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The Evoluation of Crew Resource Management Concept in Civil Aviation

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Abstract

The fact that 60% of mortal accidents made by scheduled passenger transports in civil aviation sector are human error initiated and more than 70% is direct cause of human error is reported in past analysis. However, human error can not be reduced to zero. Because human nature has potential to make mistakes in every condition and/or situation, especially stress status. For this reason, it is impossible to reduce the error margin to zero in human factor and also minimizing constitutes main theme in this research. The concept of cockpit/crew resource management (CRM) in civil aviation was first introduced by National Aeronautics and Space Administration (NASA) in 1979 with aim of improving flight safety by regulating communication principles between flight crews at the beginning. Today, the concept has been further developed and a significant part of civil aviation trainings. In this research, the concept of CRM is divided into five generations under the name of cockpit and cabin resource management. The concept of CRM, which has been exposed to great criticism in previous generations has become a concept that needs to be included in the curriculum of staff trainings. Especially flight crews in all airlines, the concept of CRM has become more and more relevant with the analysis of error management in fifth generation more deeply. In conclusion compilation technique is used in this research paper by evaluating different opinions of researchers related with this subject.

Keywords: Cockpit Resource Management, Crew Resource Management, Error Management, Human Factor, Troika Error Model.

1. Introduction

The roots of cockpit/crew resource management training was emerged in the United States of America with came up as a result of the conference called Resource Management on the Flightdeck which were sponsored by the National Aeronautics and Space Administration [6]. This conference is the result of NASA's research into causes of air transport accidents. The research presented at this conference; most of the air accidents have been defined as mismanagement, interpersonal

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communication, decision making and leadership mistakes. The concept of cockpit/crew resource management (CRM) in the negotiations was applied to the training process of flight crews in order to reduce "pilot mistakes" by making better use of human factor in the air. Many of the air carriers represented at this meeting are committed to developing new training programs to ensure that human factor of flight operations can be better assessed. Since then CRM training programs have continued to grow in the United States of America and all around the world. Approaches to concept of CRM have continued to evolve every year since the NASA meeting [1]. The focus of this research is; CRM curriculum focuses on the problems encountered while changing the attitude and behavior of the flight team in the context content of CRM concept [2].

In the past two decades, "evolution" has been used to describe changes in CRM. Evolution; as defined officially is the growth and development process which is also suitable for the mission of CRM concept. Similarly, training programs called CRM have different content and focus points. For example, the ever-changing human race justifies definition of different content and focus points (the generation that is temporarily exposed to the concept of CRM is even closer to the concept of Drosophila than it is human). For these reasons, our focus here is on the most recent approaches to CRM training and how these new approaches can be further developed [3].

2. Theoric Method

2.1. First Generation Cockpit Resource Management

The first comprehensive CRM program was launched in 1981 by United Airlines from the United States of America. The training was developed with help of consultants who were developed training programs for companies seeking to improve management effectiveness. United Airlines' program was modeled similarly to a training called "Managerial System" which were developed by psychologists Robert Blake and Jane Mouton (13).

The training was conducted in an intensive seminar arrangement. Identification of participants' own administrative styles is also included. Other airlines of this period have also benefited from the relevant training approaches in management structures. In these programs, it was aimed to correct problems such as the lack of communication young employees especially and the excessive authoritarian behavior of young masters by altering the centrality of approaches. National Transportation Safety Board (NTSB) has supported this process and found that the lack of decision-making by young crews especially younger captains is one of the factors that caused the United Airlines accident in 1978 (including improper team planning). For this reason, NTSB contributed more to the process of related programs [11].

First-generation CRM training is often focused on general concepts such as psychological testing and leadership. In these trainings, general strategies were defended by cockpit personnel who reflected interpersonal behavior without making appropriate behavioral definitions. In order to clarify more clearly of the concepts specified in most education, non-aviation examples are given. However, since these trainings are planned with related examples, it is determined that the content of CRM is the only training related to concept of communication between pilots, so the trainings should be repeated on an annual basis and samples from the sector should be given. For this reason in addition to classroom training simulated trainings (Line Oriented Flight Training), include which are intended to give full definition of the task systems which crews can put out their personal skills without putting their own lives at risk have also been developed in this period. Nevertheless, despite the general acceptance many of the content training, some pilots thought that these practices have a structure that is more commercializable (in line with the view of "charm school", "attractive education organization") and manipulate of personal abilities [27].

2.2. Second Generation Crew Resource Management

In 1986, NASA organized another workshop for civil aviation sector [8]. Until the 1990s, the United States of America especially around the world by establishing a number of increasingly airline CRM training in their own initiative published reports on their programs. One of the conclusions drawn by workgroups at meetings is CRM training can not be considered a separate component when included in flight training and flight operations. At the same time new generation CRM courses began to emerge in this period. In order to focus on team group dynamics, training in cockpit resource management together with name change in education has received crew resource management. The new curriculum identified and the training program developed by Delta Airways have become more modular and more team-focused, with more specific civil aviation concepts related to analyzed flight operations [14].

In the context of basic education in seminars held mostly; team building, briefing strategies, situation awareness and stress management. By examining certain modular decision-making strategies in this training program, the reasons for catastrophic failure can be explored in a better way. To illustrate the concepts in the curriculum, non-interest-related samples were included in civil aviation. The number of participants in second generation courses was higher than that of first generation courses. However, the criticism that education was filled with "psycho babble" and "unnecessary contents" continued as in first period. For example, in the context of group dynamics, concept of "synergy" was considered by the participants as a meaningless concept (irrelevant jargon). Despite all criticism; however, second generation courses have often been included in staff training by airlines in many parts of the World [24].

2.3. Third Generation Crew Resource Management - Dissemination Of Training Scope

At the beginning of the 1990s, many strategies for CRM training were developed. A large number of content that must be fulfilled by the crew such as the organizational culture that determines safety guidelines in the direction of characteristics of civil aviation system is included in third generation trainings. Trainings have also begun to focus on integrating with technical concepts, skills and behaviors that teams can use to work more effectively. Many airlines have added modules to their training curriculum that refer to CRM issues to use of in cabin automation and equipment. Curriculum content is based on identification and evaluation of human factors. It is aimed to reinforce the airline in technical and human factors together with training contents and to minimize these human errors caused by technical errors with evaluating these factors in the best way.

The development of the CRM concept and the training for flight crews included in more content. Apart from flight crews in third generation CRM concept, trainings have also started to be given other personnel who are license holders in airline such as dispatcher and maintenance personnel. While some airlines provide CRM trainings under a common curriculum, other airlines have also provided tailor-made CRM trainings to better fulfill their leadership role in flight teams. Third generation CRM training is needed to better manage the flight team while the main goal is to reduce rate of human error in the accident.

2.4. Fourth Generation Crew Resource Management - Integration and Procedure Basics

The Federal Aviation Administration (FAA) initiated an advanced qualification program (AQP - Advanced Qualification Program) in 1990 by drastically changing the quantity and quality of flight crew training [12]. AQP is a voluntary program that enables the organization of airlines to develop innovative training in line with needs of organization. With this training facility, airlines need to provide both CRM and line-oriented flight training for all flight teams and integrate CRM concepts into technical training. The major airlines in the United States of America and several major regional airlines have passed the old-fashioned AQP, as expressed in the FAA Regulations sections 121 and 135. In order to complete the transition of the AQP system, detailed analysis of the individual training needs of each type of aircraft with the

airline must be completed and considerations should be given to issues about human factors in all areas of the curriculum. In addition, authorized personnel are required in the area of line operational evaluation (LOE) in order to document crew and evaluate all job descriptions in flight simulations.

Within the context of CRM integration, some airlines have begun to make procedures related to specific behaviors procedure by adding specific modules to training checklists. Relevant airlines are committed to take account of decisions and actions and to ensure that CRM bases are learned, especially in non-standard situations. In the fourth generation CRM, the aim is to solve human error problems as an integral part of flight training. It has been observed that providing a systematic CRM training is very close to realizing the goal of "reducing the probability of failure". Though detailed review with empirical data is not possible, AQP approach has been adopted with consensus among the US airlines in particular to provide improvements in the training and competence of flight crews. However this situation is more complicated than it seems and the problem of human error with the idea consensus has not been solved completely. However before considering fourth generation of CRM, it is clear that what has been accomplished with CRM training in the last two decades has clearly been examined not only completely but also in coming years.

3. Findings and Discussions

3.1. Verification Of CRM Training: The answer to the problem that CRM training can accomplish with goals of improving flight safety and efficiency can not be explained in a simple way. For example, the most obvious verification criteria is accident rate per flight is one in a million, which does not indicate everything is alright. The general rate of accidents is very low and variability of training programs does not make it possible to draw strong conclusions about the impact of CRM training in a given period (24). In the absence of a single and dominant benchmark measure for determination of communication principles in aeronautical safety, researchers are unable to establish key criteria to better identify problems [19, 20].

The reports of weather events do not result in accidents but have an error component which is a different measure. In the past reporting of such events was voluntary. Today however, it is not necessary to end up with an accident in order to investigate an event in direction of briefings and inspections that have been done after each other. Of course the investigation made is less detailed than one carried out after incident resulted in an accident. The most accessible and logical consequences can be achieved in an emergency situation as a result of attitude and behavior of flight crew in cabin. During simulation training in which full job description is performed, official evaluation line operation evaluation system (LOE) is not sufficient to get over difficult conditions. The fact that flight team is well coordinated when evaluated by simulation system under hazardous conditions does not mean that they can show the same coolness during normal line operations. The result is that most useful data can be obtained under hazardous conditions by examining faults at the end of each accident [15].

It can be observed that data obtained from such inspections can provide desired improvement in flight safety in direction of LOFT and CRM training [19]. Observed findings are consistent with the participants' educational evaluations. Flight teams completing course assessments report that LOFT and CRM training is effective and efficient [19]. The attitude of flight team in terms of trainings represents another indication of positive effect as it reflects cognitive aspects of defended concepts. Since attitudes are not an excellent predictor of process orientation, it is unlikely that those who interpret inappropriate attitudes as inappropriate under concept of CRM will be able to strive for regulatory compliance. Nevertheless, measured attitudes to assess impact of CRM concept outside of subjective criteria; air accidents and objective phenomena that play a role in weather events [19, 18]. The fact that attitudes are expressed in terms of subjective outcomes such as air accidents and weather events has changed flight team's attitudes towards CRM training more positively [20].

3.2. CRM Does Not Reach Everybody: Only a small audience from the first generation courses to day to day did not find content of CRM training

inaccurate and incomplete. Errors related to CRM training are available on all airlines. Because error of human factor can not be reduced to zero. However, when these mistakes are known by the management and necessary determinations are made, related errors can be corrected thanks to CRM concept [20].

Especially CRM trainings designed for cabin crew have not proved to be fully effective. Although the content of CRM curriculum is approved by majority of cabin crews, all rules are not adopted in general terms. For example according to pilots, many airlines have introduced CRM modules for use of cockpit automation according to instrument flight rules. However, pilots consider that these modules should be given according to the flight rules in context of the CRM curriculum. Experts who designed the trainings found that it was appropriate for trainers to prepare their trainings in general and in this way according to the instrumental flight rules of the aircraft. However most of the pilots in preferred orientation of airlines are not affecting the safety element and they are also used visual flight rules to shorten existing route due to fuel consumption, other than instrumented flight rules [25].

3.3. Acceptance of Basic Concepts may Deteriorate Over Time: Only a small audience from the first generation courses to day-to-day did not find the contents of CRM trainings wrong and incomplete. Errors related to CRM training are available on all airlines. Because the error of human factor can not be reduced to zero. However, when these mistakes are known by the management and necessary determinations are made, related mistakes can be corrected thanks to CRM concept [20].

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A few years after the first CRM training was taken, the pilots in the airlines were examined. One of the negative findings of this review; there are disagreements about the acceptance of basic concepts even in the continuing education curriculum for many years [26]. While the causes of these disputes can not be easily determined, speculations about negativity are frequently made. Failure of even one candidate is considered as a general failure based on the evaluation criteria such as the lack of management support determined in the direction of CRM training and the line control aircraft.

Another problem is that CRM training is designed for flight teams and the inclusion of other personnel in training may be devoid of specificity that must be differentiated for all staff depending on working conditions and environment. Systematic practices of error management can be changed especially as trainings are continuously provided from one group to another. Regulation of CRM according to procedure (that is, compulsory implementation of the official CRM directive) means that even if there are different job descriptions, they are common in educational contents. In support of this view, the answers of flight crews can be shown in the question "What is CRM?" For example, the response of flight crews is "training that is designed to best suit the working conditions of motivation elements that will enable us to work better." But even this response is far from showing that the entire education system has been perfectly organized. In these trainings, a job definition should be acted within the team spirit is far from individuality of civil aviation that is wanted to be explained. However in many unfavorable conditions, errors are loaded into flight teams so that basic logic of CRM disappears over time and is

considered as a training that includes standard curriculum issues.

3.4. The CRM Concept Has Not Been Marketed Well: As first and second generation CRM training programs began to multiply and train with other airlines or educational institutions in the World, especially the United States of America by examining the world's many airlines and other airlines. Even in the United States of America which is one of the most important countries in civil aviation sector, CRM curriculum has not provided same incentives in direction of lessons developed to reflect organizational culture and operational problems that differ from airlines to airlines. In fact, training in airlines in the United States of America has been described as less efficient than training in the airlines of other countries. The reason for qualification sytems from the fact that trainings are not well prepared in segregated way due to presence of airlines that implement many transport strategies; including traditional (scheduled), low cost, regional and charter which are contrary to the norms of flight crews.

The Dutch scientist Geert Hofstede defined the dimensions of national cultures, many of which are related to acceptance of CRM training. According to these definitions; countries such as China and many Latin American countries whose cultures are old and strong have argued for necessity of cultural structure that has been under absolute authority of leaders throughout history. The subordinates in these cultures are reluctant to question their superiors' decisions and actions so that they are not perceived as disrespectful. It is very difficult for team members to question their captains when they arrive. There is no collectivist structure in these cultures. In collectivist cultures emphasizing interdependence and priority for group goals for the concept of teamwork and education that emphasizes need for effective group behavior can be easily accepted [7].

On the other hand when there is a strong cultural structure in the United States of America in the first place, the ancestor has been adopted within the cultural structure independently of team and team solidarity. Ancillary understanding is that other team members are not on front plan and that team and team structure of pilot control is largely dominated by one person and that the other team members are considered as complementary parts. This refers to a system that is clearly defined in terms of procedures with avoid ambiguity and are governed by certain rules as a mastery to specify who they are [3].

In Greece, Korea and many Latin American countries the understanding of teamwork which form the basis of the CRM concept has been adopted based on sound of cultural values. Because the authoritarian understanding is more prevalent in the United States of America that leads to the fact that it is self-centered. This requires flexibility to be more dependent on standardized procedures [27]. Management of cockpit automation is also influenced by national culture. While pilots from culturally normed cultures think that automation should not be questioned, pilots who grow up in societies far from the authoritarian structure that culture norms do not overtake are predicting that previously identified automations could be questioned [23].

Pilots in the United States of America believed that CRM training could damage the safety factor by changing linkage from past to the rule in direction avoidance of uncertainty. For countries outside the United States of America, there is a growing tendency to customize CRM curriculum to incorporate national culture into CRM culture and to be compatible with its cultural heritage. This is an important development for CRM to increase the impact of these countries on airlines. For example; Malaysia Airlines has made CRM concept a part of national culture [15].

Considering the possible responses to CRM training which is tried to be integrated into the cultural structures of many countries with authoritarian structure are examined. Especially the emergence of CRM concept in the United States of America (A certain group of the sector see this system is positive but another part is negative), related with CRM education in the first four generations is determined with the emergence of the fifth-generation CRM approach.

3.5. Fifth Generation CRM - Seeking Universal Rational Conception

In fifth generation CRM, solutions were sought for CRM training that could be approved by pilots of all nations. For example when evaluating CRM concept as a way of avoiding mistakes, we concluded the concept of error management should be included in most parts of CRM training curriculum [15, 17].

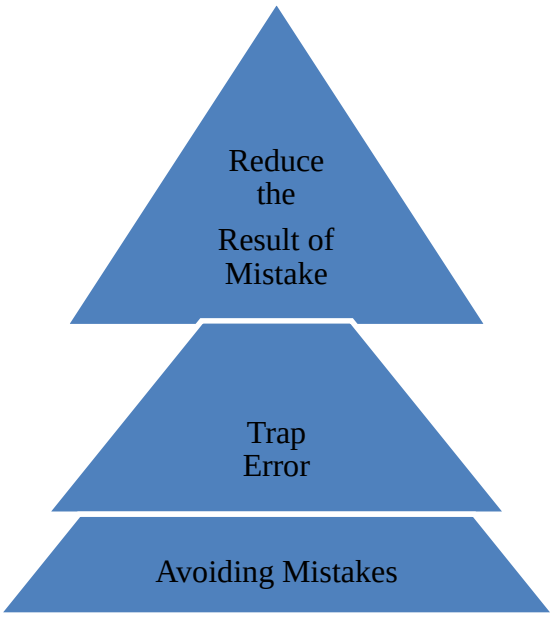
Professor James Reason's work has been influential in the study concept of error management in fifth generation CRM [9, 10]. Even if the investigation of human error in concept of error management was the case even for first generation CRM, it was very difficult to analyze this examination objectively and to evaluate it in the communication criteria. Even if previous generation CRM training advocates certain behaviors, the criteria for evaluating and implementing these behaviors were not always clear. Fifth generation CRM is based on a sharper system which was understood and accompanied by proactive organizational support.

3.5.1. CRM as Error Management: The most controversial issue in fifth generation CRM is that human error is inevitable everywhere and it is necessary to minimize these mistakes irreducibly. For example where a mistake is unavoidable, CRM supports the prevention of mistakes within a triple system. First, this system defines how to best comply with rules to avoid errors. Second, it analyzes situations that may cause errors before they are made. Even if there is no error, processes that do not go systematically are regarded as errors. Thirdly and finally, it is necessary to make the necessary stimuli irrespective of the result even in case of faults which can not be detected because the result is not heavy. Troika, which is designed according to the triple system concept is shown below.

For each situation related to the detection of faults, different communication methods are mentioned under the same CRM concept depending on capacitance and type of the aircraft. CRM concept is also related to systemic issues. For example, even when the wrong route is entered into the flight management computer (FMC - Flight Management Computer), when you think of a forward-looking technology that has succeeded in delivering the flight in a controlled way (CFIT - Controlled Flight into Terrain). A planned briefing on approach procedures and possible hazardous situations can be avoided if combined with the verification of FMC entries. However in the case of a systematic error, planned communication may increase the chances of getting rid of it even is not guaranteed to get rid of accidentally. Errors made by mutual control can be detected before monitoring the system related processes. Finally, it is possible to detect that every stage of the entire process is questionable and monitored in detail and that there is a fault before CFIT.

In order to ensure the acceptance of error management approach, airlines should adopt a punitive but motivating approach when it is necessary to defend against mistakes by developing positive behavior patterns of the time when errors will arise (In this case, an airline can never accept intentional infringement of its rules or procedures). In addition to normalizing faults, strategic steps must be taken to determine the sources of faults in airline's operations. In the United States of America, Federal Aviation Administration (FAA) announced a new initiative, Aviation Security Action Program to encourage case reporting for proactively address airline safety issues [4]. For example, American Airlines co-sponsored the pilot program with the cooperation of pilots with themselves and FAA. This confidential and non-hazardous reporting system allows pilots to report safety concerns and faults. The program has achieved significant success with nearly six thousand reports over a two year period, contributing significantly to civil aviation safety. Significant steps have been taken to prevent or minimize the occurrence of accidents or occurrences in airborne data and events generated by this system.

Graph 1. Troika error model



(6).

3.5.2. Things to Consider for Fifth Generation CRM: The fifth-generation instructions aim to develop strategies to better manage and analyze faults [21]. The basis of CRM should be related to determining limits of human performance. Determination of boundaries like examining the nature of cognitive errors; as well as identifying harmful empirical findings that affect the stress, such as fatigue, workload and emergencies. Exploring these issues requires formal training. In this training, it is important that CRM curriculum should be described under each of the same criteria. In these trainings, examples from accidents and events in which human error plays a role can be shown in a striking and educational way. Analysis of human performance is common in all CRM training generations. The CRM concept has become a phenomenon that emerged in fifth generation CRM, where both errors were identified and how positive examples of how they were managed could be more productive as a result.

In particular, it has been observed that pilots working around the world exhibit erroneous attitudes about affected performance as a result of stress. For example, a truly professional pilot has major overhaul in his decision to leave his personal problems in flight and not to be affected by personal problems especially in emergency situations [15, 2]. The attitude shown in emergency situations is an essential component of professional cultures with pilots and doctors [15]. The attitudes shown are wrong or excessive in direction of beliefs are important factors causing fault. As each individual is exposed to the strase, training given in this direction can make attitudes more professional by minimizing the factors related to personal vulnerability. For this reason, staff with low performance related to stress should adopt CRM training more easily as a precaution against stress.

In theory, the error management approach should provide a more accurate training content for human factors in CRM concept. In addition, this content should continue to be evaluated empirically. Continental Airlines has redesigned both the basic awareness of CRM and its repetitive components under concept of error management. As part of this new design, the entire flight team has been given a basic course within new curriculum. Data on the output of this new curriculum has set out effectiveness of fifth generation CRM training. At the same time, Continental Airlines has launched a new program to educate trainers on identifying and strengthening fault management which has created the primary focus of CRM training [5].

This new program emphasizes that team performance will become more efficient with a good analysis of error handling so that mistakes can be minimized in direction of effective performance. In addition, the terms used in LOFT checklist are used to measure crew performance, including data on error types and error management for use as an organizational evaluation strategy for line control which have been reviewed [22].

Thanks to new program which’s name is airline preliminary reviews; the personnel was able to easily analyze faults of observers and sources of these faults with management strategies. As the causes of mistakes are better understood and different qualifications in trainings have made both quality of curriculum better and better understood by trained staff. For example, faults that could not be detected by the crew in old accidents which were resulted in death and/or serious injuries could be

detected by the new program. This is why the focus on error management on LOFT checklist is considered by entire civil aviation community as a common denominator that can provide valuable feedback and support for teams.

3.5.3. How to Link Error Management to CRM Research: Fifth generation CRM is compatible with previous generations. Particularly in the automation use of special training and emphasized in third generation, the leadership role of captains in crew was better handled in this model. The error management approach has reinforced AQP (Advanced Qualification Program) approach in all areas of education by providing an all important demonstration of reasons for emphasizing CRM in all areas of education. In the same way, proceduralization of CRM with technical training ensured that the objectives which included the curriculum were better understood and accepted in the organizational context. Flight crews should also be able to develop more effective strategies for error management when the procedures are incomplete and provide a focus point for situations that are not suitable for proceduralization.

The briefings make to create situational awareness enable better implementation of basic error management techniques in context of training modules. The common content of cabin and cockpit teams training in the same way is to create a culture in which content of safety management is in context of curriculum for all the staff [25]. Finally, clarifying key objectives in CRM training is crucial for a complete understanding the concept of error management.

3.5.4. Content of CRM concept: CRM is not the mechanism to remove fault from ground and provide security for a high risk sector, such as civil aviation and it will never happen. The error is an inevitable result of the natural limitations of human performance and functional skills of complex system. CRM is just one of the tools that civil aviation organizations can use to manage an error.

Safety of operations are related with unprofessional and organizationally distressed national cultures. The concept of safety aims to direct these problems to an organizational culture that proactively deals with errors in professional attitudes [15]. When analyzed in the context of CRM civil aviation system, it is clearer with its contributions and limitations. The human factors observed in this study are that content of education is as strong as first generation of CRM concept [16].

4. Conclusion

CRM trainings, which were formed under the name of cockpit/crew resource management in civil aviation were examined within five generations from the first departure to present day. First generation CRM which began in 1979, has been applied to training courses of flight crews to reduce pilot errors by better using human factor in air under name of cockpit resource management. In second generation CRM cockpit resource management training together with name change in training, crew resource management was named to focus on team group dynamics. In third generation CRM a large number of content, such as organizational culture that determines the safety bases for characteristics of civil aviation system has to be fulfilled. In fourth generation CRM, the aim is to solve human error problems as an integral part of flight training. In fifth generation CRM, solutions were sought for a CRM training that could be approved by pilots of all nations and it was concluded that concept of error management should be included in most of the training curriculum. Nowadays, the criticisms of previous generations have come to an end with fifth generation CRM concept. Fifth generation CRM is still valid and other sectors outside the civil aviation sector are given similar trainings under different headings especially communication, human factor and error management by using different curriculum and content.

Acknowledgement

In crew resource management concept; five phases of the development process is examined. In first phase the concept was named as cockpit resource management however in following phases the concept was named as crew resource management. The concept of crew resource management (CRM) is significant and necessary to

identify the human factor in error management. Because of this I am lucky for finding enough information to write this research article.

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