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Research paper

Air Traffic Controller Perception towards Air Traffic and Taskload

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Abstract

Malaysian airspace in specific Kuala Lumpur Flight Information Region (KLFIR) is considerably strategic due to its geographical location. It is set in-between major airports in India, the Middle East, and European country on its western side, and airports in Singapore, Indonesia, and Australia on its eastern side. Thus, increasing air traffic movement between these two regions will significantly increase air traffic volume in KLFIR sectors. Currently, with more than 1800 flights per day, crossing, and operating within the airspace, understanding of Air traffic Controller (ATCO) taskload is vital in order to maintain a safe and orderly flow of air traffic. One of the most common method in maintaining an acceptable ATCO taskload level is by establishing the sector capacity or the maximum number of aircraft that can be within a sector at any given time. To capture this, it is important that ATCO perception towards Air Traffic and their taskload is fully understood. Based on interview sessions with active en route controller working at Kuala Lumpur Air Traffic Control Centre (KLATCC), it was found that there were certain sector/ area that was considered more difficult than others due to either its size, radar capabilities or routes organization. Also, there were certain coordination task that were perceived to be more demanding than others, such as coordination with adjacent Area Control Centre (ACC) unit. It is hoped that using the structured input from ATCO, a better understanding of controller perception towards air traffic and taskload can be gathered, enabling design of a more effective working condition with optimum taskload in the future.

Keywords: *Air Traffic Management; Taskload; Air Traffic Controller; Kuala Lumpur Flight Information Region.*

1. Introduction

The demand for air travel continues to grow rapidly especially in Asia and Middle East regions. In May 2018, the International Air Transport Association (IATA) indicated that the growth in international passenger for the month of May in Middle East and Asia Pacific are at 3.7% and 6.2%, respectively. The total passenger traffic market shares based on Revenue Passenger Kilometers (RPK) for Middle East and Asia-Pacific are at 9.5% and 33.7%, respectively [1].

Malaysia, in specific the Kuala Lumpur Flight Information Region (KLFIR) which lies in between of those two regions also has significant increase of traffic flow in the recent years, as our airspace is part of the airways that cater air traffic from Middle East to Asia pacific and vice versa. The rapid growth of air traffic movement between Asia Pacific and Middle East may result in air traffic congestion within the KLFIR in the future.

As volume of air traffic increase, Air Traffic Controller (ATCO) workload will also increase significantly. However, traffic volume alone cannot be used to gauge ATCO workload. Nevertheless with increasing traffic, one would experience an increase in taskload or mental taskload that in the end would result in an increase in overall workload. Thus, one of the most common method in maintaining an acceptable ATCO taskload level is by establishing the sector capacity or the maximum number of aircraft that can be within a sector at any given time.

The capacity of any airspace system that consist of a network of ATC sectors, is known as the maximum number of aircraft that may be within a sector at a time given an acceptable workload level for the ATCO to perform their tasks safely [2]. This flow measure of capacity includes aircraft, that during the given period of time which is entering, exiting and transiting through the airspace.

ATCO workload is a subjective attribute and an effect of air traffic complexity. Those complexity factors include but not limited to potential conflicts, number of hand-off or coordination with other sectors or units, direction, speed differences, presence of weather and number of aircraft [3]. Previous researches have looked into understanding taskload, sector design complexity and its effect on workload, situation awareness and controller performances [2-7]. Some focuses on sector design complexity [2, 3], others focus on capacity and distribution of traffic [4, 6] and how its effect taskload. This research aims at understanding how ATCO perceived air traffic and how it affect the level of taskload as well as workload imposed on them.

1.1 Kuala Lumpur FIR

Malaysian airspace in specific Kuala Lumpur Flight Information Region (KLFIR) is located strategically due to its geographical location. With an average increase of 6% traffic yearly and more than 600000 movement in 2016, Malaysia's aviation industry must be ready in terms of technology, human resources and knowledge in order to be able to cope with the traffic increase.

ATCO plays a vital role in maintaining an orderly flow of air traffic by controlling the air traffic under their jurisdiction in a safe and expedient manner. The airspace through which the aircraft

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flies is divided into Air Traffic Control (ATC) sectors. Such a sector is a region of airspace, defined by geographical and height boundaries, within which one air traffic controller or one team of controllers is responsible for providing the air traffic control service.

KLFIR is divided into six (6) sectors, with Sector 6 having the same geographical properties with Sector 1 and is only divided into upper section namely Sector 6 with Flight Level (FL) of more than 32 000 ft (FL320) and lower section namely Sector 1 with lower than FL320. Figure 1 shows KLFIR's airspace geometrical boundary together with its sectorization. Based on the figure we can see that each sector has its own characteristics, whether in terms of sector size or complexity of routing.

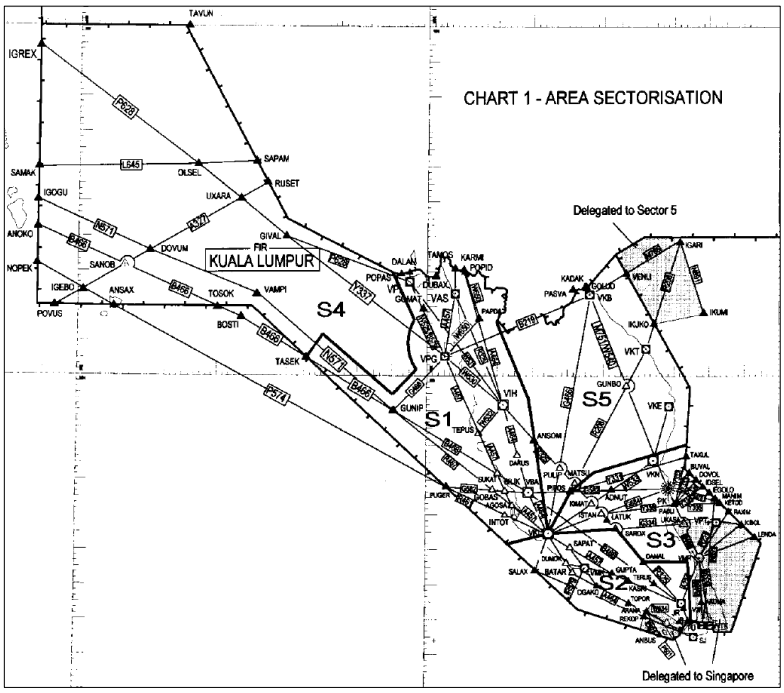

Fig 1: Kuala Lumpur Flight Information Region geometrical boundary [8]

2. Interview with Air Traffic Controller

Traditionally, controller workload is usually estimated either by using measure of behavior or physiological recording, measure of traffic characteristics and measure of subjective rating. As this is an initial study to understand Kuala Lumpur Air Traffic Control Centre (KLATCC) ATCO perception towards air traffic, task demand and workload, one to one interview session is seen as the most fitting methodology in gathering the needed information.

2.1. Participants

A total of 24 respondents agreed to take part in the one to one interview sessions and all are active en route controller working at KLATCC. The respondents are between the age of 25 to 54 with mean age of 33 and standard deviation of 6.9969. As for the years of experience, the respondents have experience ranging from 1 year to 50 years with average of 4.7083 and standard deviation of 5.6065. The diversity in age and years of experience is important to capture a bigger picture of ATCO insight to air traffic, task demand and workload, with less experienced controller might have a different view with a more experienced controller.

The interview question ranges from direct information gathering questions (10 questions) to questions that requires 10-point Likert scale information to determine weighting coefficients (4 questions with two to three components each). By using a 10-point Likert scale, a rating from 1 (very less importance) to 10 (very highly importance) shall be assigned to each question based on subjective opinion of ATCO. It is hoped that by using a 10-point scale, it would provide us with better opportunity to detect smaller changes in rating values.

3. Results and Discussion

Based on the interview sessions, the result was gathered and clustered into 4 categories. The categories are ATCO input on sector complexity, traffic condition, perceived workload and general opinion. These will be discussed in the subsequent sections.

3.1. Sector Complexity

Manning & Pfleiderer in their research has stated that sector complexity is associated with and not limited to aircraft movement, aircraft mix, presence of severe weather, amount of coordination required, or frequency congestion [9]. These characteristics are specific to each airspace or sector. Thus we need firsthand information in order to understand what makes a sector more difficult that others from ATCO point of view.

Based on comments gathered from the interview, Sector 4 was rated as the most challenging sector (37%) due to its location that serves the oceanic part of KLFIR. Due to its location and limited radar coverage, controller needs a bigger minimum safe separation between aircraft that is 10 minutes lateral separation with no closing speed [10] compared to 5 nautical miles (NM) lateral separation in other sector with surveillance control [11] and 30 NM and 40 NM in trail with no closing speed as agreed between adjacent FIRs [10]. Consequently, the respondent find it more challenging to manage traffic in Sector 4 compared to other sector. The respondent also highlighted other factors such as the sector size, multiple crossing routes and also traffic deviation due to weather as contributor to the sector difficulty.

Sector 2 and 5 on the other hand were seen as difficult in 24% and 17% of the response, respectively because of its small sector size and short routes for Sector 2 and large size and long routes for

Sector 5. The respondent feels that, the small sector size for Sector 2, would mean that the controller needs to work and respond very fast when the traffic is high.

Unlike other sectors, Sector 1 was rated as difficult in 13% of the response because it is busy with domestic flights with the sector comprises of 6 airports, namely Kuala Lumpur International / Sepang Airport, Subang / Sultan Abdul Aziz Shah Airport, Ipoh Airport, Penang Airport, Alor Setar Airport and Langkawi Airport. This would also mean that the movement between these airports would be monitored only by controller assigned to Sector 1. Based on real traffic movement gathered from the Department of Civil Aviation (DCA), on the 1st January 2017, almost 20% of total traffic in KLFIR is Domestic Flight with 100% of the flights originating or flying to the airport in Sector 1 and 53% of the traffic are flights between the 6 airports in Sector 1. Thus, this scenario supports controller claims that Sector 1 is difficult due to the high number of domestic flights.

It is also interesting to see the relationship between the years of experience versus the number of sector rated as difficult. Based on the findings, it is gathered that the years of experienced have a weak positive correlation with the number of sector rated as difficult using Pearson Correlation Coefficient (0.4928). This can be seen in Figure 2 where a certain peak in years of experience can also be seen together with a peak in the number of sector rated as difficult. This can be due to more experienced controller having more experience in dealing with different sectors.

Fig 2: Years of experienced and number of sector rated as difficult

3.2. Traffic Condition

In the traffic condition we wanted to gauge the optimum number of aircraft that an ATCO can manage with regard to safety and situation awareness. Based on the input from the respondent we found that 62% of the respondent feels that the maximum comfortable number of aircraft in 5 minutes is less than 10 aircraft. 38% of the respondent feels that they can manage up until 20 aircraft at a time. Table 1 summarizes the real traffic movement data gathered from the DCA, on the 1st January 2017. The number of aircraft is based on the number of aircraft that passes the respective sector (counted as 1), whereas the number of reporting points is based on the total number of waypoint for each flying aircraft. The data on the reporting point per aircraft was gathered either through communication with controller or based on data that were automatically captured by radar. This data is important as it can better represent the amount of time each aircraft is present in a sector.

Based on the data, the maximum number of aircraft can reached up to 8 aircraft for Sector 2. This together with the fact that Sector 2 was one of the smallest sector will definitely increase ATCO taskload at that given timeframe. However, based on the amount of time each aircraft spent in each sector as shown in Table 1, the maximum number of aircraft per sector is actually much higher. For example, each aircraft spent an average time of 7 minutes and a maximum time of 48 minutes in Sector 2. Thus, the within the next 5 minutes time frame, the same aircraft can still be present in the sector but will not be accounted for. Further analysis on the data based on time stamp per reporting point is needed in order to capture the real number of aircraft per sector.

The second highest aircraft movement is for Sector 1 and 6 with a maximum of 7 aircraft in 5 minutes interval. For Sector 1, each aircraft spent an average time of 11 minutes and a maximum time of 61 minutes in the sector. For Sector 6, each aircraft spent an average time of 11 minutes and a maximum time of 56 minutes in the sector. Sector 4, being the largest sector have the highest duration an aircraft was in the sector, which was 65 minutes. It also have the highest average duration of 19 minutes. This clearly validate the difficulty rating reported by the controller.

Table 1: Traffic movement and communication for 1st January 2017

	S1	S2	S3	S4	S5	S6
Total number of reporting points	1761	1758	1104	767	1148	1008
Number of aircraft	590	582	492	193	359	357
Mean*	2	2	2	1	1	1
Min	0	0	0	0	0	0
Max	7	8	6	4	6	7
Average duration in sector	7	11	3	19	12	11
Longest duration in sector	61	48	33	65	41	56

*rounded values

Figure 3 shows the traffic movement analysis, highlighting the number of aircraft movement per sector basis. Based on Figure 3, we can see the pattern throughout the day when traffic was busier, that is between 12.00 am to 4.00 pm and also when traffic was calmer for almost all sector, that is between 5.00 pm to 9.00 pm. Also, based on the response, all respondent agreed that they are not being informed on the expected number of movement per day / hour and they also feel that the number of peak traffic hour is increasing. The combination of high traffic together with an incorrect expectation of traffic pattern will actually result in a higher workload experienced by controller than it supposed to be.

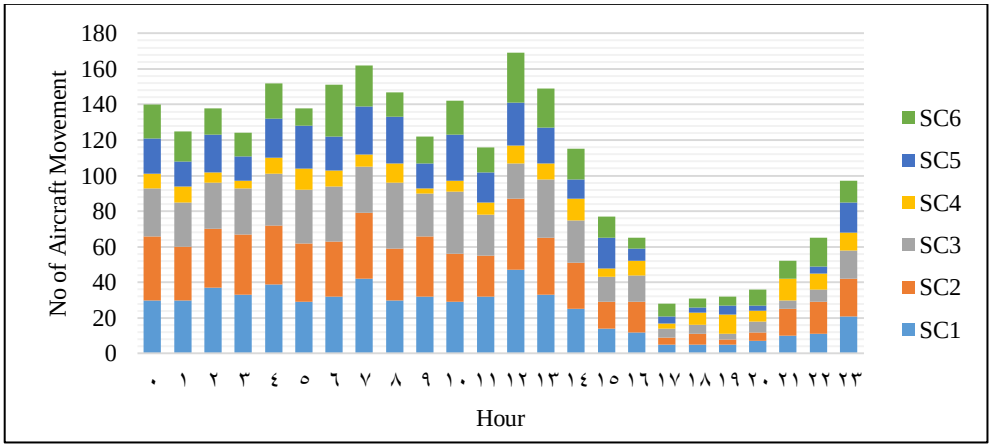

Fig 3: Number of aircraft movement per sector

The number of movement is also confirmed by the respondent response when asked to rate the level of traffic as in Figure 4. However, only 14 out of 24 respondent answer this section properly. The respondent were asked to rate the level of traffic between, low (1), moderate (2), high (3) and very high (4). Based on the response, we can observed that respondent feels that the level of traffic was the highest where it was rated averagely as high (3) during the night and lowest, where it was rated averagely as moderate (2) during the afternoon. This correlates well with the number of movement analysis performed and presented in Figure 3.

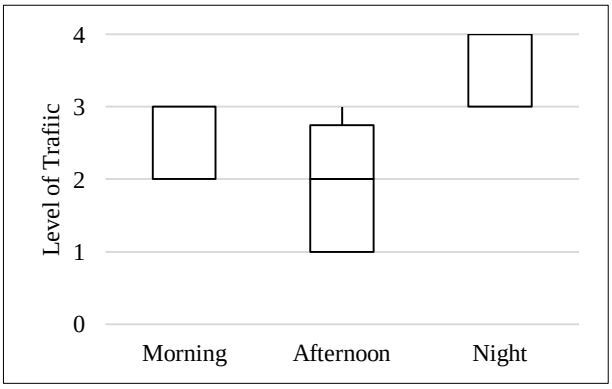

Fig 4: Level of Traffic

3.3. Perceived Workload

The respondents were also ask to rate the level of difficulties during coordination between our military unit, adjacent Area Control Centre (ACC) unit and also different unit within our ACC. Based on the response data as shown in Figure 5, the least difficult task perceived to them was coordinating traffic with different unit in KLFIR ACC. However, coordination with adjacent ACC unit was seen to be the most difficult (rated as 5 based on the 10-point Likert scale) compared to the other coordination task, where on average they rated difficulty level to coordinate with our own military unit as 5 and between different unit in our ACC as 2.

The respondent were also queried regarding the frequency and the level of workload when pilot requested change in FL, or change in routing, or coordination due to weather deviation. This is presented in Figure 6 and 7, respectively. Based on the response, it can be seen that even though the frequency of coordinating traffic due to weather deviation were the least (rated as 4 based on the 10-point Likert scale), the task itself contribute the highest workload (rated as 7 based on the 10-point Likert scale) compared to other coordination task.

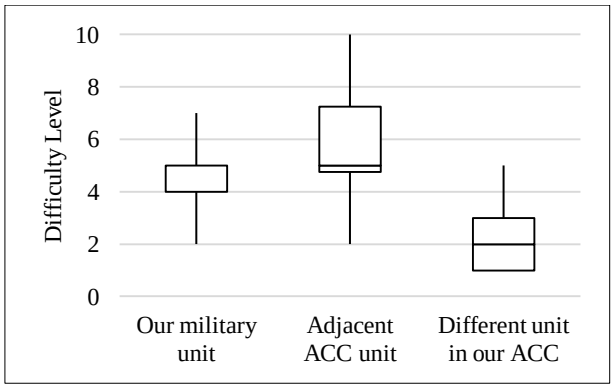

Fig 5: Difficulties in Coordinating Traffic

On the contrary, directing route is seen as one of the most frequent task, which was rated as 7 based on the 10-point Likert scale but contribute the least to the increase of ATCO workload with rating of 4 based on the 10-point Likert scale. This shows that the amount of work that needed to be done does not constitute to the level of workload imposed to the ATCO. However, the difficulty in coordinating the task due to external circumstances could also influences how we see work.

For example with weather deviation, coordinating traffic through safe airways needs a higher cognitive level as one would need to solve the coordination problem within a limited available area or areas that is not affected by weather condition. However, directing aircraft to a certain predefined routing needs a lower cognitive level as the routing is not restricted but careful consideration is still needed to ensure the safety of the aircraft.

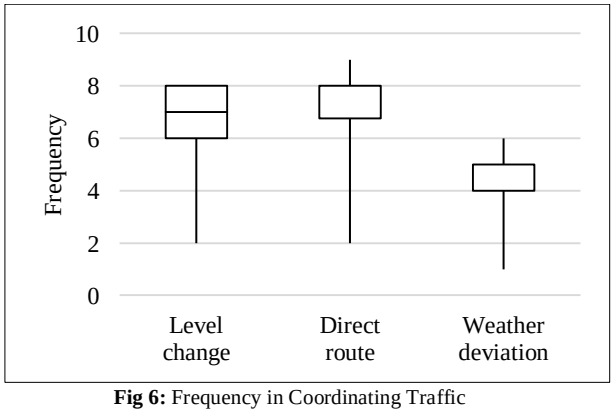

Fig 6: Frequency in Coordinating Traffic

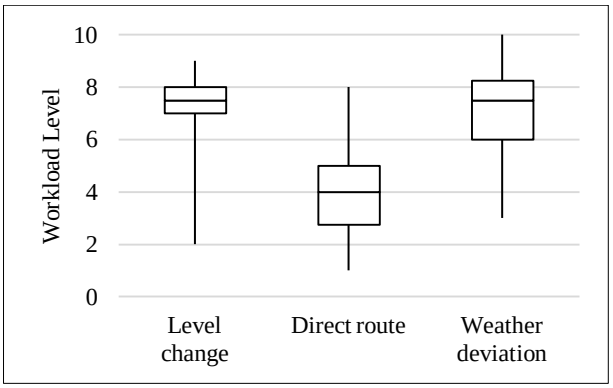

Fig 7: Workload in Coordinating Traffic

3.4. General Opinion

Respondent were also inquired on other work related question such as on pilot compliance to instructions, traffic rescheduling and also on the system used at the KLATCC. Based on the response, 46% of the respondent claimed that pilot does not always comply with instruction. Another 12% responded with a conditional no with comments that pilot either want to avoid complying with instruction or pilot try not to comply with instructions. The remaining 42% responded that pilot either comply (21%) or try to comply (21%) to controller instruction. This scenario also demonstrate the dynamics of ATCO taskload, where pilot compliance to instruction is important to ensure safety of air traffic.

To understand the dynamics of controller to controller communication, the interview also inquire about the frequency of neighbouring FIR units to release aircraft using No Pre-Departure Coordination (PDC) level without spacing. The respondent were asked to rate between 1 (Never) to 10 (Always). Figure 8 shows that 42% (10 respondent) say that it never happens but 58% of the respondent response differently. 29% (7 respondent) reported that it happens moderately by rating 5 out of 10. This shows the level of concern of ATCO with regards to controller-to-controller communication that needs to be continuously improve in order to ensure safety and efficiency of traffic flow.

When asked on their opinion on traffic rescheduling, 92% of the respondent think that flying time should be reschedule. 76% of the total respondent agreed that rescheduling traffic is necessary in order to avoid congestion, and the remaining 24% feels that rescheduling is needed to reduce controller workload.

It is also gathered from the interview session the view of respondent of the current system/ software, whether it serves as a mediator that helps them ease their task load. Based on their response, 67% stated that the system either ease their taskload (38%) or it did help but still need improvement (29%). The remaining 33% did not agree that the system help ease their workload with one respondent suggesting that the system/ software still needs improvement.

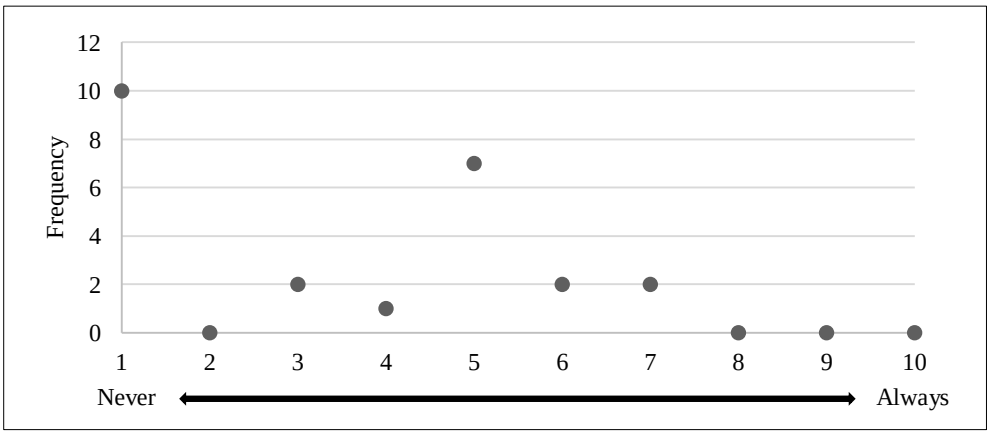

Fig 8: Frequency of neighbouring FIR units to release aircraft using No Pre-Departure Coordination (PDC) level without spacing

4. Conclusion

Increasing air traffic movement in KLFIR sectors demands for a better understanding of our air traffic movement environment as well as our ATCO welfare and mental health. This research is looking at the understanding of how our KLATCC ATCO currently perceiving air traffic and taskload.

Based on interview sessions with 24 active en route controller working at KLATCC, it was found that there were certain sector/ area that was considered more difficult than others. For example, Sector 4 was rated as the most difficult sector based on the fact that it is an oceanic sector and requires more separation compared to other sectors. On the other hand, Sector 2 was perceived as difficult because of its small size and short routes, whereas Sector 5 was perceived as difficult because of its large size and longer routes. Unlike other sectors, Sector 1 was rated as difficult because it was busy with domestic flights with the sector comprises of 6 airports. By looking at the different sector characteristic that is deemed difficult by respondents, it is important that each contributing characteristic and its effect on controller task demand is investigated in the future.

The interview also looked at how ATCO perceives coordination tasks. It was found that some coordination task was seen as more demanding than others, irrespective of its frequency. For example coordination due to weather deviation was rated as the least frequent coordination task but rated as the most difficult task compared to level and routing change by the respondents.

Another criteria that was highlighted by the respondent was coordination between military unit, different unit in our ACC and adjacent ACC unit or neighbouring FIR. Looking at the results, it can be seen that coordination with adjacent ACC unit or neighbouring FIR is regarded as the most difficult task compared to coordination within our own unit (military or different unit in our ACC).

By looking at the response, the characteristic whereby a sector is considered difficult is vast. It is hoped that by using the structured input from ATCO, an optimum taskload can be allotted in the future to ensure a more effective working condition designed for ATCO.

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