www.bircu-journal.com/index.php/birci
Budapest International Research and Critics Institute-Journal (BIRCI-Journal)
Humanities and Social Sciences
ISSN 2615-3076 Online)
ISSN 2615-1715 (Print)
Budapest Institute

An Influence Safety Technician Flight Aircraft on Workload

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Abstract

Flight safety is identical to the performance of aircraft. To have a standard of flight safety, an aircraft needs good maintenance to achieve the best performance. An aircraft technician should have a good qualification as stated in ICAO. They have a complex job that usually creates a high workload which is harmful to flight safety. This research aims to analyze the workload experienced by the aircraft technician at Lion Mentari Airline and in which interval, to examine factors affecting the workload value and to examine the influence of workload value on flight safety. The aircraft technician workload was analyzed using Subjective Workload Assessment Technique (SWAT) software. The data was taken from 50 aircraft technicians of Lion Mentari Airline inline maintenance. They were asked to rank the Sort Card according to their perception of mental workload. There are combination levels that should be made in order from the lowest to the highest. The mental workload combination consists of Time Load (T), Mental Effort Load (E), and Psychological Stress Load (S).The result shows that the workload experienced by the aircraft technician at Lion Mentari Airline is 61.44 which is in the interval of Over Load. From three dimensional workloads, Time Load (T) has the highest value (percentage) than Mental Effort Load (E) and Psychological Stress Load (S) which is 40.67% (participant 1-25) and 41.48% (participant 26-50). It shows that the workload concern of the Aircraft technician at Lion Mentari Airline in line maintenance is on Time Load. The high workload will make high error risks and the probability to produce accidents is high. The errors can be reduced or prevented by identifying causes which most frequently occur (Dirty Dozen) and making barriers (Safety Nets/ Safeguard) to prevent the accident by using the Swiss Cheese Model and ICAO's SHELL Model Approach.

Keywords
workload; subjective workload assessment technique (SWAT); dirty dozen.

I. Introduction

Nowadays airplanes are growing rapidly. Airplanes are highly complex machines with parts that must function within extreme tolerances in order to be able to operate safely.To keep the safety for an aircraft to operate, the aircraft technicians perform scheduled maintenance, repairing and completing inspections required by Federal Aviation Administration (FAA). Besides performing their job, technicians also have responsibility to release the aircraft to operate when it is surely in good performance. What they do is related to the safety of passengers. Technicians have to do the inspections, maintenance even repair in the certain time for many aircrafts to maintain flight schedules or, in general aviation, to provide comfort for customers. At the same time, technicians have a huge responsibility to maintain safety standards.

This kind of activity can cause the job to be stressful and also make aircraft technicians work under time pressure. This stressful job can affect the workload of the aircraft technicians. The workload of technicians is important to be considered because errors may occur if the tasks or job given to the technicians surpass the capabilities of the technician themselves. Therefore, the consequences of these errors might be critical and detrimental to flight safety. As we know that the performance of the aircraft determines the safety of the flight. Safety according to ICAO Doc 9859, Safety Management Manual 2009, concerns with the condition where the opportunity in having injured or destruction of people or properties are decreased, remained the same as before or lower the certain level that is usually determined by hazard identification and safety risk management process continuously. Safety is measured by the errors and risks that usually arise during the flight operation. Whenever the errors and risks are still under control, the civil aviation is regarded as safe.

The objectives of this research are:

1. To analize the workload experienced by the aircraft technicians at Lion Mentari Airline and in which interval;
2. To examine factors affecting the workload value;
3. To examine the influence of workload value on flight safety.

The scope of the study is Lion Mentari airline at Soekarno-Hatta airport. This study will focus more on aircraft technicians in line maintenance than heavy maintenance for the workload result. Technicians in line maintenance are considered having more workload than in heavy maintenance, as they directly communicate with the flight time schedule and have responsibility to release the aircraft.

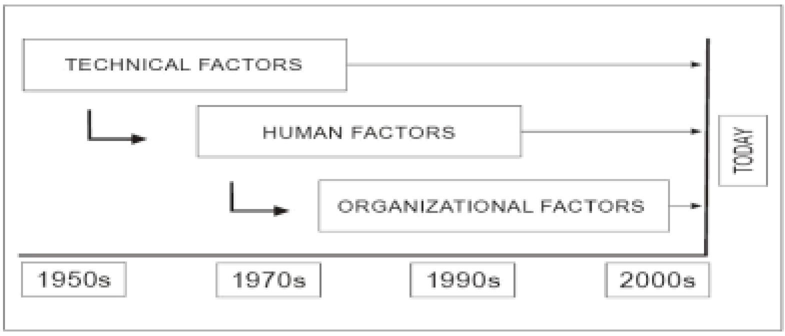
II. Review of Literature

2.1. Safety Concept

Safety is a condition where the opportunity in having injured or destruction of people or properties are decreased, remained the same as before or lower than the certain level that is usually determined by hazard identification and safety risk management process continuously (ICAO Doc 9859, Safety Management Manual 2009). Lately, the safety programs are usually indicated by the human performance and human factor. It is because these indicators usually influence the safety in aviation. According to the ICAO, 2009 there are factors that usually influence the flight safety i.e. technical factors, human factors and organizational factors. In addition, human factors become the only factor that always shows up to be frequent problem in aviation.

Work safety is a safe or safe condition for sufferers, damage or loss at work. Safety risks are aspects of the work environment that can cause fires, bruises, sprains, fractures, impaired vision and hearing. Whereas work healthy shows a condition that is free from physical, mental emotional or pain disorders caused by the work environment. Health risks are factors in the work environment that work beyond the specified time period (Mangkunegara in Mora, Z. et al 2020).

Therefore, the human performance always appears in the safety breakdown factors as seen on figure 1.

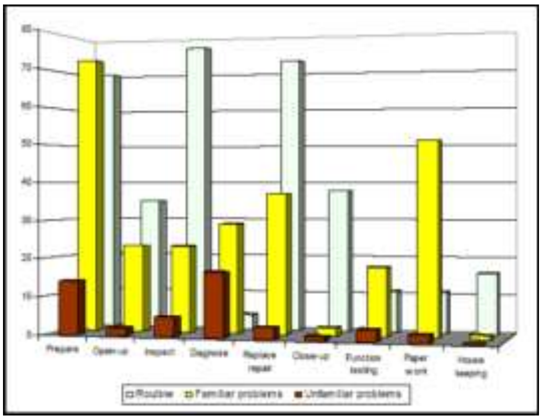


(Source: ICAO Doc 9859, 2009)

Figure 1. *The evolution of safety thinking*

2.2. Maintenance Human Factors

Maintenance is a process where a performance of the systems is performed in accordance with safety and reliability standard. Therefore, without maintenance personnel, a system which has high technology equipment will lead to unreliability implicating to safety risk.

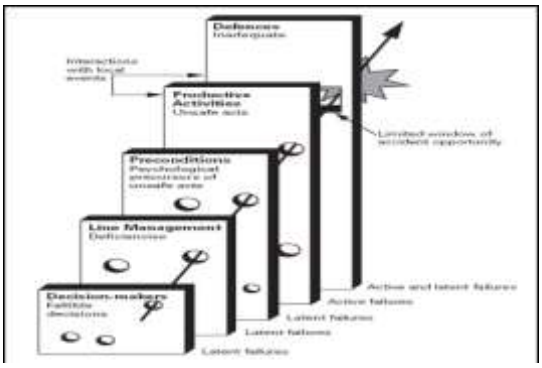


(Source: Hobbs, A., 2004)

Figure 2. *The cognitive demands and job stage in line maintenance*

2.3. James Reason's Model

James Reason's Model is a model of accident causation where every human has their own part to contribute in making or preventing accidents. This model had been developed in 1990 and had been revised in 1993 by Professor Reason himself. This model has been used extensively in the scope of Human Factors and accident prevention specialists.



(Source: ICAO, 2002)

Figure 3. *James Reason's Model*

2.4. Workload

Workload is a parameter in developing and researching comfort, satisfaction, efficiency, and safety in the workplace of human-machine interfaces. Many methods show how to evaluate or estimate the workload for human or operators. Many studies appear in calculating or predicting the workload of the human perceived. Those studies yield a number of tools in estimating and calculating human workload and some methods then can be categorized in three categories (Meshkati, Hancock & Rahimi, 1992) such as:

1. Performance-based measures;
2. Subjective measures;
3. Physiological measures.

2.5. Time Pressure

The negative effects of time pressure on human performance have been reported in various studies (McDaniel, 1990; Lin & Su, 1998; Kellog, Hopko, & Ashcraft, 1999; Braun, 2000). Zakey (1993) argued that under time pressure, performance degradation occurred in complex tasks due to the shortage of cognitive resources, thus leading to the adoption of simple strategies and increased performance errors.

III. Research Methods

3.1. Tools

The tools that are applied include statistical method and Subjective Workload Assessment Techniques (SWAT). The statistical method was used to determine how many sample needed in getting the data for workload. SWAT is used for statistical method and software.

3.2. Participants

The participants are aircraft technicians working in Lion Mentari airlines at Soekarno-Hatta airport. Three hundred Aircraft technicians of Lion Mentari airlines work in line maintenance. The sample taken from this airline is 50 participants.

IV. Result and Discussion

4.1. The Result of Ordering SWAT Card

The SWAT card ordering (27 cards) gives an explanation about the perception of each participant (aircraft technician). It shows that every participant has their own perception about mental workload experienced in their job. Even, they have the same task and responsibility as an aircraft technician. SWAT card ordering is as an input for the analysis of aircraft technician’s mental workload for 50 aircraft technicians.

4.2. Event Scoring

Data processing was carried out using SWAT software. Event scoring gives the result of workload rating for each participant that is determined related to their task. The result on table 4.1 and table 4.2 show workload of subject related to the activity research. The average workload of aircraft technician at Lion Mentari Airlines is 61.44 which is in the interval of Over Load. The workload interval is determined as follow:

1. Lower Load has scale value 0 – 40
2. Medium Load has scale value 41 – 60
3. Over Load has scale value 61 – 100

Table 1. The workload value of participant 1 – 25

Participants	**T (Time)**			**E (Effort)**			**S (Stress)**			**Workload Value**	**Workload Category**
1	1	**2**	3	1	**2**	3	1	2	**3**	64,9	Over Load
2	1	2	**3**	1	2	**3**	1	2	**3**	100	Over Load
3	1	**2**	3	1	2	**3**	1	**2**	3	57,1	Medium Load
4	1	**2**	3	1	2	**3**	1	**2**	3	57,1	Medium Load
5	1	**2**	3	1	**2**	3	1	**2**	3	40,2	Lower Load
6	1	**2**	3	1	2	**3**	1	**2**	3	57,1	Medium Load
7	1	**2**	3	1	2	**3**	1	2	**3**	81,7	Over Load
8	1	2	**3**	1	2	**3**	1	2	**3**	100	Over Load
9	1	**2**	3	1	2	**3**	1	**2**	3	57,1	Over Load
10	**1**	2	3	1	**2**	3	1	2	**3**	46,9	Medium Load
11	1	**2**	3	1	**2**	3	1	**2**	3	40,2	Lower Load
12	1	**2**	3	1	**2**	3	1	**2**	3	40,2	Lower Load
13	1	**2**	3	1	**2**	3	1	**2**	3	40,2	Lower Load
14	**1**	2	3	1	**2**	3	1	2	**3**	46,9	Medium Load
15	1	2	**3**	1	2	**3**	1	**2**	3	75,4	Over Load
16	1	**2**	3	1	2	**3**	1	**2**	3	57,1	Medium Load
17	1	**2**	3	1	2	**3**	1	**2**	3	57,1	Medium Load
18	1	**2**	3	1	**2**	3	1	**2**	3	40,2	Lower Load
19	1	2	**3**	1	2	**3**	1	**2**	3	75,4	Over Load
20	1	**2**	3	1	2	**3**	1	**2**	3	57,1	Medium Load
21	1	**2**	3	1	**2**	3	1	**2**	3	40,2	lower Load
22	1	**2**	3	1	2	**3**	1	**2**	3	57,1	Medium Load
23	1	**2**	3	1	**2**	3	1	**2** **2**	3	40,2	Lower Load

24	1	**2**	3	1	2	**3**	1		3	57,1	Medium Load
25	1	2	**3**	1	2	**3**	1	2	**3**	100	Over Load

Table 2. The workload value of participant 26 – 50

Participants	T (Time)			E (Effort)			S (Stress)			Workload Value	Workload Category
26	1	2	**3**	1	2	**3**	1	**2**	3	91,6	Over Load
27	1	**2**	3	1	**2**	3	1	**2**	3	48,4	Medium Load
28	1	**2**	3	1	**2**	3	1	**2**	3	48,4	Medium Load
29	1	**2**	3	1	2	**3**	1	**2**	3	63,7	Over Load
30	1	2	**3**	1	2	**3**	1	**2**	3	91,6	Over Load
31	1	**2**	3	1	**2**	3	1	**2**	3	48,4	Medium Load
32	1	**2**	3	1	2	**3**	1	**2**	3	63,7	Over Load
33	1	2	**3**	1	2	**3**	1	**2**	3	91,6	Over Load
34	1	2	**3**	1	2	**3**	1	**2**	3	91,6	Over Load
35	1	**2**	3	1	**2**	3	1	**2**	3	48,4	Medium Load
36	1	2	**3**	1	2	**3**	1	**2**	3	91,6	Over Load
37	**1**	2	3	1	**2**	3	1	**2**	3	17,6	Lower Load
38	1	**2**	3	1	2	**3**	1	**2**	3	63,7	Over Load
39	1	2	**3**	**1**	2	3	1	**2**	3	68,5	Over Load
40	1	**2**	3	1	2	**3**	**1**	2	3	53,8	Medium Load
41	1	**2**	3	**1**	2	3	1	2	**3**	49	Medium Load
42	1	**2**	3	1	2	**3**	1	**2**	3	63,7	Over Load
43	1	2	**3**	1	2	**3**	1	2	**3**	100	Over Load
44	**1**	2	3	1	2	**3**	1	**2**	3	33	Lower Load
45	1	**2**	3	1	**2**	3	1	**2**	3	48,4	Medium Load
46	1	**2**	3	1	**2**	3	1	**2**	3	48,4	Medium Load

47	1	2	**3**	1	2	**3**	1	2	**3**	100	Over Load
48	1	**2**	3	1	**2**	3	1	**2**	3	48,4	Lower Load
49	1	**2**	3	1	2	**3**	1	**2**	3	63,7	Over Load
50	1	**2**	3	1	**2**	3	1	**2**	3	48,4	Medium Load

4.3. Examining the Factors Affecting the Workload Value

The software processed only 30 participants in one time run. Therefore, data were divided into two time's process, participants 1 – 25 and 26 – 50. SWAT software processed the data into two steps i.e. Kendall's Coefficient of Concordance and Conjoint Scale Method. Kendall's Coefficient of Concordance (W) for participant 1 – 25 is 0.7516 and Kendall's Coefficient of Concordance (W) for participant 26 – 50 is 0.7608.

Conjoint Scale Method consists of Scale Development phase. The Scale Development shows the average scaling factors for Time (T), Effort (E) and Stress (S) from the lower workload to the upper workload according to their opinion. The result of the combination of workload dimensions for participants 1 – 25 as seen on figure 4.2 is 40.67% for factor Time (T), 31.08% for factor Effort (E) and 28.25% for factor Stress (S). While, the combination of workload dimensions for participants 26 – 50 as seen on figure 4.3 is 41.48% for factor Time (T), 21.82% for factor Effort (E) and 36.70% for factor Stress (S) respectively.

4.4. Examining the Influence of Workload Value on Flight Safety

Table 4.3 is Swain table that is usually used to count the effects of workload on human errors rates in routine tasks. Swain stated that stress (or pressure or high workload) has a definite influence on the likelihood that a person will make an error. The higher the stress level (above normal level), the higher the error probability.

Table 3. The effects of stress level on human errors rates

Workload Level	**Skilled Person**	**Novice**
Very low	2 times	2 times
Optimum	Normal rate	Normal rate
Moderately high	2 times	4 times
Extremely high	5 times	10 times

4.5. Determine Errors

Errors especially human error has the greatest potential to harmfully affect the current aviation safety. Workload of aircraft technicians of Lion Mentari Airlines which is in the level over load can influence the errors which can produce accidents and create a safety risk. Therefore, to minimize the accidents, the errors should be minimized and the workload will decrease simultaneously. Before reducing and preventing the errors, the causes that usually occur to make error should be recognized and then safeguards called *safety nets* are provided.

4.6. ICAO's SHELL Model Approach

This approach uses the accumulated data from many incidents. It is based on the analyzed data of 130 incidents that had effects in ground damage to civil aircraft. Data were tested using Chi-Square test and a significant relationship where $X_3^2 = 15.2$ and $p < 0.001$ was found. From table 4.4 shows that when the aircraft parked (HP1), hardware latent failures were higher than the others. It also shows that the higher relationship between hazards patterns to hardware latent failures is equipment striking aircraft (HP 1.1). Indeed, it was due to the poorly ground equipment maintenance. In relation with HP 1.2 where the aircraft or component moves to contact object, the latent failures that entail the human failure i.e. liveware and liveware-liveware interaction were higher. This is a fact that liveware-liveware interaction runs into lack of awareness (L-L) or failure to perceive hazards (L).

V. Conclusion

This chapter consists of conclusions related to the objectives of this research and recommendations for the future research and for the operator.

1. The workload experienced by the aircraft technician at Lion Mentari Airlines is 61.44 which are in the interval of Over Load.
2. Factors affecting the workload value are Time (T), Effort (E) and Stress (S) where every factor has different value, such as participants 1 – 25 is 40.67% for Time (T) factor, 31.08% for Effort (E) factor and 28.25% for Stress (S) factor while participants 26 – 50 is 41.48% for Time (T) factor, 21.82% for Effort (E) factor and 36.70% for Stress (S) factor. This shows that Time (T) factor is the most affecting factor in workload value, because it has the biggest value than the other factors.
3. The result of workload value experienced by the aircraft technician at Lion Mentari Airlines is in between moderately high to extremely high level. This workload level will influence the flight safety by producing error rates 2 times to 5 times for skilled person and 4 times to 10 times for novice according to Swain table. This high error rates can produce accidents and create a safety risk. To minimize the accidents, the errors should be minimized and simultaneously the workload will decrease. These can be avoided or reduced by determining the error using Dirty Dozen and then find the safety net/ safeguard to overcome the errors.

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