crew's behaviors (fig.2).

In general, project management in aviation should focus on the decision-making model, which allows:
- large growth in the potential of conducting of aviation projects,
- progressive upgrade of aircraft,
- budgetary constraint and greater strategy choices,

- integration of equipment selected and used by an aircraft crew,
- industrial expertise in aviation program,
- common training in ground handling to support an aircraft crew in the future.

It has to be underlined that, this model enables to integrate of aircraft safety within the quality logistic process. Moreover, the model describes factors connected with aircraft crew's physical condition (e.g. their genetic heritage) for making correct, rapid decision during flights.

All components of this model relate to: requirements, analysis of intention, decisions and activities, and are connected with habits, behaviors and reactions which altogether show the decision loop.

The requirements refer to a collection of norms and the „conditions" in which they are performed. The pilot and number of crew have to also adapt themselves to unpredictable circumstances during flight.

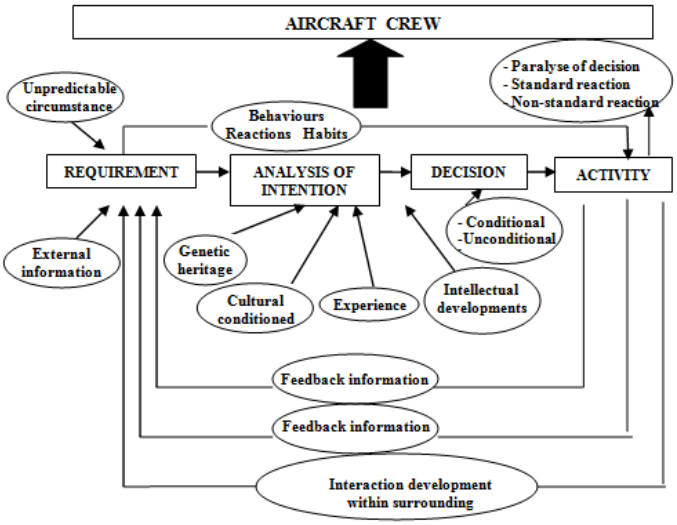


Figure 2. Aircraft crew decision model [1]

The analysis of intentions must correspond with an analysis of the correctness, reasoning in the context of e.g.: genetic heritage, cultural conditions, experience and intellectual development based on the practical observations during tasks and other servicing activities. The decision-making process is therefore an ultimate condition of the realization of particular tasks.

Another aspect of the whole process of decision-making is a team's activity undertaken for the successes of a definite task. Apart from the above mentioned problems there are also these issues concerning reversible information perceived as a return messages about the arrangement of events. Their importance for requirements 'after the job is done' are creating by the decision-making and analysis carried out of an aircraft crew before their a task. performance. It can also be added that the decisional loop is a process related to the forecasting of ways of behavior in various situation.

## IV. THE DECISION PROCESS OF PILOT (CREW)

The base of aviation developing needs a big pressure on safety and effectiveness of flight by pilots (crew). The damages often are the reasons of aviation accidents during operation of airplane.

According to ICAO (International Civil Aviation Organization) the majority of aviation accidents are caused by human mistakes and technical damages. The method to solve the problem concerning the correct performance of the air task is identification physiological and behaves our aspect in the decisional process of pilot and crew [9].

Particularly, this matters to assure the reliability for:
- the safety of flights;
- the regularity of flights;
- the technical readiness;
- the effectiveness of the management in the operational process;
- the economy of the operational process.

The sum up, the behavioral pilot (crew) properties correlates with an aircraft survivability (resistance to damage) That means if the level of an aircraft survivability is higher, the pilot (crew) has more time for decision.

The adequate level of air tasks safety reliability in the decisional process may be conducted by using planned programs such as: „SHEL" (Software-Hadware-Environment-Liveware) as the working plan of ICAO „Flight Safety and Human Factors Program". It is purpose to introduce the appropriate system together with the software for the information management, the human-centered automation and the crew recourse management (fig. 3) [5].

The stroke and the damage can occur during the routine flight or the flying training. The damages during the flying training are also linked with different durability of particular units and components.

The stroke can cause the loss of stability and handling characteristics forcing to stop the flight what ends with crash landing.

Ability of aviation company to satisfy needs of equipment which should be demand simultaneous selection of suitable factors. The suitable factors make possible for integrated knowledge with regard to successes of present sciences. Existing knowledge system is an object of analysis and test in improvement airside. Unfortunately pilot (crew) experiences make difficult in decision process. Presumably, it is the reason of lock satisfying successes. The problem can be solved by knowledge system analysis, what means by logical approach and basing on morphological method. However such approach did not be able fully dissolve of air companies' problems. Very often is difficult to achieve useful system during analysis of mental decision process.

That is why, the above problem refers to every system which will be supporting by parallel service of pilot (crew) experiences.

In this context, the knowledge with essential technical tools, should improve activity of aviation companies.

Furthermore risk analysis of aviation safety by factual research, allows its penetrating qualification of situation in sphere of operating.

The fact above regards to skills, capacities and capabilities of rational acting for proper schedule of operating center in order to improve working aviation companies.

Important element of this system is also prophylaxis of professional diseases of ground staff and pilots (crew). It is important for different kind of measures to prevent bad workers accidents.

It has influence on efficiency and quality of aviation services. Decision system with using measures of informative support (e.g.: computer simulations) permits to solve a lot of decision problems with consider action of high coefficient of risk related to aircraft safety [1].

Additionally, the examining interpersonal relation concerning mutual human dependence and personality relationships allows obtaining important innovative relating to needs of working aviation companies.

Taking into innovation for creating methods, there will be able to find system which influences on development of aviation companies.

The idea of knowledge system for decision process gives development of aviation companies. It is held by organizational transformation of knowledge refers to efficient activities. It creates success of high production qualities and equipment repairs with regard to low risk for aircraft safety.

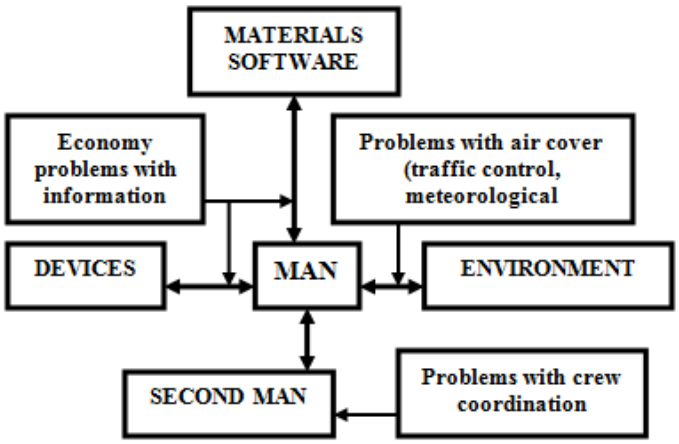


Figure 3. Program „SHEL" (Software-Hadware-Environment-Liveware) [2]

The pilot and crew play an important and responsible part of mission. The work of pilot (crew) is not only to coordinate dynamically controlling elements, but also to take responsibility of all systems on board. Their task is to find immediately all appropriate handling and navigational (navigating) devices and its correct interpretation. They also have to interpret correctly external information to make right decisions, which are essential for flight safety.

The pilot and crew, who don't expect and aren't resistant to disruptions, they can make a mistake which will lead to an air accident.

The capacity of human's brain is limited; pilot (crew) can't receive couple of signals at the same time and work decisions concerning couples of activities. So it means that in relation of the configuration pilot (crew) –the man constitutes this weak cell [2].

The interpretation of information is given from air measuring instruments what is not very easy in the stressful situation under the time pressure. Moreover, the division of attention is also hampered because it doesn't facilitate handling. That is why; the defined aircraft or helicopter survivability influences the decisional process of pilot (crew).

The main use of the investigation in airside is to prevent disasters, eliminate or lower risk as much as possible. One of a main element is hazard identification.

Hazard identification is a process to identify the significant risks to safety and health of any person arising out of or in connection with any work activity. It should identify how those risks arise and how they impact on those affected.

The following elements should be included in the hazard identification process:

- describe the operation or task,
- identify the hazards associated with the operation or maintenance.

Next step is Risk Assessment. Risk assessment is a process to determine whether the level of risk, as determined from the hazard identification process, arising from workplace activities is acceptable or whether more needs to be done to control or reduce the risk. There are few steps of risk assessment:

- determine the level of risk involves, i.e. the magnitude,
- determine if the level of risk is acceptable.

Risk assessments are required to be suitable and sufficient. This means they should be:

- considered all those persons who may be affected which is including contracted work performed by third parties (human factors),
- appropriate to the nature of the work,
- such that they remain valid for a period of time (fig.4).

Last part is a risk control. A process must be established that determines action to be taken as the result of hazard identification and risk assessment findings. Risk control can involve any one or a combination of solutions. As far as is practicable and engineering controls should be implemented in preference to administrative controls.

In order to prevent from accidents or incident in aviation people require training. They need to know the risk and need to know what to do. People are welcome to have knowledge of the task and equipment involved, standard investigative techniques including fact finding, effective interviewing and task observation skills are helpful. It is recommended that anyone with investigation responsibilities attend a safety investigation course, such as that offered by IATA [3].

The form is comprised of four sections:

**Section 1 :** General Information.

This includes type of event and phase of operation.

**Section 2 :** Impact of Event.

Provide information of the impact including cancellation and delay information, and a description of the event. The only facts record when led up to the event. Do not include

assumptions or anecdotal information.

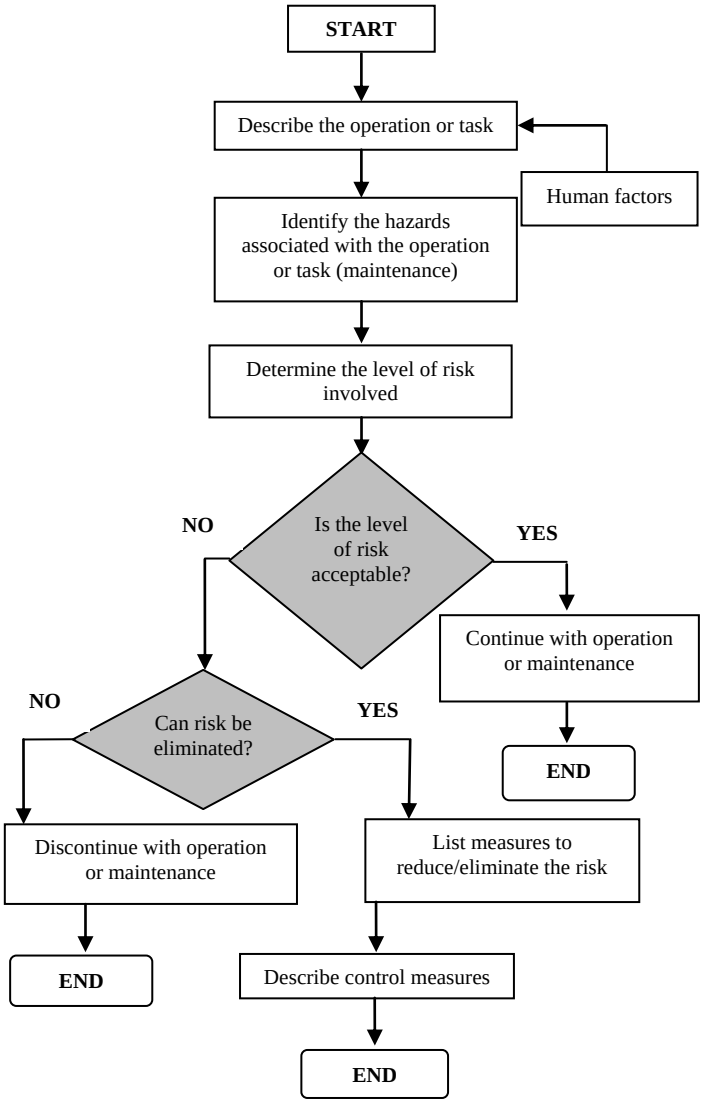


Figure 4 Risk management flow chart [3]
Source: The author's reference is based on Airport Handling Manual Booklet, 27Th Edition, IATA

**Section 3:** Contributing Factors Checklist.
There are potential contributing factors listed including:
- environment,
- equipment,
- communication,
- ergonomics,
- procedures,
- prophylaxis of professional diseases,
- individual factors,
- leadership,
- organizational factors.

It is only necessary to complete the factors that contributed to the event. If the factor did not contribute there should move to the next factor. If a factor did contribute, then provide details in the open field area below that factor.

Typically there are multiple contributing factors of a single incident. If all contributing factors are not identified, then repeat of the same or similar incident is probable.

**Section 4:** List Contributing Factors and Associated Corrective Action.
Documents corrective actions identified in Section 3 and corrective action plan. Each contributing factor shall have an associated corrective action.
An owner and estimated completion date shall be assigned to each corrective action. The status of each corrective action shall be tracked to completion and once completed the intended impact shall be validated.
Prudent and timely use of this form will help the safety department trend injuries and damages, and develop corrective action plans for the purpose of preventing safety related incidents as well as operational incidents.

The decision model of an aircraft crew should be based on certain assumptions:

1. Contemporary development of physiological characteristics allows creating a new approach and a system for defining the concept of a safe aircraft using the decision-making process of crew.
2. The proper level of aircraft's shape, design and maintenance value is achieved by means of making correct decisions, which contributes to the good technical service and subsequently the safety of flight.
3. The integrated support for aircraft crew influences the quality of executed tasks, development of technological service and of knowledge for aviation project management.

The human factors in aviation safety investigations are very important to avoid and lower risk accident. The purpose of all investigation is to eliminate risk by contributing human factors. Safety investigations should result in factual information which leads to a corrective action in aviation prevention. There are many procedures always has good result in aviation safety. As accidents sometimes happens to avoid them in the future.

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