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Decision-Making Processes in Conflict Resolution among Air Traffic Controllers (ATCOs) during Aircraft Arrivals

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Abstract

Decision-making processes is an important topic especially among Air Traffic Controllers (ATCOs) as they need to make decisions in a very dynamic environment. Managing air traffic can be quite challenging for them. This study aims to provide valuable insights into the decision-making processes of ATCOs within the Malaysia context, an area with limited prior research. Using the Generalized ATC Model, this research contributes to the model through empirical data and existing literature. This research specifically investigates the decision-making processes involved in conflict resolution among ATCOs, with a particular focus on adverse weather conditions during aircraft arrivals. The study also examines the workload ATCOs experience during these decision-making processes and how they manage that stress. Data were collected using three methods: semi-structured interviews with 12 informants, observations, and document analysis. The findings revealed that decision-making starts with area controllers monitoring aircraft, followed by approach controllers who sequence the aircraft based on specific criteria, and aerodrome controllers granting landing clearance. In relations with that, the findings have major implications for improving training and development of the ATCOs. The insights derived from this research can guide the training needs analysis (TNA) process conducted by HR departments to enhance ATCOs' decision-making capabilities in managing aircraft arrivals. Other than that, future researchers are encouraged to conduct mix method research by employing both qualitative and quantitative methods to different geographical locations, such as the Civil Aviation Authority of Malaysia (CAAM) in Peninsular Malaysia which can offer valuable comparative insights into decision-making practices among ATCOs across diverse contexts.

Keywords: Decision-Making Processes, Conflict Resolution, Air Traffic Controllers, Aircraft Arrivals, Training And Development

Introduction

Decision-making in a dynamic environment is indeed very challenging. These challenges are faced by ATCOs in the aviation industry who handle aircraft arrivals, particularly during

conflict resolution. In Malaysia, ATCOs are employed under the CAAM and they fall into three categories: area controllers, approach controllers, and aerodrome controllers. These roles are accompanied by several ratings such as aerodrome control rating, approach control procedural rating, approach control surveillance rating, approach precision radar control rating, area control procedural rating, and control surveillance rating (Civil Aviation Authority of Malaysia [CAAM], 2022). Each type of ATCOs is tasked with making rapid decisions to prevent delays that could potentially heighten the risk of accidents. According to the systematic literature review conducted by the researchers on 22 articles chosen, it is very critical for the ATCOs to ensure minimum separation between the aircrafts while making a quick decision and ensuring the safety aspect in the aviation industry (Anthony, Ahmad & Osman, 2023). Furthermore, workload stands out as a critical human factor influencing the performance of ATCOs (Alzughibi, Azmin, & Nordin, 2021). Therefore, it is crucial to identify the specific workload challenges faced by ATCOs to enable effective management within their dynamic working environment.

Existing research in Malaysia's aviation industry has primarily focused on several key topics such as the job performance of ATCOs (Tharikh, Hamzah, Baidi & Rajadurai, 2021); air traffic performance (Nusyirwan & Rohani, 2017); Emergency Response Plan (ERP) (Saroni, Samad & Ibrahim, 2019); strategies applied in Procedural Control (Sidik, Rahman & Mohamed, 2017), and cognitive tasks in air traffic control (Anding & Songan, 2000).

Despite the importance of aircraft management, there is limited studies conducted on decision-making processes in the Malaysian context. Therefore, this study is significant as it intends to bridge these gaps by examining decision-making processes among ATCOs, with a particular focus on the management of aircraft arrivals during conflict resolution. It is important to focus on decision-making during conflict resolution as it requires the ATCOs to determine the separation standards between the aircrafts and it is the most critical decisions to be performed by the ATCOs. According to Neal (2008), conflict resolution is known as a significant topic in developing the future air traffic management systems.

Histon et al (2002, p. 2) presented a model known as the Generalized ATC Process Model to analyse on how structure based abstractions influences the Cognitive Complexity of controllers. According to this model, controllers receive surveillance information on air traffic conditions from radar systems and use it to generate output commands. There are only three components involve in the decision-making processes: monitoring, evaluating, and planning introduced by (Pawlak et al., 1996). There are limited known research conducted using this model, thus, this research contributes to the literature review of this related research, addressing the empirical gaps.

In addition, there were two significant incidents involving Malaysia Airlines in 2014, which underscored the critical role of ATCOs' decision-making during conflict resolution, directly impacting the safety of air travel for passengers. The first incident was the disappearance of MH370 on the 8th of March, followed by the crash of MH17 in eastern Ukraine on the 17th of July of the same year. Neither aircraft emitted distress signals (Lewis, 2024; Hassan, 2022). These incidents emphasise the necessity for ATCOs to make swift decisions when faced with such critical situations. These real incidents highlighted the importance roles of the ATCOs especially during conflict resolution. In short, therefore, it is crucial to pursue this research to

gain a comprehensive understanding of the decision-making processes among ATCOs which includes identifying factors influencing their job performance as well as the competencies required by the ATCOs.

Hence, the objectives of this study is to explore decision-making processes in conflict resolution among ATCOs, specifically in adverse weather conditions during aircraft arrivals; to identify ATCOs' workloads in decision-making during aircraft arrival management; and to analyse coping strategies used by ATCOs when making decisions in conflict resolution during aircraft arrivals. Specifically, there are three research questions that guide the research objectives. Firstly – How do the ATCOs make decisions when solving conflicts during aircraft arrivals specifically in adverse weather conditions? Secondly – What are the workloads faced by the ATCOs in decision-making during aircraft arrival management? Thirdly – What are the coping strategies employed by ATCOs to make the optimal decisions during conflict resolution in aircraft arrival management?

Methodology

This study employed a qualitative approach to gain deeper insights into the decision-making processes of ATCOs. Participants were selected through purposive sampling, focusing on ATCOs with a minimum of three ratings and more than 11 years of experience. A total of 12 ATCOs stationed at various locations such as Kuching, Bintulu, Sibu, and Miri were selected as informants for semi-structured interviews. The interviews were conducted in English, audio recorded and later transcribed for data analysis. Since the research focused on a single organisation, the Civil Aviation Authority of Malaysia (CAAM) in Sarawak, a case study methodology deemed most appropriate, following Yin's (2018) protocol for case study research.

To ensure credibility of the research, the researchers established through detailed protocols and procedures during the data collection process. A key aspect of this was the implementation of triangulation, a crucial method for validating the data. Methodological triangulation was employed, by integrating three sources of data: semi-structured interviews, observations, and document analysis. Furthermore, thematic analysis was used to interpret the data, with coding techniques to identify and categorize key themes. Besides, the researcher also focused on ethical issues from the beginning stage of the research. The researcher has prepared for permission letter and submitted to the Manager of CAAM to grant an access for data collection purpose in that organization. The researcher also provided consent form for every informants involved in the interview sessions.

During analysis, the researchers introduced the initial codes used for analysing the data. These codes served as the foundation for identifying patterns within the data. Then, these initial codes are combined to form themes. These themes are synthesized to address the research questions. Table 1 shows some examples of how the initial codes are used in data analysis, illustrating their progression from initial codes to thematic insights. The findings are presented in a "tree diagram".

Table 1
Initial Codes, Themes and Research Questions

Initial codes	**Themes**	**Research Questions**
Controlling aircraft	Theme 1: Monitoring by area controllers	RQ1: How do ATCOs make decisions when resolving conflicts during aircraft arrivals?
Observing distance of aircraft		
Sequencing aircraft	Theme 2: Evaluating by approach controllers	
Approach control procedural and approach control surveillance		
Sequencing aircraft	Theme 3: Planning by aerodrome controllers	
Landing clearance		
Surface Movement Controllers (SMCs)		

Findings and Discussions

Table 2 presents the demographic details of the informants, outlining their qualifications and expertise in air traffic control.

Table 2
Informant Demographic Information

Informant	**Age**	**Job position (Active ratings)**	**Working experience**
1	56	Aerodrome control rating and surveillance	More than 11 years
2	57	Approach control procedural rating and approach control surveillance rating	More than 11 years
3	53	Aerodrome control rating, approach control procedural rating, approach control surveillance rating, approach precision radar control rating, area control procedural rating and area control surveillance rating	More than 11 years
4	44	Approach control procedural rating	More than 11 years
5	56	Aerodrome control rating, approach procedural rating and approach surveillance rating	More than 11 years
6	37	Area procedural rating, area control surveillance rating, approach control procedural rating, approach control surveillance rating and aerodrome control rating	6-10 years
7	59	Aerodrome control rating and approach control procedural rating	More than 11 years
8	40	Aerodrome control rating and Flight Information Service	More than 11 years
9	56	Area control procedural rating and area control surveillance rating	More than 11 years
10	39	Approach control surveillance rating	More than 11 years
11	37	Area control surveillance rating	6-10 years

12	37	Aerodrome control rating	6-10 years

How do the ATCOs make decisions when solving conflicts during the aircraft arrival specifically in adverse weather conditions?

The findings revealed that the key components of the decision-making processes among ATCOs include monitoring, evaluating, and planning.

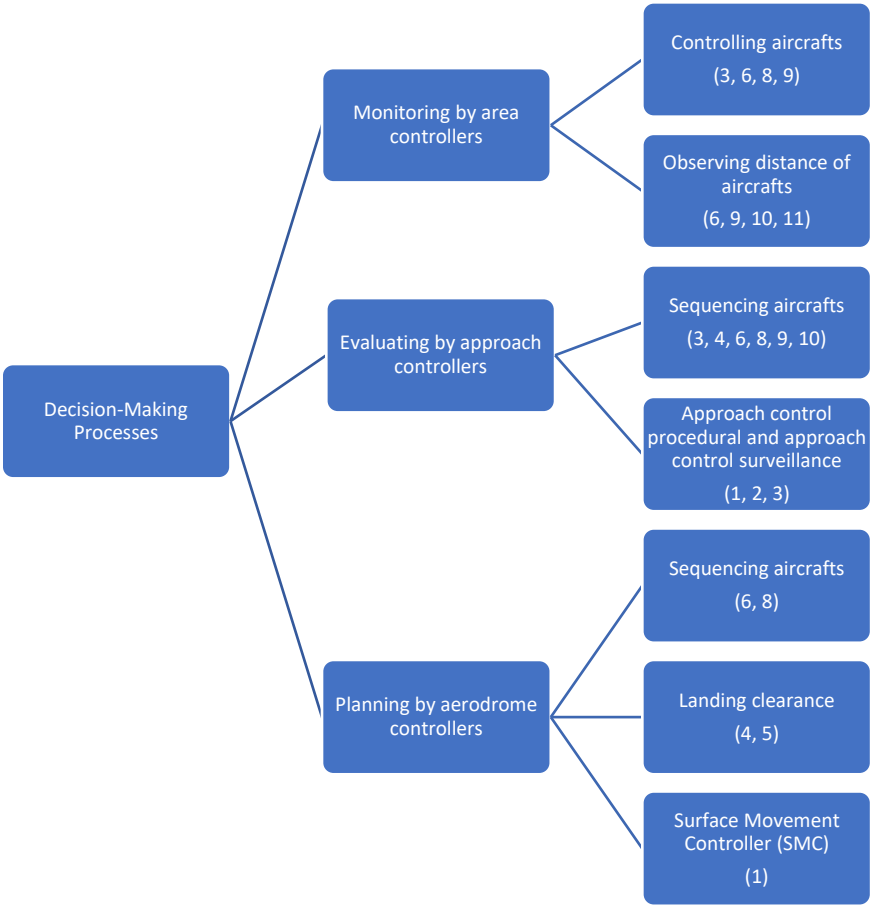

Figure 1: Decision-Making Processes

Monitoring by Area Controllers

Monitoring by area controllers is the initial component in the Generalized ATC model (Histon et al., 2002). Based on the findings, monitoring is performed through controlling the aircrafts as well as observing the distance of the aircrafts. Controlling the aircrafts means that the ATCOs are in control for the performance of the aircraft up till a certain level. For example, while the ATCOs coordinate with other ATCOs from other stations and receive an aircraft from another station, the ATCOs need to monitor the traffic and control the level of the aircraft by considering the type of aircraft as well. If there is another aircraft flying below the aircraft, then the ATCOs need to inform the aircraft to increase its level. Other than that, the ATCOs need to observe the distance of the aircrafts. For example, when there are two aircrafts of the same level, the ATCOs need to distance the aircrafts either by changing the speed of the aircrafts or maneuver the aircrafts. The findings indicate that area controllers primarily undertake monitoring duties during aircraft arrival. Below are excerpts from the informants' responses:

"… sometime when he fly almost reach Singapore airspace, suddenly another plane at 380 also. They can if there is enough spacing. If not enough, they can fly at 380 or 400. So this level from Sibu side, we just key in inside the system but to get this level will be decided by Kuching or Singapore later. Kuching will climb at certain level and if Singapore already coordinate with Kuching. For Kuching, this aircraft at 380, is approved. But if Singapore said not approved, then Kuching can climb at certain level, 300 for example …"
[Informant 6]

"… Sometime it can be the same level. Let say this one is flight level 300. This one flight level 330 … Either you remain high speed or reduce speed … Another way is you have to open it up and then you need to maneuver the aircraft to a certain position so that when you maneuver the aircraft to certain position, he will slowly lose the distance …"
[Informant 9]

Controlling Aircraft

According to the division of responsibility stated in the CAD 1101 – ATM (CAAM, 2021), area controllers are responsible for controlling aircraft when both area controllers and approach controllers are not part of the same air traffic control unit. Data collection revealed that not every CAAM station has its own area controllers. In Malaysia, area controllers under CAAM are stationed only in Kuching, Kota Kinabalu, and Kuala Lumpur. As a result, area controllers oversee the largest regions for monitoring aircraft, each with specific jurisdictions. Below are excerpts from the informants' responses:

"… if you are an ATC, you are controlling until a certain level and certain distance … you'll have a larger and higher control. Higher in terms of perspective of level for aircraft to approach fly up to level 140 only. So, anything higher than that level belongs to area ..."
[Informant 3]

"… They can help the approach surveillance to sequence the aircraft … area controllers control aircraft in the bigger airspace."
[Informant 9]

Observing Distance of Aircraft

The area controllers are tasked with monitoring aircraft to maintain safe distances among them, typically by regulating aircraft speed or altitude. Below are the relevant excerpts from the informants' responses:

"… for example, one aircraft at level 360 and another aircraft at level 340. Even though it is vertical, you still need to make sure the higher aircraft is number one, the aircraft below is number two, for example. So, what you do, you vector the aircraft …"
[Informant 6]

"… Like I said after I calculate the distance, the time they will reach that is fixed. Then, I give instruction to area "okay, this aircraft will reduce speed to 70 knots", "okay, this aircraft maintains high speed …"
[Informant 10]

Evaluating by Approach Controllers

Based on the observation conducted by the researcher, the evaluation phase is carried out by approach controllers. These controllers manage air traffic based on daily flight schedules provided to them. During the observation, the researcher witnessed how approach controllers handled aircraft arrivals. For example, approach controllers directed aircraft arriving from Kuala Lumpur to descend to 2500 feet. Upon the aircraft becoming visible from the airport's ground tower, the approach controllers transferred control to aerodrome controllers. This practice aligns with CAD 1101 – ATM, which specifies that approach controllers should transfer arriving aircraft to aerodrome controllers upon their proximity to the aerodrome controllers' location at a designated level or upon landing (CAAM, 2021).

There are two primary categories of rating outlined in CAD 1 - PEL (CAAM, 2022): approach control procedural rating and approach control surveillance rating. The main distinction between these two ratings lies in the use of radar systems. ATCOs with approach control procedural rating do not utilise radar systems, whereas ATCOs with approach control surveillance rating use radar systems to manage aircraft.

Sequencing of Aircraft

The sequencing of aircraft is primarily carried out by approach controllers, who arrange aircraft based on criteria such as aircraft priority, performance, speed, and the distance between aircraft. Below are the related excerpts from the informants' responses:

"...approach controllers will do the sequence again if necessary and pass to the aerodrome controllers…"
[Informant 6]

"… For approach, we usually give way to the scheduled flight first. So, for flight arrival, if the aircraft is a scheduled flight, then we give them priority number one, followed by light aircraft such as helicopter and fixed wing ..."
[Informant 8]

Approach Control Procedural and Approach Control Surveillance

ATCOs with approach control procedural rating are tasked with providing approach control services to aerodrome controllers, as stated in the CAD 1 - PEL (CAAM, 2022). In contrast, approach control surveillance operates similarly to approach control procedural, but ATCOs with approach control surveillance rating utilise ATS surveillance systems to deliver approach control services to aerodrome controllers, as detailed in CAD 1-PEL (CAAM, 2022). Below are the related excepts from the informants' responses:

"… approach procedural is basically like you imagine where the aircraft are based on the chart, where they are coming from, it's all procedural … surveillance is radar. You can see on the monitor. Before this is called approach radar, now is called surveillance …"
[Informant 1]

"… approach procedural, you totally don't have the picture on the screen, so what you have to do is you have to visualise something inside your head, you just imagine … approach radar, you can see the aircraft, you have the monitor there, all the information has been displayed

… surveillance control, you can reduce the speed of the aircraft and you can vector the aircraft …"
[Informant 2]

Planning by Aerodrome Controllers

Planning constitutes the final component in the Generalized ATC model, culminating in the formulation of the "Current Plan" for ATCOs (Histon et al., 2002). This phase is critical in decision-making as it provides the directives for efficiently managing air traffic. According to Pawlak et al. (1996), the aim of the planning process is to determine the optimal solutions for resolving traffic conflicts. Based on observations and informants' responses, aerodrome controllers are responsible for the planning process. Subsequently, they transfer control to Surface Movement Controller (SMC). Initially, aerodrome controllers grant landing clearance to arriving aircraft. Thereafter, SMCs oversee the management of aircraft until they reach their respective parking bays.

Sequencing of Aircraft

Aerodrome controllers are also responsible for sequencing aircraft. According to the responses from the informants, aerodrome controllers adjust aircraft sequencing as needed. Below are the related excepts from the informants' responses:

"…aerodrome controllers will do the last sequence before the aircraft land…"
[Informant 6]
"… In aerodrome, if there is a helicopter coming in aerodrome, then we have to hold the aircraft. We have to decide which one is coming first. So, we have to decide which to prioritise …"
[Informant 8]

Landing Clearance

Based on the findings, the decision-making among ATCOs also includes issuing landing clearance and sequencing aircraft, tasks primarily performed by aerodrome controllers. Additionally, approach controllers manage aircraft sequencing. Landing clearance is crucial to expedite and maintain separation of air traffic. ATCOs must request landing clearance to prevent collisions and to maintain orderly air traffic flow (CAAM, 2021). Below are the relevant excepts from the informants' responses:

"… control tower will give them a landing clearance, give them instruction to park at the perspective bay at the terminal building …"
[Informant 4]

"… we just give them clear to land and then proceed to aerobridge …"
[Informant 5]

Surface Movement Controller (SMC)

SMCs also participate in the planning process, assisting aerodrome controllers. They guide landed aircraft to available parking bays at the airport. Below are the relevant excepts from the informants' responses:

"… When the aircraft is starting and be given clearance, it will be under surface moment controller, under different frequency …"
[Informant 1]

In conclusion, the first research question has been addressed through the identification of three themes that represent the key components of decision-making: monitoring, evaluating, and planning. Each type of ATCOs plays a distinct role in managing aircraft arrival. The process begins with area controllers monitoring and controlling aircraft over a broad area. It continues with approach controllers evaluating and sequencing the aircraft based on specific criteria before transferring them to aerodrome controllers. Upon receiving the aircraft, aerodrome controllers issue landing clearance, after which SMCs guide the aircraft to their respective parking bays at the terminal building. It can be concluded that the decision-making processes involved in managing aircraft arrival clearly involve both ATCOs and SMCs. The handling of aircraft arrival is a crucial task for ATCOs. In Malaysia, their decision-making processes are primarily guided by the Civil Aviation Directives 1101 – Air Traffic Management (CAD 1101 – ATM) and CAD 2 – Rules of the Air. CAD 1101 – ATM was established in accordance with Regulation 76 of the Malaysian Civil Aviation Regulations (MCAR) 2016, while CAD 2 – Rules of the Air aligns with Regulation 77 and 81 MCAR 2016. These directives provide the framework for ATCOs to ensure a safe and efficient air traffic management during aircraft arrivals in Malaysian airspace. By conducting this research via observation, the researcher found out that the decision-making processes in real situation are in line with the standards required by the CAAM as stated in the CAD 1101 – ATM (CAAM, 2021).

What are the workloads faced by the ATCOs in decision-making during aircraft arrival management?

The findings show two main factors contribute to workloads: traffic conditions and the demands inherent to their job scope.

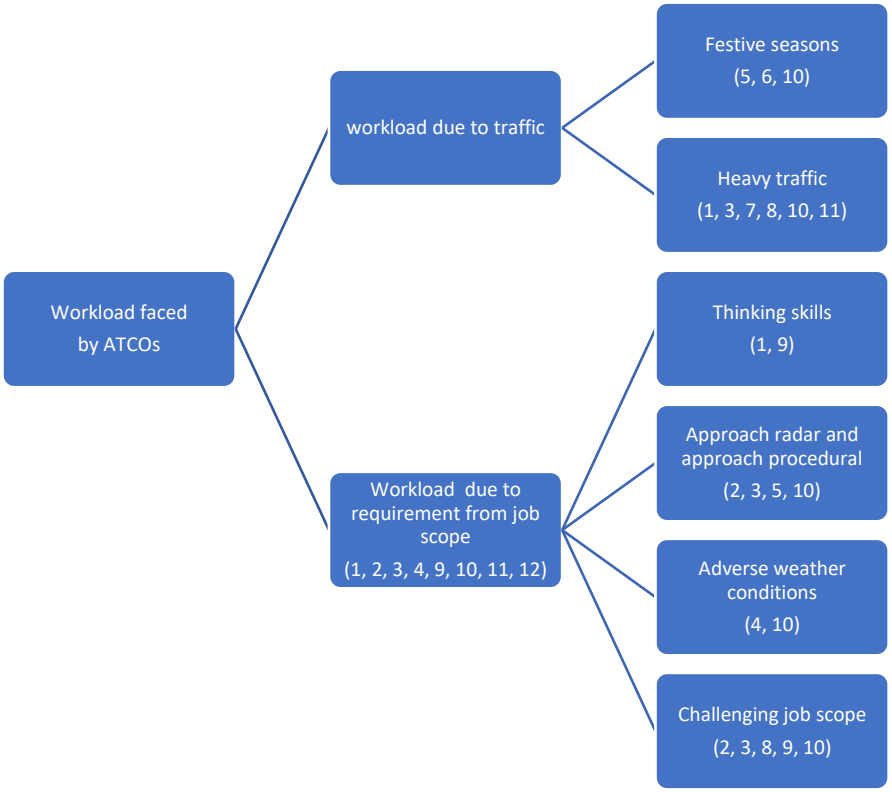

Figure 2: Workloads Faced by ATCOs.

Workloads Due to Traffic Conditions

The air traffic condition is highly dynamic and serves as a primary factor influencing the workloads of ATCOs. According to the responses from the informants, air traffic significantly contributes to ATCOs' workloads, particularly during festive seasons and peak hours.

Festive Seasons

Flights volumes usually increase during festive seasons. Below are the corresponding responses from the informants:

"… other than traffic conditions, festive seasons also contribute to the workload …"
[Informant 5]

"… workload is high, particularly during peak hours …"
[Informant 10]

Heavy Traffic

The workloads faced by ATCOs are also influenced by the volume of flights. They must exercise extra caution when handling a high number of aircraft. Below are responses related to this issue from the informants:

"… the actual workload, how much traffic we're controlling for the day…"
[Informant 3]

"… the workload is largely determined by traffic volume … if only one or two traffic are arriving, that means there's less workload. However, if there are multiple inbound aircraft, that means the workload is heavier …"
[Informant 7]

Workloads Due to the Requirement of Job Scope

Workload stemming from the requirements of the job scope is a significant concern mentioned by most informants. These factors collectively impact ATCOs' workloads and may influence their job performance.

Thinking Skills

ATCOs play a crucial role in ensuring the safety of air traffic by managing aircraft movements. Thus, it is crucial for ATCOs to be aware of their workloads and manage them effectively to make informed decisions. The thinking style of ATCOs can lead to varying cognitive approach and significantly influences their workload. For example, the necessity for ATCOs to possess strong critical thinking skills adds to their workloads. Below are the related responses from the informants:

"… you have to analyse a lot of things … our way of thinking can effect our decision …"
[Informant 1]

"… this is a high risk job; our job is very challenging …"
[Informant 9]

Approach Radar and Approach Procedural

In terms of procedural and surveillance approaches, ATCOs using procedural methods tend to experience higher workloads compared to those using radar systems. Procedural ATCOs must mentally visualise aircraft positions and distances based on provided information. In contrast, radar-based ATCOs, known as approach procedural ATCOs, utilise surveillance methods employing radar systems to monitor aircraft positions and distances more effectively. Below are the related responses from the informants:

"… in air traffic control, the word procedural, when you do the traffic, control the aircraft, it means to say you do not use the system. You use visualisation. It's much easier with radar because you don't have to ask radial report as you can see where they are …"
[Informant 3]

"… continuous mental thinking… using imagination when radar is not available, and this increase the workload …"
[Informant 10]

Adverse Weather Conditions

The workloads faced by ATCOs increase during adverse weather conditions compared to good weather conditions. Below are the related responses from the informants:

"… more workload for the controller during bad weather …"
[Informant 4]

"… in bad weather, the workload will increase because of congestion …"
[Informant 10]

Challenging Job Scope

The job scope of ATCOs is challenging because they need to maintain a high level of focus and alertness to their surroundings. This role comes with high expectations and is perceived as a high-pressure job. Below are the responses related to this aspect from the informants:

"… you have to focus …"
[Informant 8]

"… this is a high risk job; our job is very challenging …"
[Informant 9]

To summarise, two themes were identified in addressing the second research question: workload arising from traffic volume as well as from job scope demands. As the number of flights increases, ATCOs experience heightened workloads in aircraft management. Additionally, the research findings underscore the challenging nature of ATCOs' job scope, which contributes to their overwhelming workloads which then influence their job performance. It was also discovered that some stations lack radar facilities, necessitating the use of procedural methods and procedural ratings for ATCOs to carry out their duties.

These findings are similar with previous research conducted by Imroz, Sadique and Trambadia (2022), who studied on overwhelming workload among the ATCOs. The difference is the researcher focused on workload faced by the ATCOs during decision-making processes while Imroz, Sadique and Trambadia (2022) emphasized on workload in influencing the job satisfaction of the ATCOs.

What are the coping strategies employed by ATCOs to make optimal decisions during conflict resolution in aircraft arrival management?

The findings revealed two main strategies employed by ATCOs: undergoing training and proficiency examinations. These strategies are implemented at various levels, including the organisational level, involving CAAM management.

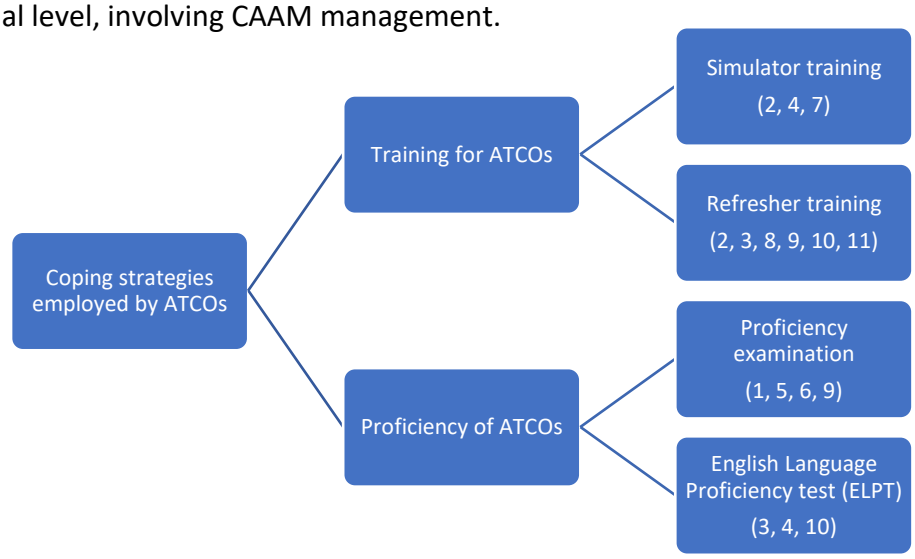

Figure 3: Coping Strategies employed by ATCOs.

Training for ATCOs

Various training programmes are conducted for ATCOs to enhance their skills and knowledge, including Lead-in Training, On-The-Job Training (OJT), Familiarisation Training, and Refresher Training, as outlined in their CAD 1201 – ATC Licensing (CAAM, 2021). The majority of informants reported participating in training such as simulator training and refresher training.

Simulator Training

Simulator training conducted at the Malaysia Aviation Academy (MAVA) in Sepang, Selangor, is designed specifically for new ATCOs. They undergo three months of primary training, followed by an additional three months of aerodrome course. Below are the responses related to this training from the informants:

"… the course will teach you how to sequence the aircraft to land, how to separate the departures and arrivals … These skills are included as part of the training …"
[Informant 4]

"… training is normally conducted in MAVA … for up to three to six months ... for the new intakes, you'll have to do the primary training for three months and the aerodrome course for another three months …"
[Informant 7]

Refresher Training

Refresher training, also referred to as a refresher course, is a training programme tailored to the ratings of ATCOs. For example, an ATCO currently assigned to approach control would undergo a refresher course when transitioning to radar operations. Below are the responses related to this training from the informants:
"… the organisation needs to address the importance of having as many refresher courses as possible …"
[Informant 3]

"… refresher courses cater more on current situation and emergency …"
[Informant 11]

Proficiency of ATCOs

According to the CAD 1201 – ATC Licensing publication, ATCOs must undergo an examination upon the completion of their training at the On-The-Job-Training (OJT) centres (CAAM, 2021). These examinations include rating/validation examinations, proficiency examinations, competency examinations, and familiarisation assessments. Additionally, ATCOs are required to pass the English Language Proficiency Test (ELPT). Respondents highlighted proficiency examinations and the ELPT as crucial aspects.

Proficiency Examinations

According to CAAM (2021), proficiency examinations should be conducted annually or as needed. It is mandatory for controllers to pass the proficiency examination to maintain a valid license. If a controller fails the examination, they will no longer be licensed to exercise the privilege of any rating. Below are responses related to this requirement from the informants:

"... you have practice … that's why proficiency check is to check your ability …"
[Informant 1]

"… the one that you are not actively working on, you don't have to do the test …"
[Informant 6]

English Language Proficiency Test (ELPT)

The English Language Proficiency Test (ELPT) is a mandatory requirement for ATCOs assigned to international airports. They must attain a minimum score of Level 4 in the ELPT. If an ATCO scores below Level 4, they must retake the test until they achieve Level 4 or higher proficiency. Proficiency in English is a crucial requirement for ATCOs due to its importance in their duties. Below are responses related to this requirement from the informants:

"… English proficiency among ATC … also helps pilots who might need other information during Radial Traffic (RT)
[Informant 3]

"… ELPT … all controllers who want to work as an active controller, they need to be proficient at least at Level 4 …"
[Informant 10]

The final research question has been addressed through two themes: the training and proficiency of ATCOs. The demanding nature of their work necessitates skills in decision-making, problem-solving, situational awareness, teamwork, and communication. Therefore, effective training is essential for ATCOs to develop these capabilities, given the predominantly hands-on nature of their tasks. Training provides valuable opportunities for ATCOs to simulate real-life scenarios, including emergencies, enabling them to practice and apply theoretical knowledge. These findings are similar with the research conducted by Alzughibi, Azmin and Nordin (2021), who examines factors influencing ATCOs performance. Their study emphasised the critical role of training in enhancing skills and practical experience necessary for effective task performance. However, in this research, the researcher focused on the training as one of the coping strategies in decision-making processes during conflict resolution of managing the aircraft arrival.

Furthermore, proficiency examinations play a crucial role in assessing ATCOs' abilities and maintaining their valid licenses for performing their duties. Proficiency in speaking and understanding English is particularly critical for effective two-way radio communication among ATCOs, pilots, and SMCs. For example, clear communication is vital when ATCOs issue descent instructions to pilots, ensuring precise adherence to procedures for descending aircraft to a certain level. Without effective communication, pilots may not be able to follow instructions accurately. These requirements for ATCOs are explicitly outlined in CAD 1201 – ATC Licensing (CAAM, 2021), which supports research findings on coping strategies utilised by ATCOs in their decision-making processes.

Implications, Recommendations and Conclusions

Implications

The implications of this research can be viewed through three primary dimensions: empirical, theoretical, and practical.

Empirically, this research addresses a significant empirical gap by shedding light on the underexplored area of decision-making processes among ATCOs within the Malaysian context.

Theoretically, the findings contribute to a deeper understanding of ATCOs decision-making processes particularly in managing aircraft arrivals. The research highlights decision-making is not only a collaborative effort among ATCOs but also involves significant support from SMCs. According to the Generalized ATC Model, as outlined by Histon et al. (2002), three essential components are integral to ATCO decision-making: monitoring, evaluating, and planning. During the planning phase, the aerodrome controllers oversee the process, often in collaboration with SMCs. Consequently, these findings contribute to a new theoretical framework supported by both empirical data and existing literature. Particularly within this framework, the planning component of the Generalized ATC Model is jointly managed by ATCOs and SMCs, illustrating the integrated nature of decision-making processes in air traffic control operations.

Practically, the findings contribute to significant implications to improve training and development aspects of the ATCOs. Interviews revealed that ATCOs are required to undergo various forms of training and proficiency examinations. Consequently, this research has significant implications for improving ATCOs' coping strategies in decision-making regarding arriving aircraft. The research findings contribute to the training needs analysis (TNA) process, helping HR professionals identify essential key training and development areas for ATCOs. By pinpointing specific areas where ATCOs may need additional training or support, organisations can tailor training programmes effectively. This targeted approach aims to strengthen ATCOs' overall competency and resilience in handling complex decision-making scenarios. Ultimately, these efforts can contribute to enhancing safety and efficiency within the aviation sector.

Recommendations

Based on the findings of this research, the researcher offers several practical recommendations aimed at future researchers, policy makers, HR practitioners, and organisations to enhance decision-making capabilities within the aviation industry. Future researchers are encouraged to employ diverse methodological approaches, including quantitative methods, to further explore this area of study. This could provide deeper insights into decision-making practices among ATCOs during aircraft arrivals and departures, both procedurally and through surveillance. Additionally, expanding research to various geographical locations, can offer valuable comparative insights into decision-making practices among ATCOs across diverse contexts. Different stations of CAAM may differ in terms of volume of traffic and the facilities of the radar. Thus, there may be slightly different in terms of decision-making processes due to the volume of traffic. For instance, as has been discussed earlier, high volume of traffic may increase the workload of ATCOs in decision-making processes.

Policy makers can utilise insights from this research to tailor policies that support ATCOs' well-being, thereby enhancing their effectiveness and resilience in performing duties. For example, they could implement policies to ensure that there are regular assessments on stress level of the ATCOs. Besides, HR practitioners are recommended to leverage these findings to develop customised training programmes for ATCOs. There are two types of training methods which are technology-based and traditional. As HR trends evolve to meet the needs of the next generation, such as Generation Alpha, HR practitioners should adapt training programmes accordingly. Understanding the behaviour and learning preferences of Generation Alpha individuals will be crucial in designing training that resonates with them and maximises engagement and learning outcomes. The Generation Alpha are very digitalised. Therefore, the HR practitioners may consider to conduct technology-based training such as by having virtual reality for each type of ATCOs to provide the real situation especially to the new ATCOs. These training programmes should not only focus on technical job-related skills but also aim to enhance broader competencies such as communication skills to improve the communications of the ATCOs. The skills are very crucial especially when the ATCOs convey information on a particular aircraft to the pilot to ensure that there is a minimum separation between the aircrafts.

By incorporating these insights, organisations can foster an environment that supports continuous improvement in decision-making capabilities among ATCOs, ultimately enhancing safety and efficiency within the aviation sector. Plus, these recommendations should be continuously monitored once implemented to reinforce the idea of fostering an environment of continuous improvement.

Conclusions

In conclusion, this research provides valuable insights into the decision-making processes among ATCOs, employing the Generalized ATC Process Model as a framework to illuminate these processes. The study demonstrates that decision-making in planning extends beyond aerodrome controllers to involve SMCs, underscoring the collaborative nature of decision-making within the ATC context. Furthermore, this research highlights the substantial workloads that ATCOs face, arising from traffic conditions and job demands alike. Their role is inherently demanding as they carry the responsibility of ensuring the safety of aircraft and passengers while making prompt and informed decisions.

Furthermore, the study advocates for organisational coping strategies aimed at facilitating optimal decision-making by ATCOs during conflict resolution in aircraft arrival management. This involves designing customised training programmes derived from Training Needs Analysis (TNA) findings, ensuring ATCOs possess the essential skills to navigate intricate decision-making scenarios effectively.

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