航空宇宙政策・法學會誌 第33卷 第2號
2018년 12월 30일 발행, pp. 345~366
http://dx.doi.org/10.31691/KASL33.2.11.

논문접수일 2018. 11. 30
논문심사일 2018. 12. 15
게재확정일 2018. 12. 26

Evolution of Aviation Safety Regulations to cope with the concept of data-driven rulemaking - Safety Management System & Fatigue Risk Management System*

Gun-Young Lee**

CONTENTS

* This study was supported by 2018 Research Grant from the Korea National University of Transportation.

** Professor, Dept. of Aeronautical Science & Flight Operation, the Korea National University of Transportation, E-Mail : airsafe@hotmail.com

I. Introduction

Each member State of ICAO[1] should promulgate it's own Aviation Acts based on ICAO Standard and Recommended Practices (SARPs) in accordance with the Chicago Convention[2] Article 37 "Adoption of International Standards and Procedures". This means that each Member State should develop rule making procedures to comply with amended SARPs which are normally delivered to States in each year. Recently, the ICAO has developed several new SARPs, related to human factors, which are critical to reducing aviation accidents and incidents. Among these, the Safety Management System (SMS) was introduced to the aviation safety frame with the newly developed ICAO Annex 19[3]. Aviation safety data and safety information is key to enabling the development of a healthy and useful SMS with a comprehensive Safety Index and Safety Targets. In addition to SMS, ICAO and the greater international aviation society are focusing on the Fatigue Risk Management System (FRMS) to reduce fatigue related aviation accidents. The FRMS also heavily relies on fatigue reports as well as the analysis of those reports. This research here is trying to discover the actual contents of the SMS and FRMS, and key elements of rulemaking procedures related to data-driven methodologies. Some advanced States' rulemaking practices were reviewed for this case study. Limitations and remedial recommendations are presented to help develop future rulemaking in aviation on the concept of data-driven advancements.

---

1) International Civil Aviation Organization
2) The Convention on International Civil Aviation ICAO Doc 7300, Ninth Edition, 2006
3) Annex 19 Safety Management

Ⅱ. Case study of Data-Driven Rulemaking

1. Safety Management System (SMS)

SMS is newly developed international aviation regulation which utilizes safety data and safety information. ICAO Annex 19 to the Convention on International Civil Aviation " Safety Management" was adopted by the Council on February 25th, 2013 and applied on November 14th, 2013. Based on Annex 19 4.1.3, the SMS of a certified operator of aeroplanes or helicopters, authorized to conduct international commercial air transport, in accordance with Annex 6, Part I or Part III, section II, respectively should be acceptable to the State of the Operator. Also for the implementation of the SMS, guidance material was prepared under the title of "Safety Management Manual (Doc 9859). The Manual consists of nine chapters, and the data related section is Chapter 5 "Safety Data Collection and Processing System". The manual highlights that the effective management of safety is highly dependent on the effectiveness of safety data collection, analysis and overall management capabilities[4]. Analysis of safety data and safety information allows decision makers to compare information to a control or comparison group in order to draw more accurate conclusions from the data. There can be various analysis approaches including descriptive, inferential, and predictive analysis (Refer to Fig 1.).

4) ICAO Safety Management Manual (Doc 9859) - Fourth Edition 2018

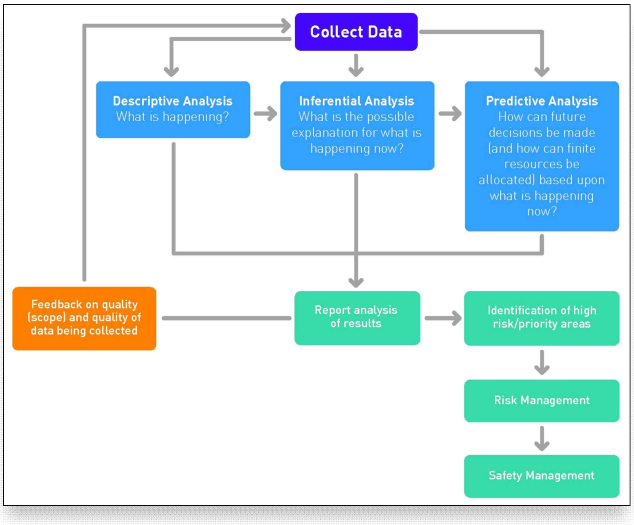


Fig 1. Integrating Data-Driven Decision-Making with Safety Management

In the Republic of Korea, a study was done based on FAA NPRM for the Development of Crew's Fatigue Management Regulations[5]. The SMS rule was introduced in Aviation Safety Act on March 29, 2016 Article 58 (Aviation Safety Program etc.). Based on this article, aircraft manufactures, air operators, aircraft maintenance organizations, aerodrome operators, air traffic control service providers, and aviation training organizations should develop their own aviation safety management systems to prevent aviation accidents and incidents, and to enhance overall aviation safety, then should submit them to the Minister of the Ministry of Land, Infrastructure and Transport for approval. The Mandatory Safety Reporting System (Article 59) and The Voluntary Safety Reporting System are important to the framework of collecting safety data and safety information from front line technical experts. The SMS implementation requirement is relatively low, and violations of the SMS rule are penalized with minimal amounts of

5) Lee, Koo-Hee, A Study on the Development of Crew's Fatigue Management Regulations, The Korean Journal of Air & Space Law and Policy Vol. 27, No 1, 2011

money (less than 5 million won, or 5,000 US dollars). In the United States, an Advisory Circular (AC 120-92B) was developed to provide information for Title 14 of the Code of Federal Regulations (14 CFR), part 121 stating that air carriers are required to implement Safety Management Systems. The AC provides details of regulatory requirements, guidance and methods of developing and implementing an SMS. The contents of the AC include a confidential employee reporting system which provides a means for employees to communicate safety information to management. Front-line workers can observe aspects of the operation that were not expected and were not listed in audit or evaluation protocols. The reporting system may fill in the gaps in the organizations' data collection process.

In Europe, the Commission Communication on "Setting up a Safety Management System for Europe" published in 2011, described the safety challenges faced by the Union and its Member States, and concluded in the necessity to develop a more proactive and evidence-based approach. (EU) No 376/2014[6] on the reporting analysis and follow-up of occurrences in civil aviation, was developed and implemented for EU member States[7]. The European Parliament and the Council of the European Union believes that a high level of safety should be accomplished in civil aviation and every effort should be put to reduce aviation accident for public confidence. Even though the rate of major aircraft accident has remained constant over the several decades, the number of accidents could rise due to an increase of air traffic and an increase in the technical complexity of aircraft including atomization. Aircraft accidents are often related with deficiencies of safety hazards. Therefore safety information is an important resource for the detection of potential safety hazards. In addition to this, reactive systems have been found to have limitations for future improvements. That's why reactive systems should be enhanced by proactive systems which utilize safety information to make

6) Regulation (EU) No 376/2014 of the European Parliament and the Council - Reporting analysis and follow-up of occurrences in civil aviation, 2014

7) Report from the commission to the European Parliament and the Council - The European Aviation Safety Programme (7 December 2015)

effective improvements in aviation safety. The European Union and its Member States, the European Aviation Safety Agency is trying to improve aviation safety through in introduction of more proactive and evidence based safety systems based on the analysis of relevant safety related information.

2. Fatigue Risk Management System

On February 12, 2009 the Colgan Air crashed which resulted in the death of 50 people onboard. The National Transport Safety Board announced in a press release the results of the accident investigation on February 2, 2010. The NTSB has examined the relationship between time since awakening (TSA) and errors in 37 aircraft accidents (1978-1990) in which flight crew actions or inactions were causal or contributing factors.[8)]

> Safety Recommendation
> Require U S. air carriers operating under 14 CFR Part 121 to include, as part of pilot training, a program to educate pilots about the detrimental effects of fatigue, and strategies for avoiding fatigue and counteing its efects. (Class 11, Priority Action) (A-94-5)

Although the NTSB did not point out that fatigue was a probable casual factor to the accident, it made an recommendation[9)] to the FAA to take actions to address pilot fatigue in this way: “Require all 14 Code of Federal Regulations Part 121, 135 and 91K operators to address fatigue risks associated with commuting, including identifying pilots who commute, establishing policy and guidance to mitigate fatigue risks for commuting pilots, using scheduling practices to minimize opportunities for fatigue in commuting pilots, and developing or identifying rest

8) NTSB study 94/01
9) NTSB Accident Report. Loss of Control on Approach Colgan Air, Operating as Continental Connection Flight 3407 Bombardier DHC-8-400, N200WQ Clarence Center, New York February 12, 2009, NTSB/AAR-10/01, PB2010-910401, 2010

facilities for commuting pilots(A-10-16). The recommendations are related to flight and duty time limitations. Firstly, modify and simplify the flight crew's hour regulations to consider length of duty, starting time, and workload. Secondly, require all part 121 and part 135 airlines to incorporate fatigue related information into initial and recurrent pilot training programs. On August 1, 2010, the President of the United States signed "Airline Safety and Federal Aviation Administration Extension Act of 2010"(Pub. L. 111-216). It required the FAA administrator to issue regulations to limit the number of flight and duty time allowed for pilots to address pilot fatigue[10]. After 180 days of deadline of the NPRM, FAA can issue a final rule and about 8,000 comments were received. International Standards and Recommended Practices regarding limits for flight time, duty periods, flight duty periods and rest periods for fatigue management was introduced to ICAO Annex 6 on 2 March 2009 and effected on 19 November 2006 with the amendment of 33 A. ICAO also developed a guidance on the development and implementation of fatigue management reputations which is named "Manual for the Oversight of Fatigue Management Approaches (Doc 9966). ICAO mandated that the State of the Operator should establish local regulations for the purpose of managing fatigue. The regulations should be developed with scientific principles, knowledge and operational experience with the aim of ensuring that flight crew can perform with proper level of alertness. Also the State of Operator should inact prescriptive regulations for flight time or authorize an operator's Fatigue Risk Management System (FRMS) to manage fatigue. However, Annex 6 emphasize that complying with the prescriptive regulations does not relieve the operator of the responsibility to manage its risks, including fatigue-related risks, using its safety management system (SMS) in accordance with the provisions of Annex 19. Also approved variations should provide a level of safety equivalent to, or better than, that achieved through the prescriptive regulations. In case of airlines, they should incorporate scientific principles within the FRMS and identify

10) Public LAW 111-216, Airline Safety and Federal Aviation Administration Extension ACT, 2010

fatigue related safety hazards, develope remedial actions, necessary to mitigate the risks associated with the hazards. Continuous monitoring and regular assessment of the mitigation of fatigue risks should be prepared by airlines. Annex 6 also requires that the Member States should integrate operator's FRMS with SMS.

Table 1. ICAO Fatigue Risk Management Processes

Identification of hazards	Predictive	1. industry experience 2. evidence based scheduling practices 3. bio-mathematical models
	Proactive	1. self-reporting of fatigue risks 2. crew fatigue surveys 3. relevant flight crew performance data 4. available safety databases and scientific studies 5. analysis of planned versus actual time worked
	Reactive	1. fatigue reports 2. confidential reports 3. audit reports 4. incidents 5. flight data analysis events
Risk assessment		1. operational processes 2. their probability 3. possible consequences 4. the effectiveness of existing safety barriers and controls
Risk mitigation		1. select the appropriate mitigation strategies 2. implement the mitigation strategies 3. monitor the strategies' implementation and effectiveness
Safety assurance		1. continuous FRMS performance monitoring 2. provide a formal process for the management of change 3. provide for the continuous improvement of the FRMS
FRMS promotion		1. training programmes 2. an effective FRMS communication plan

Source : ICAO Annex 6 Operation of Aircraft, Part I – International Commercial Air Transport - Aeroplanes, Appendix 7. Fatigue Risk Management System Requirements

The FRMS can be evaluated using phase concept which is described in figure 2. and it can be adapted for use by both the Member State and the operator at different stages of FRMS implementation. It provides a description of performance criteria for each of the key components, allowing evaluation of the Service Providers' development in each of the key component areas over time. As the FRMS matures, the Member State should encourage Service Providers to move towards these markers as part of a performance based approach for continuous improvement.

Table 2. Use of the FRMS evaluation form at different stages of the FRMS approval Process

Phase 1	Phase 2	Phase 3	Phase 4
Preparation	Trial	Trial	Launch
Gap analysis	Assessment of FRMS proposal	Assessment of FRMS trial	Launch and Continued oversight
Are all the necessary processes present?	Are the elements suitable for the scope of the FRMS?	Is the FRMS delivering according to proposal?	Is the FRMS continuing to deliver an acceptable safety level?

Source : ICAO Manual for the Oversight of Fatigue Management Approaches

Setting Flight Duty Period – based on scientific analysis

An augmented flight is put pilots, with more than a minimum number of flight crew members, to work in shift during flights. With augmentation, flight crew members can reduce the time of fatiguing tasks. Flight crew who are not in the cockpit, they can rest at an onboard rest facility; and thereby mitigate fatigue risk during flight. Based on TNO[11] report, an aircraft with a Class 1 rest facility can extend an FDP extension by 75% of the rest period, a Class 2 rest facility can

11) Jeffrey H. Goode, Are Pilots at risk of accidents due to fatigue?. Journal of Safety Research 34 (2003)

extend an FDP extension by 56% of the rest period, and a Class 3 can extend an FDP extension by 25% of the rest period. The FAA considered Dr. Belenky and Graeber's suggestion[12] and decided to introduce departure-time based approach in Table 1.

Table 2. Flight Duty Period

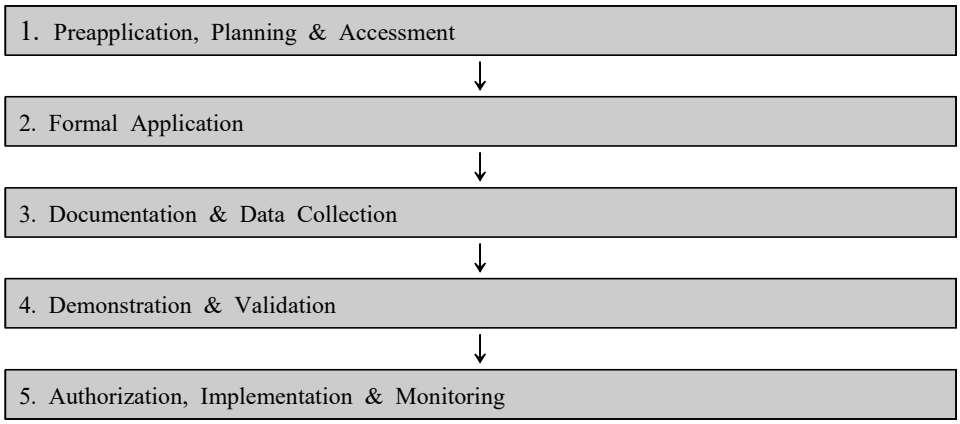
NACA Proposed table to Part 117 - Flight Duty Period : Augmented Operations						
Acclimated	Maximum flight duty period (hours) based on rest facilities and number of pilots					
	Class 1 rest facility		Class 2 rest facility		Class 3 rest facility	
	3 Pilots	4 Pilots	3 Pilots	4 Pilots	3 Pilots	4 Pilots
0000-2359	18	20	17	19	16	18

Revised Table C - Flight Duty Period : Acclimated Augmented Operations						
Time of start (local time)	Maximum flight duty period (hours) based on rest facilities and number of pilots					
	Class 1 rest facility		Class 2 rest facility		Class 3 rest facility	
	3 Pilots	4 Pilots	3 Pilots	4 Pilots	3 Pilots	4 Pilots
0000-0559	13:50	16:05	12:55	14:20	11:45	12:15
0600-0659	15:10	17:40	14:10	15:40	12:55	13:25
0700-1259	16	18	15:25	17:05	14	14:30
1300-1659	15:10	17:40	14:10	15:40	12:50	13:20
1700-2359	13:50	16:05	12:55	14:20	11:45	12:15

Source : Federal Register Vol 75 No.177 Flightcrew Member Duty and Rest Requirements; Proposed Rule, 2010

12) Graeber, R. C., Crew factors in flight operations: I. Effects of 9-hour time zone changes on fatigue and the circadian rhythms of sleep/wake and core temperature (1985)

FAA FRMS Approval Process is as follows



Cost-Benefit analysis for rule making

In the United States, to change Federal regulations, economic analyses should be conducted based on Executive Order 12866[13] and Executive Order 13563[14]. In conducting the analysis, the FAA has determined that the new rule has to have benefits that outweigh its costs. The range of estimates for quantitative benefit has a base of $ 376 million, and a high of $716 million over a 10 year period[15]. The cost-benefit of the rule will depend on the type and size of aircraft accident that the rule averts. FAA office of accident investigation evaluated the benefits of the rule as having the capacity to have prevented 6 aircraft accidents in the past 10 years. The FAA expects the rule would have 52.5 % effective in reducing fatigue related accidents over the past 10 years. In contrast, the cost of the rule is $390 million. The cost is broken into three components: 53% of the cost is

13) Federal Register Vol.58, No.190 Presidential Documents, Executive Order 12866, 1993
14) Federal Register Vol.76, No.14 Presidential Documents, Executive Order 13563, Improving Regulation and Regulatory Review, 2011
15) Federal Register Vol.77 No.2 Flightcrew Member Duty and Rest Requirements; Final Rule, 2012

related with flight operations. 43% is related with preparing rest facilities, and 4% is assigned for pilots training.

Table 3. Summary over a 10 year period

Total quantified benefits			
Estimate	Nominal (millions)	PV at 7% (millions)	PV at 3% (millions)
Base	$376	$247	$311
High	716	470	593
Total quantified costs			
Component	Nominal (millions)	PV at 7% (millions)	PV at 3% (millions)
Flight Operations	$236	$157	$191
Rest Facilities	138	129	134
Training	16	11	13
Total	390	297	338

Source : Federal register Vol. 77 No. 2 Part II 14 CFR Parts 117, 119 and 121 (January 4, 2012)

In the Republic of Korea, Flight crew and Cabin crew fatigue management is regulated by Aviation Safety Act Article 56 (Crew fatigue management)[16]. (1) An air operator, aircraft use business entity, or the owner, etc. of an aircraft for international flight operation shall manage the fatigue of flight crew and cabin crew (hereinafter referred to as “aircrew”) belonging thereto by at least one of the following methods : 1. Method of complying with standards to restrict hours on board, working hours on board, working hours, etc. (hereinafter referred to as “hours on board, etc.”) of aircrew prescribed by Ordinance of the Ministry of Land, Infrastructure and Transport;

2. Method of building and operating a fatigue risk management system.

16) Aviation Safety Act, Act No. 14551, 17. Jan, 2017

With this regulations, airlines can opt for the traditional prescriptive flight time limitation or the Fatigue Risk Management System. The effective date of the FRMS article is March 30, 2019 and the Korean government is preparing the detailed approval requirements and checklist for the FRMS. Korean Air flight 801 crash at Nimitz Hill, Guam, August 6th 1997 was an example of crew fatigue related accident. The NTSB found that the continuation of disrupted sleep patterns and illness would have affected Captain. Captain's fatigue levels would have affected his flying performance which would have contributed to the confusion over the glide slope, failure to follow standard call out procedures and failure to react properly to Ground Proximity Warning Systems. The Captain complained he was sleepy during flight, which was expected to arrive at 1 a.m. Before the Guam accident, the Republic of Korea government allowed to fly 1,500 hours in a year and now it is reduced to less than 1,000 hours in a year (refer to Table 00).

Table 4. Flight Crew Flight Time and Flight Duty Period Limitations

Flight Crew Combination	Maximum Flight Time	Maximum Flight Duty Period
1 Captain	8 hours	13 hours
1 Captain, 1 Co-pilot	8 hours	13 hours
1 Captain, 1 Co-pilot. 1 Flight Engineer	12 hours	15 hours
1 Captain, 2 Co-pilots	12 hours	16 hours
2 Captains, 1 Co-pilot	13 hours	17 hours
1 Captains, 2 Co-pilots	16 hours	20 hours
2 Captains, 2 Co-pilots, 2 Flight Engineer	16 hours	20 hours

Source : Ministerial regulations for Aviation Safety Act. Table 18

The situation related with flight crew fatigue is not properly improved yet. Based on the prescriptive regulation for the flight crew flight time, starting time of duty variance is not incorporated and the condition of crew rest facility is also not considered (refer to figure 4).

Ⅲ. Considerations for data-driven Rulemaking

Data-driven rulemaking seems to be an ideal and scientific way to solve difficult issues which arise in the rapidly changing modern aviation environment. However, it is not well established, and rulemaking expertise is nominal without prepared data collection, analysis and evaluation procedures and processes. In regards to this, the FAA developed a Charter for Aviation Rulemaking Committee dated September 6, 2010[17] that extended the charter until August 6, 2018. It is a performance-based aviation operations rulemaking committee, because the FAA is trying to implement performance-based airspace operations. Given this commitment, there exist significant issues within this dynamic industry, with new technologies and new environmental considerations. The committee is providing a forum for the aviation community to prioritize and provide direction for flight operations. In addition to that, the committee addresses international harmonization and ICAO Standards. PARC[18] input was invaluable in the drafting of the road map for Performance-Based Navigation, and they have helped update numerous regulatory documents for the FAA. The Republic of Korea should consider establishing similar Aviation Rulemaking Committee to help adequately fulfill civil servant's role in aviation safety. In contrast with this, on September 29, 2017, the European Aviation Safety Agency introduced Data4Safety, a partnership for a data driven aviation safety analysis. D4S is a data collection and analysis program. The program's ultimate goal is to help aviation professionals to "know where to look" and to "see it coming". D4S will become the main feeder for the EPAS (European Plan for Aviation Safety), and will provide practical support for rulemaking and certification activities. The measure of success will be assessed by the ability to develop algorithms that will infer intelligence and knowledge out of data. The

17) FAA Aviation Rulemaking Committee Charter, Performance-Based Operations Aviation Rulemaking Committee, 2018

18) PARC : Performance-Based Operations Aviation Rulemaking Committee

problem is that safety data is currently scattered and fragmented all over the different organizations. The data should be integrated into a Big Data platform. Another hurdle of data-driven rulemaking is requiring specific system and experts not only for industry, but also at the government level. In case of FRMS, airlines should develop a pilot roistering program with the help of medical scientists, statistical experts, pilot unions. Data collection and analysis are essential to evaluate the risk of fatigue and it also requires financial assistance and human resources. Another aspect of data-driven rulemaking is the cost-benefit analysis. Calculation of Benefit and Cost for proposed rules is not simple, and difficult to formalize. The Republic of Korea need to establish a formal procedure to require cost-benefit analysis when introduce new procedures or new requirements for aviation safety and security. The last hurdle of data-driven rulemaking is enforcement. For proper implementation, suitable enforcement mechanisms should be developed with the provision for penalties. However, data-driven rules are normally difficult to asses as proper or not. To narrow the gap between the existing and the ideal regulations, governments should develop more detailed checklists for evaluation or oversight. In-depth research of detailed, legal implementation methodologies and tools are not included with this paper, but that can be looked at in future studies.

Ⅳ. Conclusions

Each member State of ICAOs should develop and promulgate their own Aviation Act based on the ICAO Standard and Recommended Practices (SARPs) in accordance with Chicago Convention. The ICAO has developed several new SARPs related to human factors which are critical to reduce aviation accidents and incidents. Among them, the Safety Management System and Fatigue Risk Management System are good examples of data-driven rulemaking concept. Data-driven rulemaking seems to be an ideal and scientific way to solve difficult

issues arising with changes in the modern aviation era. However, it is not well established, and rulemaking expertise is nominal without prepared data collection, analysis and evaluation procedures and process. Establishing and Maintaining Aviation Rulemaking Committee can be a useful strategy to cope with new challenges. The calculation of Benefit and Cost for proposed rules is difficult to formalize. For proper implementation of data-driven rules, suitable enforcement mechanisms should be developed with provisions for penalization. For proper evaluation and oversight, governments should develop more detailed checklist of related variables.

References

[국내문헌]

Aviation Safety Act, Act No. 14551, 17. Jan. 2017

Flight Safety Regulations for Aeroplanes MOLIT AC No. 2017-1039, 29. Dec. 2017

Ministerial Regulations for Aviation Safety Act, MOLIT No. 559, 22. Nov. 2018

Lee, Koo-Hee, *A Study on the Development of Crew's Fatigue Management Regulations*, The Korean Journal of Air & Space Law and Policy Vol. 27, No 1, 2011

Lee, Kwang-jun, Rearch on the Development Strategies for Korean Type Crew Fatigue Management, 2017

[외국문헌]

Caldwell, John A. "Crew Schedules, Sleep Deprivation and Aviation Performance", Current Directions in Psychological Science, 2012

EASA Report from the commission to the European Parliament and the Council -The European Aviation Safety Programme, 2015

FAA Advisory Circular 120-100, Basics of Aviation Fatigue, 2010

FAA Advisory Circular 120-103, Fatigue Risk Management Systems for Aviation Safety, 2010

FAA Advisory Circular 120-103A, Fatigue Risk Management Systems for Aviation Safety, 2013

FAA Aviation Rulemaking Committee Charter, Performance-Based Operations Aviation Rulemaking Committee, 2018

Federal Register Vol.58, No. 190 Presidential Documents, Executive Order 12866, 1993

Federal Register Vol.77 No.2 Flightcrew Member Duty and Rest Requirements; Final Rule, 2012

Federal Register Vol 75 No.177 Flightcrew Member Duty and Rest Requirements; Proposed Rule, 2010

Federal Register Vol.76, No.14 Presidential Documents, Executive Order 13563, Improving

Regulation and Regulatory Review, 2011

Gander PH, Merry A, Millar MM, Weller J. Hours of work and fatigue-related error : a survey of New Zealand anesthetists, Anaesth Intensive Care, 2000

Graeber, R. C., Crew factors in flight operations: I. Effects of 9-hour time zone changes on fatigue and the circadian rhythms of sleep/wake and core temperature, 1985

ICAO Annex 6 Operation of Aircraft, Part I - International Commercial Air Transport - Aeroplanes, Eleventh Edition, 2018

ICAO Annex 19 Safety Management, First Edition, 2013

ICAO Manual for the Oversight of Fatigue Management Approaches(Doc 9966), Second Edition, 2016

ICAO Safety Management Manual (Doc 9859) - Fourth Edition, 2018

Jeffrey H. Goode, Are Pilots at risk of accidents due to fatigue?, Journal of Safety Research 34, 2003

Mahon, G. & Cross, T. The Fatigue Management Program: Alternatives to Prescription. Queensland Transport: Queensland, Australia, 1999

Mallis M.M., Banks S., & Dinges D.F. Aircrew fatigue, sleep need and circadian rhythmicity (Chapter). In Elsevier, E. Salas, T. Allard, & D. Maurino, (Eds), Human Factors in Aviation (2nd edition), in press, 2010

NTSB Accident Report. Loss of Control on Approach Colgan Air, Operating as Continental Connection Flight 3407 Bombardier DHC-8-400, N200WQ Clarence Center, New York February 12, 2009, NTSB/AAR-10/01, PB2010-910401, 2010

NTSB study 94/01

Public LAW 111-216, Airline Safety and Federal Aviation Administration Extension ACT, 2010

Regulation (EU) No 376/2014 of the European Parliament and the Council - Reporting analysis and follow-up of occurrences in civil aviation, 2014

WSHCOUNCIL, Workplace Safety & Health Guidelines : Fatigue Management, 2010

초 록

국제민간항공협약 37조는 ICAO에서 제정하는 국제표준 및 권고에 따라 각국의 사정에 맞는 입법을 할 것을 요구하고 있다. 국제표준 및 권고는 매년 개정되고 있으므로 각 회원국은 적기에 해당 내용을 자국 항공법규에 반영할 필요가 있다. 최근에는 데이터 기반 국제표준이 만들어지고 있으며 그 이유는 인적요소를 주축으로 하여 사고예방을 위해서는 항공안전 데이터와 정보에 기반한 입법이 중요하게 되었기 때문이다. 데이터 기반 입법의 예로 안전관리시스템과 승무원 피로위험관리시스템이 검토 되었다. 안전관리시스템은 부속서 19가 2013년 채택되었으며 관련 매뉴얼 제5장에는 안전데이터의 수집과 분석 시스템에 기술되어 있다. 안전데이터와 정보의 분석을 통하여 의사결정권자는 데이터에 기반한 결정을 할 수 있다. 대한민국은 항공안전법 제58조에 따라 모든 항공사, 정비업체, 공항공사 등이 안전관리시스템을 도입하고 이행하여야 한다. 이러한 안전관리시스템을 뒷받침하기 위해서는 의무보고와 자발적 안전보고 시스템이 활성화 될 필요가 있으며 현재까지는 안전관리시스템 도입 위반에 대한 행정처분 기준은 아주 미미한 상태이다. 미국과 유럽도 안전관리시스템의 적절한 입법을 위하여 다양한 규정이 개발되어 시행되고 있다. 피로위험관리시스템의 경우 2009년 Colgan 항공기 추락을 계기로 미국교통안전위원회는 미연방항공청에 조종사 피로위험을 확인하고 관리할 수 있는 시스템 구축을 권고하였으며 2010년 미연방항공청에서 발행한 입법예고에는 약 8,000여개의 제안이 있었다. 2011년 최종 법안이 통과되었으며 조종사의 조종사가 업무를 시작한 시간, 보조 승무원의 탑승여부, 휴식시설의 등급 등에 따라 승무시간을 차등 적용하는 입법이 이루어지게 되었다. 이러한 입법과정에 수많은 데이터와 정보가 분석되었으며 그 내용이 승무시간에 반영되었다. 최종 입법이 이루어지기 이전에 비용 대비 효과 분석이 실시되었으며 10년간 운영할 경우 비용보다는 효과가 더 크다는 결론이 이루어졌다. 대한민국도 승무원 피로위험 관련 항공안전법 조항이 있으며 항공사는 전통적인 승무시간 제한 방법 또는 피로위험관리시스템 둘 중 하나를 선택할 수 있다. 데이터 기반 입법을 위하여 미국의 경우 항공입법위원회를 구성하여 운영하고 있는데 이는 대한민국에도 도입이 필요한 내용이며 유럽에서 시행하고 있

는 D4S 도 고려할 만한 시스템이다. 비용 대비 효과 분석은 입법을 견고하게 할 수 있어 필요하다고 판단되며 데이터 기반 입법의 실효성을 제고하기 위해서는 전문 인력의 보강, 보다 자세한 점검표 작성 등이 필요하다.

주제어 : 데이터 기반 입법, 시카고조약, 국제표준 및 권고, 안전관리시스템, 피로위험관리시스템, 보고제도, 데이터 수집 및 분석

Abstract

Evolution of Aviation Safety Regulations to cope with the concept of data-driven rulemaking - Safety Management System & Fatigue Risk Management System*

Gun-Young Lee**

Article 37 of the International Convention on Civil Aviation requires that rules should be adopted to keep in compliance with international standards and recommended practices established by ICAO. As SARPs are revised annually, each ICAO Member State needs to reflect the new content in its national aviation Acts in a timely manner. In recent years, data-driven international standards have been developed because of the important roles of aviation safety data and information-based legislation in accident prevention based on human factors. The Safety Management System and crew Fatigue Risk Management Systems were reviewed as examples of the result of data-driven rulemaking. The safety management system was adopted in 2013 with the introduction of Annex 19 and Chapter 5 of the relevant manual describes safety data collection and analysis systems. Through analysis of safety data and information, decision makers can make informed data-driven decisions. The Republic of Korea introduced Safety Management System in accordance with Article 58 of the Aviation Safety Act for all airlines, maintenance companies, and airport corporations. To support the SMS, both mandatory reporting and voluntary safety reporting systems need to be in place. Up until now, the standard of administrative penal dispensation for violations of the safety management system has been very weak. Various regulations have been developed and implemented

---

* This study was supported by 2018 Research Grant from the Korea National University of Transportation.

** Professor, Dept. of Aeronautical Science & Flight Operation, the Korea National University of Transportation.

in the United States and Europe for the proper legislation of the safety management system. In the wake of the crash of the Colgan aircraft, the US Aviation Safety Committee recommended the US Federal Aviation Administration to establish a system that can identify and manage pilot fatigue hazards. In 2010, a notice of proposed rulemaking was issued by the Federal Aviation Administration and in 2011, the final rule was passed. The legislation was applied to help differentiate risk based on flight according to factors such as the pilot's duty starting time, the availability of the auxiliary crew, and the class of the rest facility. Numerous amounts data and information were analyzed during the rulemaking process, and reflected in the resultant regulations. A cost-benefit analysis, based on the data of the previous 10 year period, was conducted before the final legislation was reached and it was concluded that the cost benefits are positive. The Republic of Korea also currently has a clause on aviation safety legislation related to crew fatigue risk, where an airline can choose either to conform to the traditional flight time limitation standard or fatigue risk management system. In the United States, specifically for the purpose of data-driven rulemaking, the Airline Rulemaking Committee was formed, and operates in this capacity. Considering the advantageous results of the ARC in the US, and the D4S in Europe, this is a system that should definitely be introduced in Korea as well. A cost-benefit analysis is necessary, and can serve to strengthen the resulting legislation. In order to improve the effectiveness of data-based legislation, it is necessary to have reinforcement of experts and through them prepare a more detailed checklist of relevant variables.

Key words : Data-Driven Rulemaking, Chicago Convention, Standards and Recommended Practices (SARPs), Safety Management System (SMS), Fatigue Risk Management System, Reporting System (FRMS), Data Collection and Analysis