DECISION-MAKING MODELING IN CASE OFEMERGENCY "CAPTAIN INCAPACITATION AT TAKE OFF"

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Abstract. Optimization deterministic model of decision making in an emergency "Pilot incapacitation" have presented. Behavioral models are used

for synchronization actions of all operators, to support and timely predicting of human-operator actions in the emergence. Models are used in the Decision Support Systems of aviation personnel in emergencies.

Introduction. Analysis of aviation events shows that the cause of more than 80% of them is the human factor. Moreover, most aviation specialists are sufficiently trained as professionals. The occurrence of an emergency situation in flight is characterized by incompleteness and uncertainty of information, decision-making (DM) takes place in conditions of acute shortage of time and significant psycho-physiological load, which is one of the reasons for violations [1]. Finding the best solution in such conditions requires processing much more information than under normal flight conditions. The development of emergency decision-making models is relevant to improving existing Decision Support Systems (DSS).

The work is dedicated to the problem of developing emergency situation (ES), called "Pilot incapacitation". The data shows that the cause of approximately three accidents per thousand (15 per 1,000 deaths) is the result of pilot incapacitation. DM modeling by aviation specialists in conditions of certainty, risk, and uncertainty, the main causes of the accident are considered, a systematic analysis of the situation (decomposition of operational procedures) using the method of expert assessments determined the average time of procedures and consistency of experts) [1]. The deterministic DM model of an aircraft pilot in case of an emergency situation such as "Pilot incapacitation" was created.

Main part. Pilot incapacitation is defined as any condition which affects the health of a crew member during the performance of duties - associated with the duty/position assigned to him which renders him incapable of performing the assigned duties. The definition includes either total or partial incapacitation which does not allow the fulfilment of duties in the "normal" way.

Iincapacitation occurs frequently compared with other routinely trained non-normal conditions. It has occurred in all age groups and during all phases of flight. Incapacitation occurs in many forms ranging from sudden death to subtle, partial loss of mental or physical performance. Subtle incapacitations are the most dangerous and they occur the most frequently. Incapacitation effects can range from loss of function to unconsciousness or death. The key to early recognition of pilot incapacitation is the regular use of crew resource management concepts during flight deck operation.

Proper crew coordination involves checks and crosschecks using verbal communications. Routine adherence to standard operating procedures and standard profiles can aid in detecting a problem. Suspicion of some degree of gross or subtle incapacitation should also be considered when a crewmember

Tab. 1. Structural and temporal table “Captain incapacitation at V1”

№	Actions in case of «pilot incapacitation»	Action	Order	t, s.
1	2	3	4	5
1	Call for intention of take control and continuation takeoff: «Continue, My controls»	a_1	-	2
2	Rotate aircraft at rotation speed V_R	a_2	a_1	2
3	Retract landing gear when positive rate of climb	a_3	a_2	2
4	Engage AP at 400’ feet AGL	a_4	a_3	2
5	Check the position of essential controls and switches	a_5	a_4	10
6	Accelerate aircraft to flaps retraction speed	a_6	a_5	12
7	Retract flaps	a_7	a_6	8
8	Inform ATC	a_8	a_7	6
9	Call cabin crew to help incapacitated pilot.	a_9	a_8	6
10	Follow the SID	a_{10}	a_8	....
11	Brief cabin crew to restrain the incapacitated pilot and provide other assistance	a_{11}	a_9	60
12	*Pilot:* Check weather, type of approach and airport facilities at departure airdrome to evaluate ability to come back or choose appropriate alternate. *Cabin crew:* Restrain the incapacitated pilot and slide the seat back, assess him medical condition, provide with necessary care, call other cabin crew to find doctor on board.	a_{12}	a_{11} a_{12}	300
13	Make a decision to proceed suitable airdrome according actual situation	a_{13}	a_{12}	60
14	Prepare cabin for approach	a_{14}	a_{13}	120
15	Brief cabin crew for approach	a_{15}	a_{14}	60
16	Declare “MAY DAY” and request vectoring for approach and medical assistance	a_{16}	a_{13}	12
17	Proceed as instructed by ATC	a_{17}	a_{16}	.....
18	Slow the aircraft to extend flaps and gear	a_{18}	a_{17}	20
19	Extend flaps and gear for landing	a_{19}	a_{18}	60
20	Read with a help of cabin crew landing check list	a_{20}	a_{19}	20
21	Perform landing	a_{21}	a_{20}	60
1	2	3	3	5

22	Check activation of autobrakes and speedbrakes systems or apply manually brakes and rise speedbrakes lever	a_{22}	a_{21}	2
23	Apply reverse thrust	a_{23}	a_{21}	2
24	Keep directional control with pedals and differential braking, when required	a_{24}	a_{22}	12
25	Stop the aircraft, set parking brakes, and announce “Attention Cabin Crew! At stations!”, and	a_{25}	a_{24}	4
26	Inform ATC and request assistance (stairs, etc).	a_{26}	a_{25}	60
27	Take the left seat for further taxi, when requested by ATC to vacate the active RW.	a_{27}	a_{26}	60

does not respond to any verbal communication associated with a significant deviation from a standard procedure or standard flight profile. Failure of any crewmember to respond to a second request or a checklist response is cause for investigation.

In process of DM modeling in case of emergency "Pilot incapacitation" was used the recommendations of the Flight Crew Training Manual "Two communication rule" [2 - 4]. Take-off is the most critical case when pilot incapacitation requires immediate decision and prompt actions.

Proper crew coordination and use of standard call-outs are vital. Failure of crew members to timely respond and/or act on “80 Knots” and “V1” call-outs will require the following immediate actions from any pilot. DM Modeling in the event of an emergency is considered at the second stage of takeoff at a decision speed V1. Decomposition of the emergency "Captain incapacitation", the list and the average time of the pilot's actions are given in tab. 1.

According to the structural and temporal table, a DM deterministic model in the emergency situation is constructed in the form of a network graph, the critical time of execution of all actions by the pilot (Tcr = 988 s), critical path is determined (Fig. 1).

Conclusions. The paper considers the emergency situation "Pilot incapacitation", conducted a systematic analysis of the pilot's actions, created a DM deterministic model, determined the critical time for parrying the existing emergency situation. In the future it is planned to analyze the DM of specialists involved in the process of solving the emergency situation (Air traffic controller, medical services, emergency services, etc.), construction of deterministic and stochastic joint DM models for integrated DMSS [5; 6].

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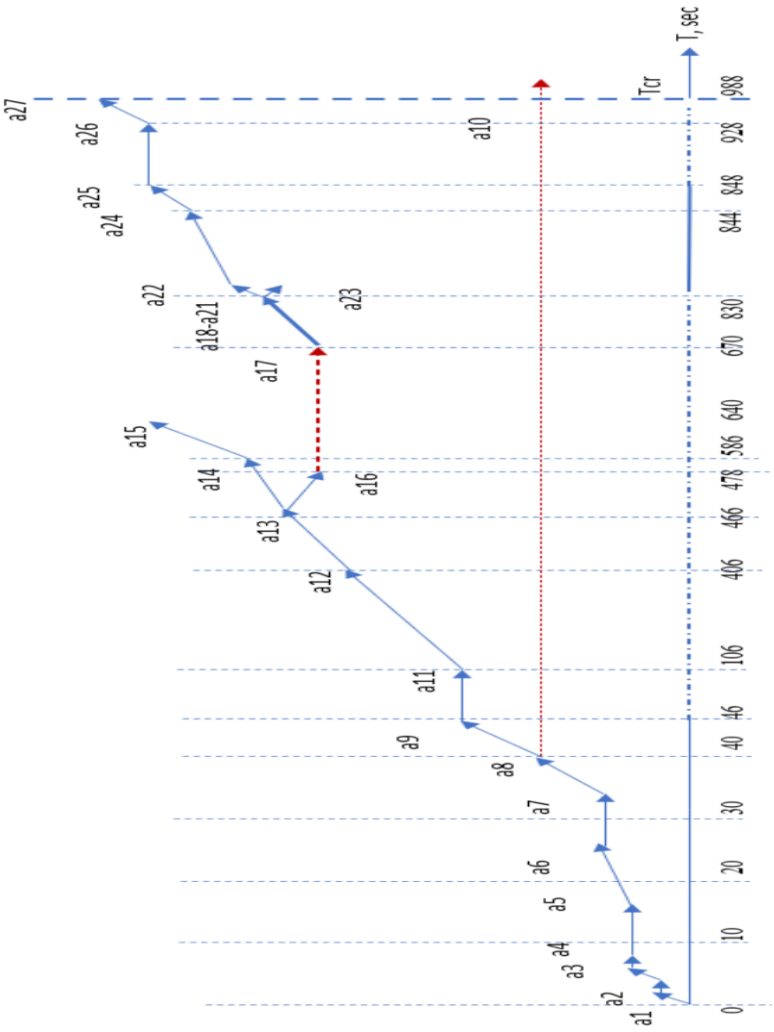
Fig. 1. DM deterministic model in the event of "Pilot incapacitation"



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