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Performance Perception of Turkish Air Traffic Controllers

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Abstract

The importance of air traffic management and the role of air traffic controller has been increasing in air transportation. This study focuces on the job performance of the air traffic controllers which affects all aviation system safety, efficiency and collected data on the controller thoughts about performance perception by giving a questionnaire. Advanced future air traffic management performance can be achieved by the qualified controllers and their high level performance. The statements on performance were scored by the controllers who are working at 5 major Turkish airports. Analysis results indicate that, controller perception on their performance significantly were found different depending on the age, experience, school, unit, working position, rate and airport variables.

Keywords: Air Traffic Management, Controller Performance, Human Factors.

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1. Introduction

Performance improvement studies are accelerating in aviation in addition to the improvements with advanced information systems and technologies. The structure of tasks can be seen exchanging from physically to mentally in the aviation system. Reaching and maintaining safe, efficient and productive objectives in other words improving performance in aviation system depend on accordance, reliability and quality of human operators and technical systems cooperation (Jorna, 2000). Pilots need a great many of technical personnel and technical aids and air traffic controllers in term of air navigaiton to complete their flighst safely and efficiently. This is because airplanes are fast, precise and air traffic is becoming more complex.

The improvement of production and information technologies in air transportation is building up demand for transportation of human and goods. Therefore air traffic rates are increasing with each passing day. Capacity and efficiency are most important factors for reaching advanced air traffic control operations (Stroeve and colleagues, 2003). Capacity increasing studies are bringing up the safety issues. This stuation is emanated from adverse interaction of implied safety rules and capacity raising issues. As a resolution for increasing air traffic, capacity improvement studies are undertaken without detriment to safety in air traffic management (ATM). And this is giving rise to the increasing importance and impact of ATM in aviation system.

The objective of ATM, as a complex net with both air and ground based systems, is performing safe, fast, economical and orderly of air traffic flow in every flight phases (EATCHIP, 1996). Performed communication, navigation and survaillance operations with this objective are dynamic and integrated with interaction of ATM manpower interactions (Miallier, 2000). ATM is advancing dynamically in full acceptation of the word. As a system providing both flow management and seperation service, ATM is interacting with all aviation systems and evolving quite complicated (Smolensky and Stein, 1998).

The errors and incidents occured in aviation environment are coming true with human behaviour, organisational dyamics, individual differences and systems design (FAA, 2005). Errors are performed conscious or unconscious. In this context, error is an act resulting an accident/incident injury, fatality or disabilitiy of individuals. Human error is generally connected to structure of the task, while at the same time fatigue, lack of sleep, ability, information and motivation play important roles (Isaac and Ruitenberg, 1999). The researches show clearly that human error is most important factor in realized incidents and accidents in ATM. It is emphasized that human error rate is over 90%. ATM's rate is quite lower in all aviation incidents and accidents (Isaac and colleagues, 2002). However, the results of incidients and accidents can be found disastrous in ATM.

2. The Task of Air Traffic Controllers

At the present day, the most important part of ATM is air traffic controller. Controllers basicly, resposible for the aircraft flight which starts and ends between a specified points and their safety without any collision with other aircraft and obstacles by executing vertical and

horizontal seperation minimas (Turhan and Usanmaz, 2004). Controllers are composing a 3D mental picture with time dimension covering aircraft actions and positions by using their animation ability. They are continuously trying to maintain this mental picture and giving requried clearences to the aircraft (Kirvan, 2001).

Different air traffic control positions andflight phases, used aids contain different cognitive tasks in term of required time usage (Xu and Rantanen, 2003). Main part of controller task is cognitive and depends on mental processes. Related to aircraft maneouvers in a specified area and time, cognitive abilities consist judgement, definition, maintaining situtation awareness, planning, rapid and correct decision making and advenced verbal communication. According to Wickens, the requried mental and perceptual abilities for air traffic control profession are advanced spatial, verbal and numerical resoning ability, selective attention and perceptual speed, short and long term memory, time sharing and phychomotor abilities (Wickens and colleagues, 1997).

The mental image of controller's task is becoming more important in changing and advancing aviation environment. Situation awareness of controllers can be identified as constant attention to the environmental information, integration of this information with previous information for creating mental picture of traffic situation and using this picture for future situations. Controllers are making decisions for control actions and maintaining situation awareness. Generally human mental capacity depends on creating clear, three or four dimension picture of airspace and aircraft with audial and visual datas (EATCHIP, 1996).

Controllers normally can perform controlling of great number of aircraft without big troubles (Isaac and colleagues, 2002). Identificaton task of the traffic conflictions requires using all resources of controllers. In the situations when controllers could not maintain seperation minimas between aircraft can occur airmiss and collision (Xu and Rantanen, 2003). When controllers are doing their job, errors and other reasons can lead life and capital loss. Despite of this fact, controllers must try to maintain their calmless because of the other traffics expecting service. This occasion is the most difficult side of the job.

Controllers should be requried to provide clear and understandable communication and coordination with pilots and other controllers. Moreover, in the controlling of air traffic safely, professionalism, acquiring appropriate qualifications to the job and high responsibility are same of the other important issues. As a consequence, selection and training of controller candidates are vital issues (Durucic and colleagues, 2003).

3. Air Traffic Controller Performance

The performance of controller can directly affect the ATM and aviation systems. Minor errors that are made by the controller can create negative impacts. Therefore, safety management and human factors studies are focused on decrease those errors and risks to the lower rates in the system. Human factors are positioned in the center of these activities. Performance of the controller who is the most efficient human factor in the system should be maintained apropriate level and improved. Since efficiency is one of the other important issues in controller performance, negative impacts are not only resulted from errors. To

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illustrate, some controllers could not correspond working capacity and technical expectations and this situation can cause some delays and general efficiency loss in ATM. In radar control environment, errors about headings cleared to the planes and aproach sequence of traffics can cost time and capital. And essential all traffics are affected by this complications. Particularly in peak traffic periods, individual job performance level of controllers affects whole system.

In aviation where time and costs are vital, decreases in controller performance can give rise negative impacts. On the other hand, performance of the controllers who are working same unit and neigbour sectors are expected very similar to each other. In contrast, performance of the controllers affect other's performance negatively since high level teamwork and interpersonel interaction are required in working environment. On trying to provide beneficial controller performance level, new technologies and otomation tools are improved. In the same way new technologies are helping to solve capacity problems. Hence research and development studies are becoming more important.

3.1. Factors Affecting Controller Performance

Controller performance comprises quantitive and qualitative tasks which are expected is how performed by the controllers. Working performance of an individual is affected by many factors. These can be listed as individual differences, information processing, organisational climate, communication and teamwork, otomation and workplace design, selection and training, stres and workload (Turhan, 2001). The figure below shows that relations between these factors.

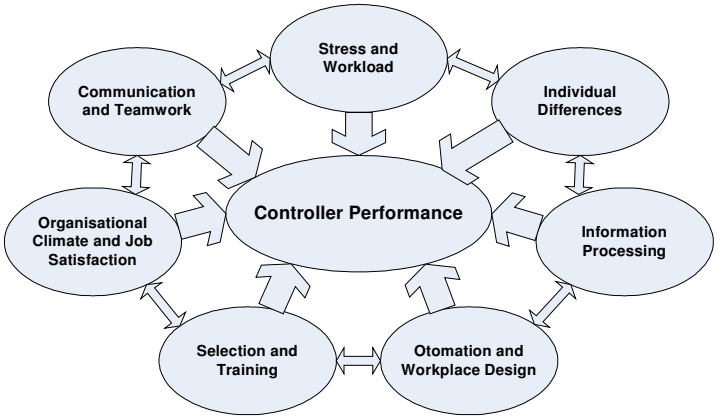

Figure 1: Factors that is affecting performance of controllers.

3.1.1. Individual Differences

Differences between individuals cause differences about working performance. These differences should be considered in selection process of new controller candidates (Smolensky and colleagues, 1998). Abilities and cognitive style of individuals should meet air traffic control job requirements. Learning ability, memory capacity can create important differences when performing difficult tasks. Training and practicing can not play role for improving this qualification (Cardosi and Murfy, 1996). Individuals should have multitasking

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ability. In term of personality, characteristics such as to be anxiety, nervous or to be excited can result negative impacts on job performance. Age and job experience have direct proportion. The important point for a controller is having sufficient experience with no any negative age impacts. In aviation, when the appropriate individuals are selected, there is no differences in term of gender (Turhan, 2001).

3.1.2. Information Processing

Human processes great amount of information as input supplied from environment. First of all human percepts stimulus by senses then perceptions are interpreted with attention and memory capacity, and finally human makes a decision for an action. There are many sitimulus around controllers. They should choose some and make a decision rapidly then they should execute a solution (Isaac and Ruitenberg, 1999). Information processing is affected by work and social environment around human. For this reason, workplace design should be improved for supporting information processing quality.

3.1.3. Organisational Climate and Job Satisfaction

Controller performance can be affected by managerial hierarchy, carirer issues, working conditions, rewarding system and meeting expectations. Motivating organisational climate is a supporting factor for the job satisfaction. When the controllers are coming to the job, they should feel satisfied for focusing to the work. International standarts should be supplied by the employer organisations. Otherwise problems could occur on board and performance decrease could be observed.

3.1.4. Communication and Teamwork

Communication and teamwork activities are in the center of controller's operations in the job. They communicate with the pilots, the controller and aviation staff. Communication errors or lack of teamwork performance can create negative impacts on their job performance. All members should behave together for ATM system objectives and support performance of each other performance. As a individual, communication and teamwork abilities are vital for the controller performance.

3.1.5. Otomation and Workplace Design

In ATM environment, otomation is expected to improve workload issues and capacity. The essential point is controllers trust to the otomated tools. If the controllers trust the otomation they can focus on the task and improve performance. It should also be emhasized that workplace design must be human centered to support job performance of the controllers. All systems which are used by the controllers should be designed compatible with the huma physical and mental structure (Cardosi and Murfy, 1996).

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3.1.6. Stress and Workload

Controllers perceive stress as a part of their job. However, the time period in which they percieve higher and lower workload, their error posibilities could increase. Stress and workload intensity create similar effects on controllers performance. Higher workload means higher stress. In contrast lower workload means lack motivation. It can be said that a beneficial stres and workload level can support controllers motivation and their job performance.

3.1.7. Selection and Training

Candidates who have appropriate abilities, motivated to the air traffic control profession and aviation culture should be atracted to selection process. After selecting qualified candidates, training phase is another determining period for controller on the job performance, since selection and training costs are too high in aviation. Well selected and trained candidates will show higher job performance in ATM system (Goeters, 1998). In this in turn means that selection and training have vital role in organisational performance (EATCHIP, 1998)

When all these factors come together above can also create differences on controller job performance. To illustrate, a person who has anxious character structure can loose job motivation, in contrast a person who is experienced on the job can easily manage the emergency situations.

4. Job Performance Perception of Turkish Controllers

In this research, a questionare study was implemented in an effort to have job performance perceptions of Turkish air traffic controllers who are working busiest air traffic control centers and airports of Turkey in 2007.

4.1. Research Environment

The research environment is composed from air traffic controllers who are working in the 5 busisest and biggest airports owned by the Turkish Air Navigation Service Provider (DHMI). This environment is unique about traffic density and complexity in Turkey. These airports are Ataturk, Esenboga, Adnan Menderes, Antalya and Dalaman airports. All air traffic service units are active in these airports. The task of controllers is difficult and complex when compared to the other units. Their job requires shiftwork in 24 hours schedule. The DHMI reported that 468 controllers were working that time in these centers. This quantity is important regarding to the controller population which is 650 active controllers. It is also important to have that their feelings and perceptions are very beneficial. These 468 controller are making up the research environment. Since environment is not too large, decided that sampling is not needed. The questionares from 261 controllers were implemented and excepted as research environment in this study.

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4.2. Measurement Tool and Data Analysis

The questionare is composed from questions about general variables such as age, gender, graduated school, working position, unit and airport etc. And 16 expressions related to controllers job performance. These expressions are scaled by 5 Likert type, which is rated between 5 and 1, as 5 is most important and 1 is less important. Cronbach Alfa value was found to as .769.

In this study, beside descriptive statistics such as percentage, frequency, average and standart deviation, the situations in which relation between two continuous variable Pearson Corelation Coefficient was used (Büyüköztürk, 2002). In order to compare controllers from different airports in terms of continuous variables; one-way between groups ANOVA was conducted. When the result of the ANOVA was significant, multiple comparison tests were selected based on the homogenity of variance assumption. That is, when the assumption was met, Scheffe was used. When it was not met, Tamhane was preferred (Field, 2000; Huck, 2000).

4.3. Distribution of the Participants

In the table 1 frequency and percentage variables are given of the participant controllers by airport and gender variables.

Table 1. Distribution of participants by airport and gender.

		Freq.	Percent (%)
Male	Dalaman	12	7,186
	Esenboga	48	28,743
	Ataturk	43	25,749
	Antalya	37	22,156
	Adnan Menderes	27	16,168
	Total	167	100,000
Female	Dalaman	7	7,447
	Esenboga	41	43,617
	Ataturk	18	19,149
	Antalya	13	13,830
	Adnan Menderes	15	15,957
	Total	94	100,000

It can be seen at the table 1, 167 controllers (64%) are male and 94 are female controllers (36%) in 261 participant controllers. Participants from Dalaman airport are 12 male and 7 female; from Esenboga airport 48 male and 41 female; from Ataturk airport 43 male and 18 female; from Antalya airport 37 male and 13 female; from Adnan Menderes airport 27 male and 15 female. It is obviously seen that both of the male and female participant rates from Esenboga airport are highest among the others.

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4.4. Findings

It can be seen at the table 2, the average scores and standart devations of participant scores which belong to each performance statements were given. Merit of the controllers feelings can be listed as, “responsive and successful team member (4,405)”, “working motivation is high (4,328)”, “realize problems easily in air traffic (4,318)”, “focus my attention long time during peak traffic periods (4,216)”, “I’m a good model for new colleagues by my behaviours and job performance (4,173)”, “adopt easily new technical improvements and rules in job (4,171)”, “aware of happenings around me when I do my job (4,132)”, “can do many tasks when I manage the traffic (4,112)”. These are qualifiction of successful controllers.

Table 2. Participant views on job performance related expressions.

	N	Average	S. Dev.
I’m a responsive and successful team member.	257	4,405	0,765
My working motivation is high.	256	4,328	0,742
I can realize problems easily in air traffic.	258	4,318	0,683
I can focus my attention long time during peak traffic periods.	255	4,216	0,858
I feel that I’m a good model for new colleagues by my behaviours and job performance.	255	4,173	0,857
I adopt easily new technical improvements and rules in job.	257	4,171	0,858
I can aware of happenings around me when I do my job.	257	4,132	0,951
I can do many tasks when I manage the traffic.	258	4,112	0,899
My error rate is lower than the teammates.	253	3,423	1,178
I consider that I will be successful in another profession.	257	2,401	1,199
I get in trouble when I communicate with pilots English in emergency situations.	257	2,125	1,122
I consider to find a job in better circumstances.	256	2,086	1,214
I feel in trouble catching air traffic speed and complexity.	256	1,875	1,04
I experience problems to understand pilots speech.	257	1,595	0,944
I experience problems to animate aircraft positions and manoeuvres in my mind.	257	1,521	0,853
I feel myself inadequate solving complex air traffic problems.	255	1,518	0,841

As can be seen at the table 2, the merits of the controllers feels on the negative subjects: “error rate is lower than the teammates (3,423)”, “consider that I will be successful in another profession (2,401)”, “get in trouble when I communicate with pilots English in emergency situations (2,125)”, “consider to find a job in better circumstances (2,086)”, “trouble catching air traffic speed and complexity (1,875)”, “experience problems to understand pilots speech (1,595)”, “experience problems to animate aircraft positions and manoeuvres in my mind (1,521)”, “myself inadequate solving complex air traffic problems (1,518)”.

After identified of the general view of controllers, in order to increase apprehension of the performance statements which were given on the table above, average socores were accounted for every statement. On this process, negative scores were reversed and reached "performance perception scores" for individuals. Then, the relationships between these and other independent variables were accounted by selecting apropriate tests. Significant differences were found in terms of age, experience, graduated school, unit, position, rate and airports. However, significant difference was not found in term of gender.

4.4.1. Age and Experience

The relationship on age, experience and performance perception scores of controllers were found by Pearson Corelation Coefficient. The relationship was given at the table 3.

Table 3. Relation between perceived performance, age and experience.

	Experience	Perceived performance
Age	**,899*** **	**,141***
Experience		**,178****

*** p< .001; ** p< .01; * p< .05.

Significant relationship can be seen between age and percieved performance (r= .141; p<.05), between experience and perceived performance (r= .178; p<.01).

4.4.2. School

In Turkey, candidates who will become a controller have two altervatives. These are Anadolu University School of Civil Aviation (ECAS) and after university degree having a course in Turkish Air Navigaiton Provider (DHMI) recruitment. For this reason school variable was conducted as ECAS graduates and other schools. t test was used for these two variables and performance perception comparison. The result can be seen at the table 4.

Table 4. Comparison for performance perception and school

	N	Mean	SD	df	t	p
ECAS	49	4,239	,341	256	**3,311**	**,001**
Other	209	4,046	,465			

As can be seen at the table 4, the controllers who were graduate from ECAS reported performance perception scores (4,239) while controllers from other schools reported performance perception scores were statisticaly found significant (t_{256}=3,311; p<.001). In order to understand which statements became efficient about this significance, t-test was used for each statement. The statements created difference that is belong to ECAS graduates can be seen at the table 5.

Table 5. Comparison for the statements of performance perceptions and school variable

		N	Mean	SD	df	t	p
I consider that I will be successful in another profession.	ECAS	49	2,061	1,144	255	2,221	**0,027**
	Other	208	2,481	1,999			
I experience problems to understand pilots speech.	ECAS	49	1,347	0,631	255	2,061	**0,040**
	Other	208	1,654	0,995			
I can do many tasks when I manage the traffic.	ECAS	49	4,490	0,545	256	3,328	**0,001**
	Other	209	4,024	0,943			
I can realize problems easily in air traffic.	ECAS	49	4,531	0,544	256	2,446	**0,015**
	Other	208	4,268	0,704			
I adopt easily new technical improvements and rules in job.	ECAS	49	4,388	0,731	255	1,975	**0,049**
	Other	208	4,120	0,879			
I experience problems to animate aircraft positions and manoeuvres in my mind.	ECAS	49	1,265	0,569	255	2,358	**0,019**
	Other	206	1,582	0,879			
I feel myself inadequate solving complex air traffic problems.	ECAS	49	1,306	0,652	253	1,970	**0,050**
	Other	208	1,568	0,874			
I can aware of happenings around me when I do my job.	ECAS	49	4,429	0,645	255	2,448	**0,015**
	Other	205	4,062	0,998			

4.4.3. Working Unit

The ANOVA results can be seen at the table 6 which shows relation between working unit and performance perception of controllers.

Table 6. ANOVA results about working unit and performance perception.

Source	SS	df	MS	F	p
Between groups	2,791	4	,698		
Within groups	49,124	252	,195	3,580	**,007**
Total	51,916	256			

It can be seen from the table 6, significant difference was found between controller working unit and performance perception scores. According to Tamhane method, source of the differences are between approach (4,27) and area (3,94) (p<.003); between approach (4,27) and approach&area (4,03) (p<.012); between area (3,94) and aerodrome&approach (4,21) (p<.006); between aerodrome&approach (4,21) and approach+area (4,03) (p<.016). The figure 2 summarizes this situation.

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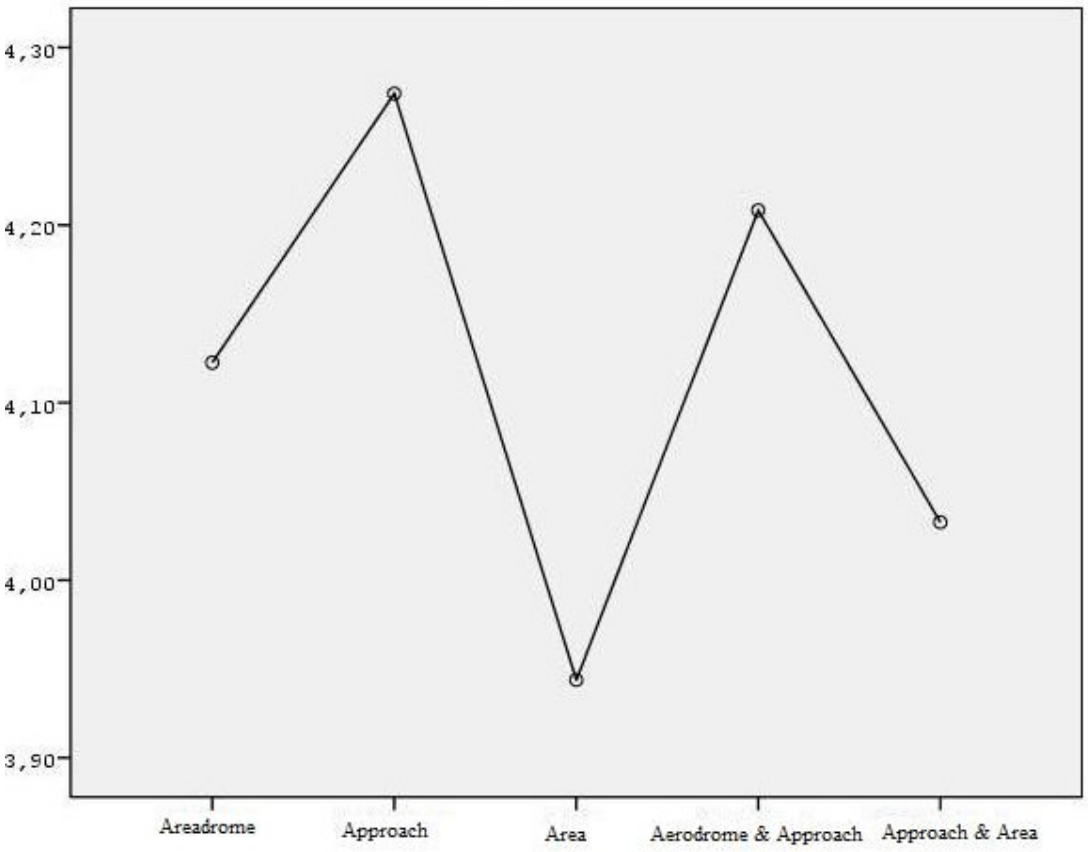

Figure 2. Illustration of controller scores in different units and performance perceptions.

4.4.4. Working Position

The ANOVA results can be seen at the table 7 which shows relation between working position and performance perception of controllers.

Table 7. ANOVA results about working position and performance perception

Source	SS	df	MS	F	p
Between groups	4,587	5	,917		
Within groups	47,357	252	,188	4,882	**,001**
Total	51,944	257			

It can be seen from the table 7, significant difference was found between controller working position and performance perception scores. According to Scheffe method, source of the differences are between assistant controller (3,73) and chief (4,31) (p<.004); between assistant controller (3,73) and On the Job Training Instructors(OJTI)&chiefs (4,38) (p<.015). The figure 3 summarizes this situation.

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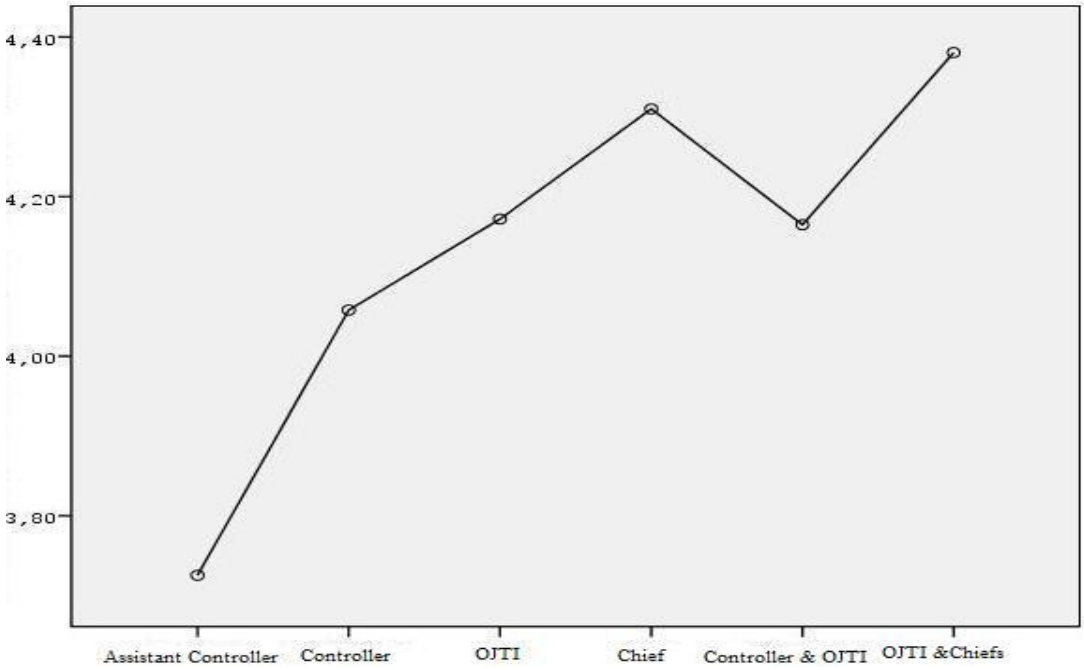

Figure 3. Illustration of controller scores in different positions and performance perceptions.

4.4.5. Rate

The ANOVA results can be seen at the table 8 which shows relation between rate and performance perception of controllers.

Table 8. ANOVA results about rate and performance perception

Source	SS	df	MS	F	p
Between groups	5,585	6	,931		
Within groups	46,283	249	,186	5,008	**,001**
Total	51,869	255			

It can be seen from the table 8, significant difference was found between controller rate and performance perception scores. According to Tamhane method, source of the differences are between nonrated participants (3,66) and approach rated controllers (4,31) (p<.003); between nonrated participants (3,66) and approach&aerodrome rated controllers (4,25) (p<.006); between approach rated (4,31) and area rated controllers (3,94) (p<.047). The figure 4 summarizes this situation.

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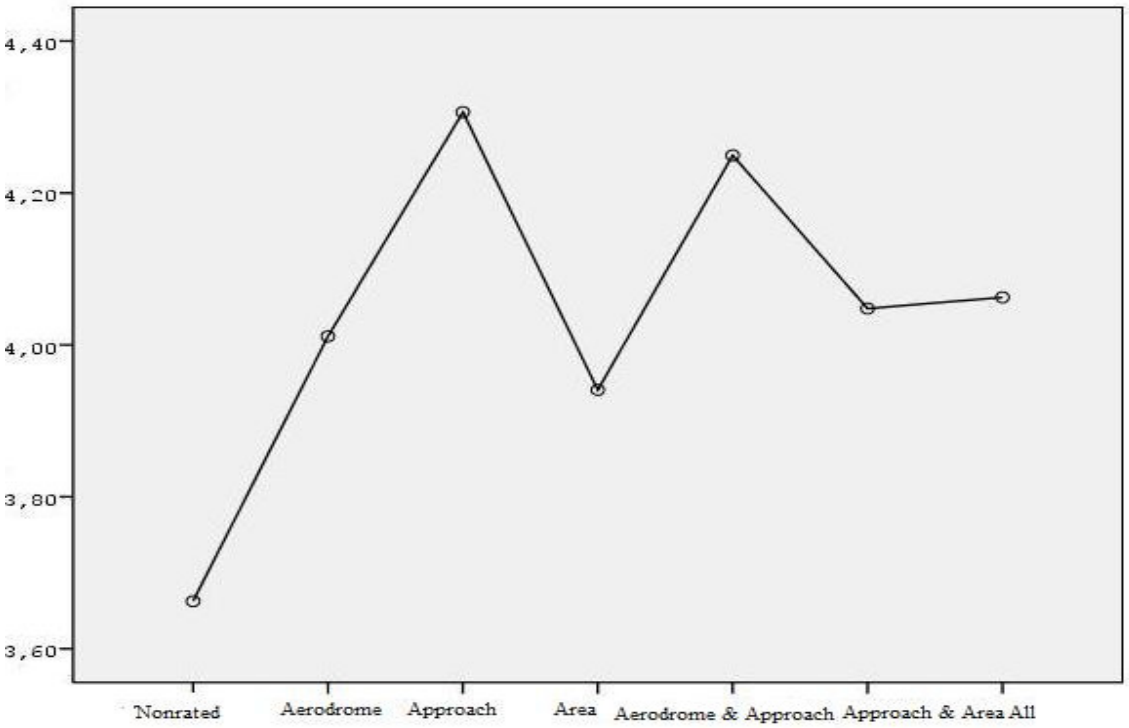

Figure 4. Illustration of controller scores in different rates and performance perceptions.

4.4.6. Airport

The ANOVA results can be seen at the table 9 which shows relation between airport and performance perception of controllers.

Table 9. ANOVA results about airport and performance perception

Source	SS	df	MS	F	p
Between groups	4,393	4	1,098		
Within groups	47,551	253	,188	**5,844**	**,001**
Total	51,944	257			

It can be seen from the table 9, significant difference was found between controller rate and performance perception scores. According to Tamhane method, source of the differences are between Atatürk (3,89) and Dalaman (4,21) (p<.006); between Atatürk (3,89) and Antalya (4,18) (p<.003); between Atatürk (3,89) and Adnan Menderes (4,25) (p<.001). The figure 5 summarizes this situation.

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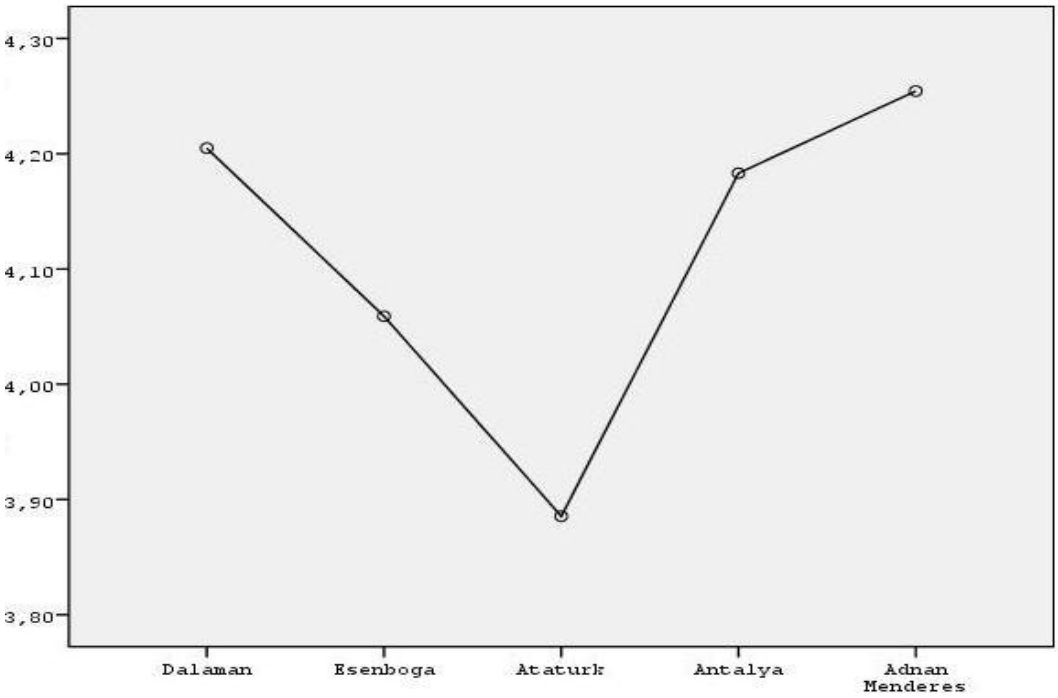

Figure 5. Illustration of controller scores in different airports and performance perceptions.

5. Conclusion

In this study, consequently the significant differences were found among controllers responses to the statements related to controller performance which are given in the questionare.

Controllers scores to the statements were high especially in terms of teamwork, situation awareness, adaptation to the new technics and rules. Indeed, they are working in very complex and high density air traffic environment. The qualifications of the participant controllers should meet job requirements. In terms of teammate performance, job change considerations and emergency situations, they behaved uncertain scoring to the statements. This situation can grow out of performance feedback issue from the organisation and managers or chiefs.

Significant relationship found between age and percieved performance, between experience and perceived performance. It can be said that, when the controllers are getting experienced and aged their perception related to the job improves.

The controllers who are graduate from ECAS reported performance perception scores and controllers from other schools reported performance perception scores were statisticaly found significant. ECAS scores showed higher rates than the others. Particularly about statements in terms of motivation, information processing and situation awareness, they behaved more qulified than others. Controllers from ECAS elected in a beter selection process before school entrance and had detailed air traffic control training at school than the other controllers. This

may create different performance perceptions. Furthermore it can be said that, individuals who wants to be controller should be taken into well designed and organised selection and training process. Results also supports that the therotical side of the study. Selection and training are identifier factors on controller performance.

Significant difference was found between controller working unit and performance perception scores. The controllers who are working at approach control units made higher scores to the performance statements. In contrast the controllers at are control units made lower scores. Approach control environment is highly dynamic and can be diffucult than the other units. In the same way, the scores of the controller who are working Ataturk and Esenboga airport and holding area control rates scored lower than the other controllers. Consequently it should be noted that, the reaserch studies should focus on controllers at area control centers. Main sources of this situation should be identified to improve controllers performance at area control centers.

The significant difference was found between controller working position and performance perception scores. Chief and OJTI's behaved more motivated and conscious than the others. It may show that, when the controllers assigned to the higher positions they get more experienced and conscious about the job related performance.

Since controller performance is important in the ATM and aviation system, future researchs should focus on human factors in the control centers. Controller job satisfaction could be another interesting research subject.

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