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The relationship among working period, work shift, and workload to work fatigue in air traffic controllers at Sultan Hasanuddin Airport☆

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ABSTRACT

Objective: This study aims to determine the relationship among working period, work shift, and workload with work fatigue in the ATCs at Sultan Hasanuddin Airport, Makassar.
Methods: This research is an analytic observational study with a cross sectional design. A sample of 65 people was obtained by purposive random sampling. The mental workload was assessed by NASA TLX, whereas work fatigue was assessed by the KAUPK2 questionnaires.
Result: The results showed that out of 65 samples, 28 (43.1%) of them experienced work fatigue. It was found that there was no significant relationship between working period with work fatigue ($p = 0.055 > 0.05$). Furthermore, there is a significant relationship between work shift with work fatigue ($p = 0.015 < 0.05$) as well as workload and work fatigue ($p = 0.021 < 0.05$).
Conclusion: It is concluded that there is no significant relationship between working period and work fatigue, while work shift, and workload have a significant relationship with work fatigue in ATCs at Sultan Hasanuddin Airport Makassar.

Background

An air traffic controller (ATC) has an important role in controlling aircraft travel activities. Starting from take-off, setting the route that is traversed, weather information, visibility, wind direction, air pressure temperature, information on the whereabouts of aircraft that are on the air which is monitored via radar. In addition, controlling the landing of the landing aircraft is through giving signals to pilots, to the establishment of an aircraft parking lot or apron.[1] Another task of an ATC is to create an orderly and smooth flow of air traffic, in addition to providing the information needed by pilots. They are required to provide the best service with a guarantee of a high level of safety.[2]

Working as an ATC requires optimal concentration, constantly dealing with the monitor screen leads to a high level of saturation. In addition, heavy psychological pressure is due to having to be responsible for guiding and monitoring hundreds or even thousands of aircraft carrying thousands to millions of people.[3]

Based on data disclosed by the International Air Transport Association (IATA), the number of requests for civil aviation continues to increase. More than seven billion passengers are estimated for 2035. This is due to an increase in the average number of passengers per year by about 4.1%.[4]

Fatigue on the ATC can be caused by, among others, excessive workload, work shifts, extreme working conditions (high-tech machines, isolated space, cold temperatures, and tight flight schedules). Excessive workload will cause work stress.[3] Thus, the research conducted on the ATC is mostly focused on psychological fatigue caused by work shifts, schedules, workloads, task time, and also on factors of resistance and vulnerability to fatigue itself.[5]

Sultan Hasanuddin International Airport is one of the busiest airports in Indonesia. Based on data from Flighradar24.com, the total number of flights at Sultan Hasanuddin Makassar airport reaches 969 flights per week. This certainly has an impact on the ATC who acts as an aircraft traffic guide. The tighter the flight schedule, the more responsibility, and workload of the ATC. This has an impact on the mental burden and fatigue felt by ATC in the Sultan Hasanuddin International Airport Makassar. The purpose of this study was to determine the relationship between work period, work shift, and workload on work fatigue at the Sultan Hasanuddin International Airport ATC in Makassar.

Methods

Research location and design

This research was conducted at Sultan Hasanuddin International Airport Makassar. This research is an analytic observational with the cross-sectional study.

Population and sample

The population of this study was 184 ATCs at Sultan Hasanuddin International Airport, Makassar. The sample was collected by using the Slovin formula, obtaining as many as 65 people with purposive sampling techniques.

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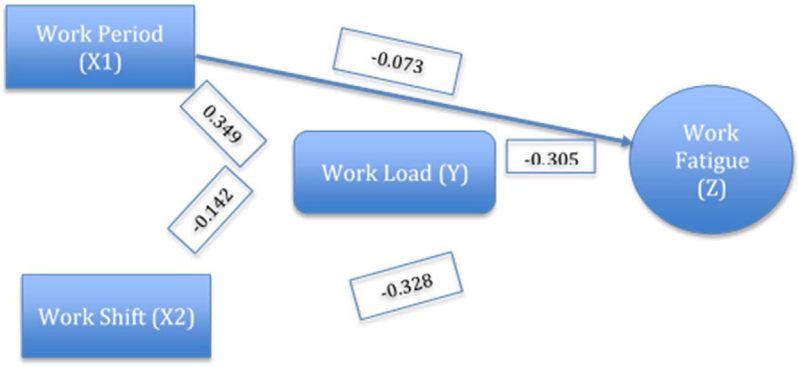

Fig. 1. The multivariate analysis based on the path analysis.

Table 1
Frequency distribution of work period, work shifts, workload and work fatigue on ATCs at Sultan Hasanuddin International Airport, Makassar.

Variable	Categories	Frequency	Percentage (%)
Work period	≤6 year	40	61.5
	>6 year	25	38.5
	Total	65	100
Work shift	Night	13	20.0
	Day	52	80.0
	Total	65	100
Work load	Heavy	37	56.9
	Light	28	43.1
	Total	65	100
Work fatigue	Yes	28	43.1
	No	37	56.9
	Total	65	100

Source: Primary Data, 2020.

Data collection method

The data were collected through questionnaires, particularly on work periods, work shifts, mental workload. These characteristics were assessed using the NASA TLX questionnaire and fatigue with KAUPK2 on the ATCs.

Data analysis

Data were analyzed by univariate, bivariate, and multivariate using SPSS for Windows 25 for frequency distribution. In addition, the relationship between the dependent variable and the independent variables were tested by chi-square and pathway analysis.

Results

The frequency distribution in Table 1 shows that out of the 65, ATCs who experienced fatigue there were 28 (43.1%), and those who did not experience fatigue amounted to 37 people (56.9%). Based on the working period, respondents who had a new tenure status (≤6 years) were as many as 40 people (61.5%), while there were 25 (38.5%) respondents who had a long tenure status (>6 years). Furthermore, there were 13 ATCs who worked night shifts (20.0%), and 52 people (80.0%) work in the day shift. Finally, 37 respondents (56.9%) who have a heavy workload, and 28 people (43.1%) had a light workload.

The bivariate analysis in Table 2 shows the relationship between the work period and work fatigue. Respondents with a tenure status of more than 6 years that experienced fatigue amounted to 15 people (60.0%), while respondents whose tenure status of fewer than 6 years and experienced fatigue were as many as 13 people (32.5%). The statistical test results using the Chi-square test obtained a value ($p = 0.055 > 0.05$), which indicates that there is no significant relationship between a work period and work fatigue on the ATCs working at the Sultan Hasanuddin International Airport Makassar.

Table 2
The relationship between work period and work fatigue in ATCs at Sultan Hasanuddin International Airport, Makassar.

Working period	Work fatigue				Total		Statistical test
	Yes		No				
	n	%	*n*	%	*N*	%	
≤6 year	13	32.5	27	67.5	40	100	$p = 0.055$
>6 year	15	60.0	10	40.0	25	100	
Total	28		37		65		

Source: Primary Data, 2020.

Table 3
The relationship between work shift and work fatigue at air traffic controller operators at Sultan Hasanuddin International Airport, Makassar.

Work shift	Work fatigue				Total		Statistical test
	Yes		No				
	n	%	*n*	%	*N*	%	
Night shift	10	76.9	3	23.1	13	100	$p = 0.015$
Day shift	18	34.6	34	65.4	52	100	
Total	28		37		65		

Source: Primary Data, 2020.

Table 4
The relationship between workload and work fatigue at air traffic controller operators at Sultan Hasanuddin International Airport, Makassar.

Work load	Work fatigue				Total		Statistical test
	Yes		No				
	n	%	*n*	%	*N*	%	
Heavy	21	56.8	16	43.2	37	100	$p = 0.021$
Light	7	25.0	21	75.0	28	100	
Total	28		37		65		

Source: Primary Data, 2020.

Furthermore, the bivariate analysis in Table 3 shows the relationship between work shifts and work fatigue. Respondents who experience work fatigue with night work shifts were as many as 10 people (76.9%), while those who experience fatigue with day shifts were 18 people (34.6%). The results of statistical tests with Chi-Square obtained a value ($p = 0.015 < 0.05$), this shows that there is a significant relationship between work shifts and work fatigue on the ATCs working at the Sultan Hasanuddin International Airport Makassar.

Table 4 shows the relationship between workload and work fatigue. Respondents with a heavy workload who experience fatigue were 21 people (56.8%), while respondents with light

workload who experience fatigue were 7 people (25.0%). The results of statistical analysis with Chi-square obtained a value ($p = 0.021 < 0.05$), this indicates that there is a significant relationship between workload and work fatigue on the ATCs working at the Sultan Hasanuddin International Airport Makassar.

The multivariate analysis based on the path analysis Fig. 1 shows that the direct effect of the working period variable on work fatigue is −0.073, which is less than the indirect effect (0.349–0.305 = 0.044) so that the inference taken from the effect of work period on work fatigue will be greater if it is through workload, so that the workload here functions as an intervening variable. The direct effect of the work shift variable on work fatigue is −0.328, which is less than the indirect effect (−0.142–0.305 = −0.447) in absolute form so that the inference taken from the effect of work shift on work fatigue will be greater if it is through workload, so that the workload functions as an intervening variable.

Discussion

This study shows that the work period (tenure) does not have a significant relationship with work fatigue on the ATCs at the Sultan Hasanuddin International Airport Makassar. The results of this study are in line with the research put forward by Jati et al.[6] regarding "The Effects of Individual Characteristics and Work Attitudes on ATC Fatigue at the Airport". It can be assumed that an adaptation process can have a good impact on which personnel will understand the job description so that it can reduce activities that are deemed less effective and efficient. In addition, the adaptation process can reduce tension so that it can increase work activity and productivity.

A different study was also put forward by Russeng and Saleh (2019), their results showed that the work period can affect workers both positively and negatively.[7] A positive effect occurs if the longer a worker works, the more experienced he will be in doing his job. Conversely, a negative effect occurs if the longer a worker works, it will cause fatigue and boredom, especially with monotonous and repetitive work activities.[8]

The results of this study also show that work shifts have a significant relationship with work fatigue on ATCs at Sultan Hasanuddin International Airport Makassar. The same results are also found in research conducted by Wang and Ke (2013) that the shift work system in ATCs has a relationship with a high prevalence of fatigue. Data analysis using the Chi-square test shows that the work period (tenure) has a relationship with fatigue. Work that is carried out continuously or for a long time will affect the mechanisms in the body (circulatory system, digestion, muscles, nerves, and breathing).[9] The tenure of service can affect workers both positively and negatively.

The results of this study also show that work shifts have a significant relationship with work fatigue on the ATCs at Sultan Hasanuddin International Airport Makassar. The same results are also found in research conducted by Wang and Ke (2013) that the shift work system at ATC has a relationship with a high prevalence of fatigue. In this study, work fatigue was mostly experienced by ATCs who worked on night shifts. This is because working on night shifts disrupts circadian rhythms, that is, at night the body should have time to rest, so there is a tendency to increase the risk of experiencing fatigue.[10] According to Suma'mur,[11] workers who work at night will experience a greater level of fatigue than workers who work in the morning or during the day, this is due to the number of hours of sleep/rest during the day the night shift workers get is relatively much smaller. In this study, there were 3 ATCs, all of whom were male, who worked on night shifts who did not experience fatigue with a work period of more than 6 years. It was assumed that the respective ATCs had adapted to their jobs well and because of the gender factor, those ATC are assumed to have good stamina in performing control.

Costa (2010) in Sharfina[10] stated that workers with day shifts are workers with the lowest risk of experiencing fatigue, in this case they do not experience sleep deprivation because work time is during the day unless the shift is completed late at night or the worker must take long trips home, delaying their bedtime.

The results of data analysis using the Chi-square test found that there was a significant relationship between work fatigue on ATCs at Sultan Hasanuddin International Airport Makassar. The same results are also found in research put forward by Dewi (2013) that excessive workload or less can cause work-related disorders or diseases. The excessive workload can cause both physical and mental fatigue and emotional reactions such as headaches, indigestion, and irritability. Meanwhile, the workload which is less but monotonous or repetitive movements will cause boredom. More work fatigue is experienced by respondents who have a heavy workload. This is due to the fact that the ATC profession requires concentration, calculation, estimation, and a good imagination. In addition, ATCs must process the information they obtained quickly and precisely and make the right decisions to prevent accidents from occurring. In this case, it can be concluded that the ATCs must always have a high concentration and must be able to make calculations, predict and imagine the aircraft they control.[12] The direct effect of the work shift variable on work fatigue is −0.328, which is less than the indirect effect (−0.142–0.305 = −0.447). Thus, the inference taken from the effect of work shift on work fatigue will be greater if it is through workload so that the workload functions as an intervening variable.

ATCs who have new and old tenure status (short/long work period) have the same duties. After analyzing this study, it was found that the respondents who experienced the most fatigue were the ones who had a long work period (more than 6 years) and in this study, the ATCs who had a long work period mostly had a heavy work burden. This study is in line with what was stated by Russeng and Saleh[7] that a work that is carried out continuously for a long time will affect the mechanisms in the body.

The workload in this study as an intervening variable that strengthens the relationship between a work period and work fatigue. This is because ATCs are required to have a high concentration in regulating, supervising, and controlling aircraft so that supervised flights can avoid accidents on the ground and in the air, coupled with isolated situations and environments.[13]

Work shifts have a direct effect on work fatigue, but a greater effect on work fatigue on ATCs at Sultan Hasanuddin International Airport Makassar is observed when it is through the workload. This is in accordance with the research conducted by Tarwaka and Bakri[14] that one of the factors that influence workload is work organization, such as length of time of working, rest time, work shift, night work shift, wage system, organizational structure model, and delegation of tasks and authority. Work shift can disrupt Cyrcardian rhythms.[14] Cyrcardian rhythms have a role in regulating sleep, readiness to work, autonomic processes, metabolism, body temperature, heart rate, and blood pressure.[15] In addition, the workload has an effect on work fatigue due to fact that the workload of the air traffic control operator is quite complex. It involves safety in flight traffic, and the ATC profession requires concentration, calculation, estimation, a and good imagination, and ATCS are required to have speed and accuracy to process the information they obtain and make the right decisions so that accidents do not occur.[12]

Conclusions

Work period/tenure does not have a significant relationship to work fatigue on the air traffic controller (ATC) and work shifts and workloads have a significant relationship with work fatigue on ATCs

at Sultan Hasanuddin International Airport Makassar. Moreover, ATCs' work period and work shifts have an effect on work fatigue through their workload. It is suggested that the management of the ATCs to monitor the level of fatigue experienced by the ATC so that further fatigue can be avoided. In addition, ATCs are advised to regulate and maintain the diet and intake of nutrients consumed, to take advantage of good rest time between shifts so as to prevent the occurrence of fatigue.

Conflicts of interest

The authors declare no conflict of interest.

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