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LOGISTICAL PROCESSES IN MILITARY AVIATION ORGANIZATIONS

Summary. This article examines airbases as organizational units of the Polish Air Force from the perspective of executing logistical processes, with a particular emphasis on multirole aircraft maintenance processes. We selected air force bases that deal with multirole aircraft in order to become acquainted with the opinions of service processing executors. The observations of most immediate executors of the processes allow us to examine the possibilities for their enhancement and development. We presented the dependencies between different factors occurring in logistics processes, and their relationships and conditionings [3, 6, 7]. We described these factors using comparative parameters by means of the analysis and tools recommended in the science of management [2, 3, 8], while the collected material was developed using statistical tools and computer software [1]. The article is illustrated with numerous pictures and tables.

Keywords: air force military organization, air force base, logistical processes, maintenance processes

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1. INTRODUCTION

Research focused on learning the views and opinions of personnel about executing logistical processes was carried out in three stages at selected air force bases. The project started with the preparation and verification of research tools [4.5], while the second step involved gathering research material. The comparative material, due to certain limitations, was collected over a period of one year. In the third stage, we analysed the data using statistical tools. The final outcome of the conducted studies took the form of numerical characteristics of the examined entity and conclusions regarding the interdependence of the phenomena. The verification of statistical hypotheses was conducted using parametric and non-parametric tests [8].

For the sake of comparison, we also referred to expert opinions obtained by means of a questionnaire devised by the authors. The survey was conducted in the Office of the Assignee of the Minister of National Defence, the Office of the Director for the Implementation of Multirole Aircraft in the Equipment of the Polish Armed Forces and the Headquarters of the General Staff of the Land Forces and the Air Force. The data obtained from the interviews allowed the authors to determine the existing investment situation in respect of air force bases, as well as clarify the long-term modernization plans of the bases. We also specified the exploitation goals with regard to multirole aircraft in the coming years.

2. CHARACTERISTICS OF THE EXAMINED PARTICIPANTS

The research was conducted among engineering air personnel and commanding staff involved in the planning, organization and supervision of the implementation of aircraft maintenance on air force bases. The studies involved a total of 176 personnel. The selection of the respondents was randomized, while their participation in the research was voluntary. The research included technical and support personnel of airbases who were involved in the process of aircraft maintenance. Among the respondents were representatives of the commanding staff and the most immediate executors of the process of operating aircraft, who performed direct maintenance (flight line) and hangar servicing (backshop maintenance), on both a scheduled and a specialized basis.

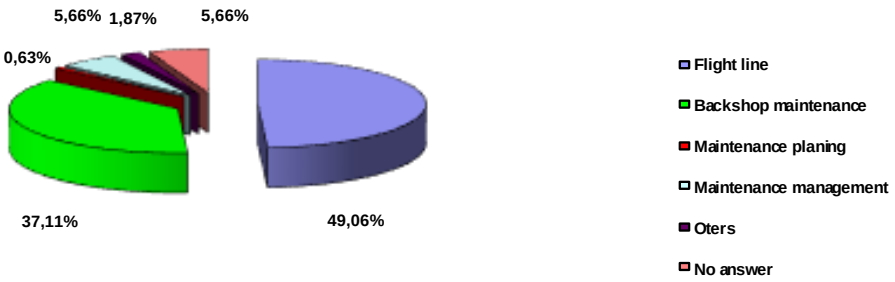

Fig. 1. Division of the surveyed personnel according to their specific area of activity
Source: own work

The research reached out to officers (F-16: 94.12%, MiG-29: 5.88%), non-commissioned officers (F-16: 67.89%, MiG-29: 32.11%) and civilian workers (all connected with F-16 maintenance). They consisted of personnel with varying levels of seniority, although the majority of the respondents had long-term experience (five to 10 years: 27.67%, over 10 years: 35.85%); see Figure 2.

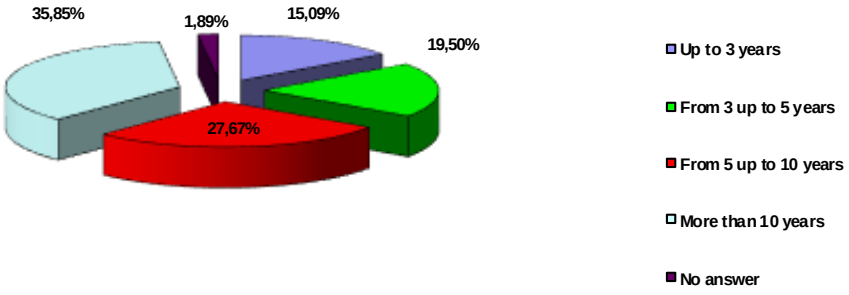

Fig. 2. Division of the surveyed personnel with regard to seniority
Source: own work

When taking the military employees among the respondents into account, we found that they were mostly non-commissioned officers (68.55%), with the remainder including commissioned officers (10.69%) and civilian workers (6.98%).

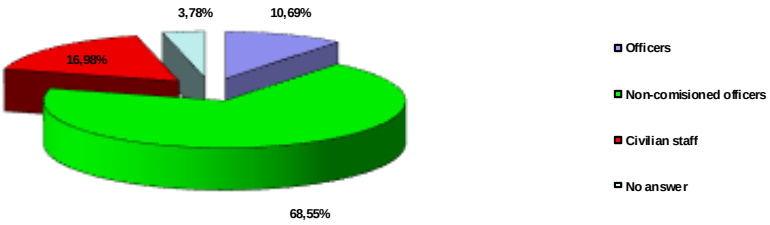

Fig. 3. Division of the surveyed personnel with regard to military employees
Source: own work

Some of the surveyed soldiers who were working on MiG-29 aircraft included those who underwent F-16 aircraft training in Poland (17.95%) and the USA (5.13%). Those responsible for F-16 aircraft maintenance were usually trained on home bases (60.83%), although a small group had undergone training in the USA (4.17%).

In conclusion, among the respondents were representatives of all personnel groups, with varying degrees of seniority, who performed tasks on air force bases, which are home to F-16 and MiG-29 aircraft. These opinions enabled the authors to formulate views on the problems concerning the use of the F-16 aircraft, the possibility of its reception and maintenance also in the base where no such planes are stationed.

3. ANALYSIS OF RESPONDENTS' OPINIONS

The first step in the analysis of the gathered statistical material was to verify the questionnaires in terms of whether they were correctly completed. Consequently, 17 questionnaires were rejected as unreliable. The analyses were performed using Statistica Software v.9.0. The presented dependencies occurred with a varying relationship strength of $p<0.05$. On analysing the obtained replies, we differentiated them with the following variables:

- military employees
- nature of work
- length of service in a military unit
- preparation for F-16 aircraft maintenance (place of training: USA or Poland)

When asked whether the available base equipment was adequate to handle aircraft other than those stationed at the base, respondents tended to choose the answer "satisfactory". Only a small fraction of non-commissioned officers (1.01%) and civilian workers (12.50%) chose "very good". The findings are presented in Table 1.

Maintenance personnel were also asked about the critical importance of proper cooperation with other airbases, in order to deal with situations when aircraft from outside the base land there. Here, the positive assessments of the surveyed were not high: 40.00% of officers indicated that cooperation was barely satisfactory, while 6.67% claimed that it was bad. The evaluations of the participating non-commissioned officers and civilian workers were higher (maximum 45.83%), although they also noticed shortcomings in this area.

Tab. 1

Distribution of respondents' answers with regard to equipment (findings in %)

Military employees	Equipment necessary for the maintenance of aircraft arriving at the base from another home base				
	Very bad	Insufficient	Satisfactory	Good	Excellent
Officer	18.75	**37.50**	**31.25**	12.50	-
Non-commissioned officer	7.07	15.15	**39.39**	**37.37**	1.01
Civilian worker	-	12.50	**45.83**	29.17	12.50

Source: own work

Another issue that respondents referred to was the number of maintenance staff. In this respect, the opinions of officers and non-commissioned officers were similar. However, civilian workers perceived this issue in a slightly different manner. It can be assumed that, while carrying out their tasks, they did not see any other activities that required soldiers. The opinions of those involved in F-16 maintenance were different from other respondents (Fig. 4).

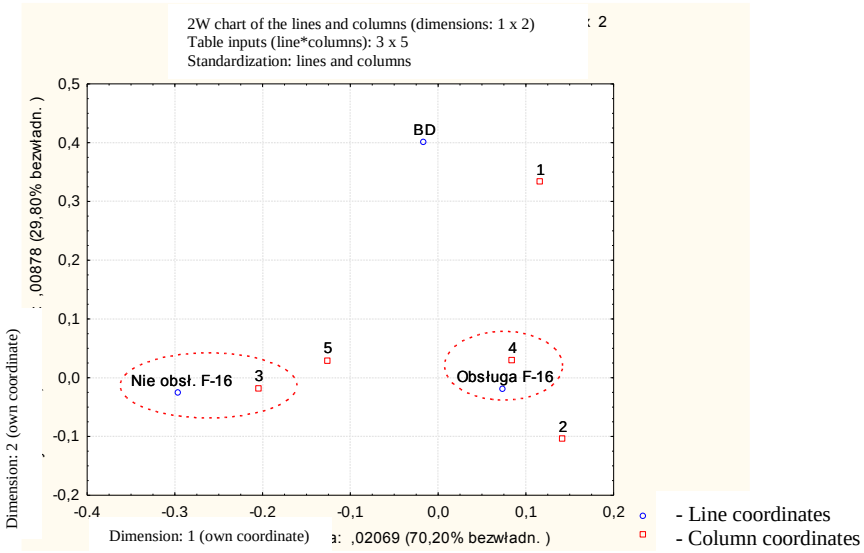

Fig. 4. The distribution of respondents' opinions with regard to the number of personnel to maintain the aircraft, where 1 equals very bad and 5 is excellent
Source: own work

All the respondents fully endorsed the choice of specialists to maintain the aircraft (41.18% of officers, 51.89% of non-commissioned officers and 59.26% of civilian workers); see Figure 5. For flight safety, it is important that staff have appropriate qualifications. All the respondents fully endorsed the professional preparation of specialists maintaining the aircraft (64.71% of officers, 83.79% of non-commissioned officers and 92.59% of civilian workers); see Figure 6.

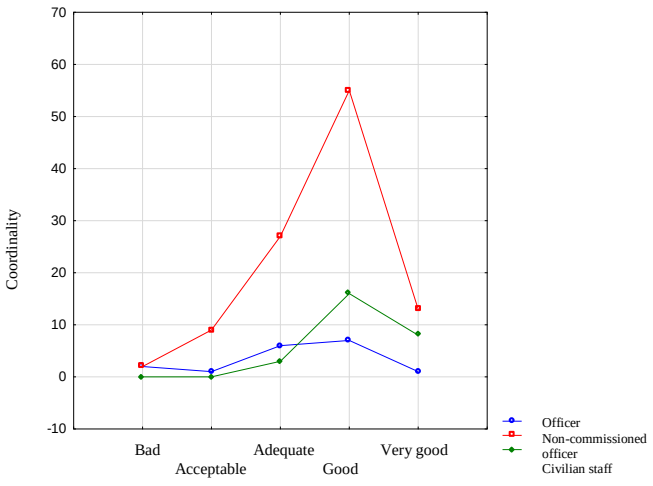

Fig. 5. Distribution of respondents' responses with regard to maintenance specialists*

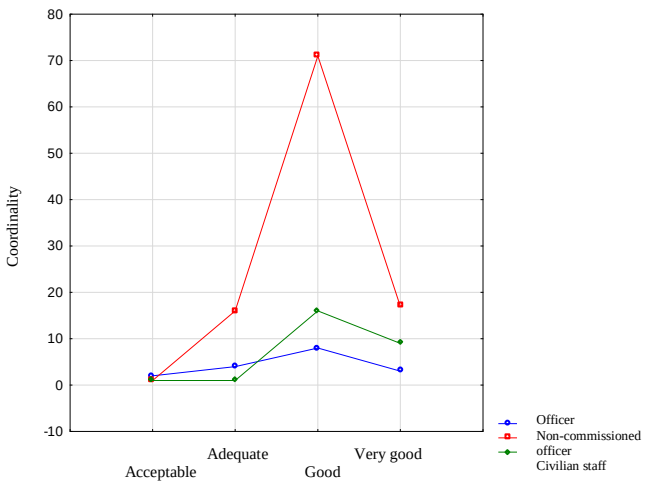

Fig. 6. Respondents' opinions with regard to training aircraft maintenance staff*

*Source: own work

Likewise, we evaluated the preparation given to support personnel on the airbase (52.94% of the officers, 76.92% of the non-commissioned officers and 100% of the civilian workers chose the top grades on the measurement scale); see Figure 7.

Organizations that are committed to the professional development of their employees seek opportunities to systematically raise their skills and qualifications. Apart from on specific projects, this can be realized through training. On the airbase, training was mostly highly regarded by non-commissioned officers: 58.76% indicated that this was executed well or very well. The opinions of officers were more varied: 58.33% of these respondents believed training was carried out badly. The remaining respondents were of a different opinion (Fig. 8).

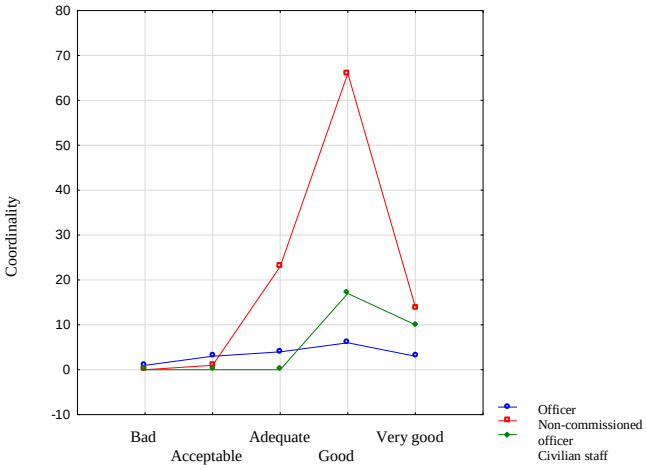

Fig. 7. Evaluation of support personnel training on the air force base*

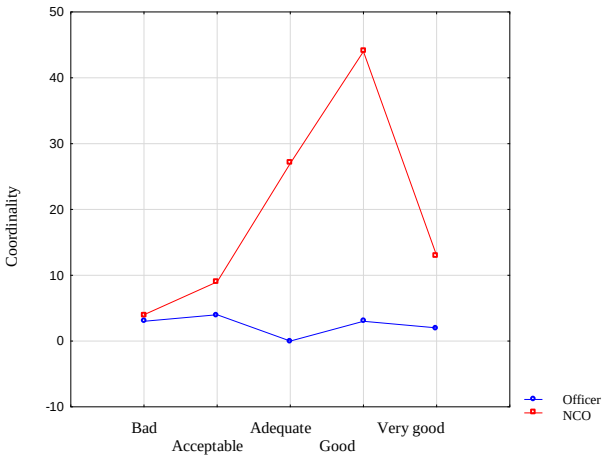

Fig. 8. Respondents' opinions about raising qualification levels*

*Source: own work

The opinions of respondents in terms of knowledge needed to maintain F-16 aircraft were varied (Table 2). The majority of respondents considered knowledge of work management to be useless (58.82% of officers, 66.97% of non-commissioned officers and all civilian workers); the usefulness of knowledge about safety at work was similarly assessed. As long as the opinions of the respondents with regard to the usefulness of overall technical knowledge were divided, the usefulness of specialist knowledge, which comes as no surprise, was rated highly.

Tab. 2

The distribution of answers among respondents with regard to the knowledge necessary to maintain F-16 aircraft (results in %)

Military employees	Knowledge of work management is essential for the maintenance of F-16 aircraft	
	No	Yes
Officer	58.82	41.18
Non-commissioned officer	**66.97**	33.03
Civilian worker	**100.00**	-
Military employees	General technical knowledge is necessary to maintain F-16 aircraft	
	No	Yes
Officer	58.82	41.18
Non-commissioned officer	**49.54**	**50.46**
Civilian worker	**100.00**	-

Cont. tab. 2

Military employees	Specialist knowledge is necessary to maintain F-16 aircraft	
	No	Yes
Officer	35.29	**64.71**
Non-commissioned officer	17.43	**82.57**
Civilian worker	**100.00**	-
Military employees	Safety at work knowledge is necessary to maintain F-16 aircraft	
	No	Yes
Officer	**70.59**	29.41
Non-commissioned officer	**58.72**	**41.28**
Civilian worker	**100.00**	-

Source: own work

Referring to the specific features of F-16 maintenance, officers (88.24%), non-commissioned officers (64.71%) and military employees (59.26%) typically indicated that there is no need to change anything in this respect; however, it may be a good idea to replace certain specialities (e.g., communication, navigation, electronic warfare) offered by other employees. It needs to be stressed that one in four surveyed military employees pointed to the need to combine specialities.

Apart from formal requirements, e.g., preparation for operation, it is important to ensure appropriate conditions for implementation. There is an interesting distribution of respondents' opinions regarding the suitability of the hangar, which serves as protection against heat in summer and against the cold in winter. Moreover, the installed hangar equipment (e.g., power sources) greatly facilitates aircraft maintenance. What is potentially intriguing is the distribution of responses given by non-commissioned officers who maintain aircraft, that is, answers were distributed almost equally.

When asked about other elements of airport infrastructure necessary to maintain F-16 aircraft, respondents' opinions varied. While all military employees acknowledged that the runway and taxiways are not necessary for the efficient maintenance of aircraft, a large proportion of officers (41.18%) and non-commissioned officers (55.05%) did not share this view. The reason for this may be the fact that military personnel do not perform all maintenance tasks.

There was no agreement among those surveyed with regard to specialist tools as an essential minimum to maintain the F-16. While the majority of non-commissioned officers (71.56%) insisted that this matter was indisputable, more than half of the officers (58.82%) and all the military personnel said that specialist tools were not the minimum requirement needed for operation. This is puzzling, since inch tools (not metric ones) are indispensable to maintain F-16s and it would be virtually impossible to carry out the work without them. It should be stressed that, without proper equipment, it is not possible to perform proper aircraft diagnostics.

Diverse opinions among respondents can also be seen with regard to aerospace ground equipment (AGE). All military employees, 64.71% of officers and 42.20% of non-commissioned officers did not consider it important to possess such resources. It is puzzling as to why 76.47% of officers, 50.46% of non-commissioned officers and 100% of military employees did not find it important to possess resources that were necessary to provide protection and safety when maintaining F-16 aircraft. This may result from the lack of awareness about threats or insufficient training in this area.

While all military employees were immediately associated with the execution of direct maintenance (62.96%) and hangar maintenance (37.04%), as well as the vast majority of the non-commissioned officers (52.88% and 41.35%, respectively), the majority of the officers were associated with performing commanding roles, as were a small percentage of non-commissioned officers.

Respondents' opinions on the possibilities of F-16 maintenance on their base were rather similar. The majority of respondents (93.75% of officers, 74.77% of non-commissioned officers and all military employees) indicated that such services could be performed on their base. Of significance, in this respect, are the responses from those who operate MiG-29 aircraft.

According to the opinions of the respondents on the base, which is home to F-16 aircraft, both the base and its personnel are well prepared. On the one hand, the personnel of the base where this type of aircraft is not stationed have varied opinions, since a significant percentage of non-commissioned officers employed on this base believe that the base is not prepared to handle this type of aircraft. A small percentage of respondents did not have any opinion on this issue. The distribution of the responses is presented in Table 3.

While analysing the results obtained by considering the nature of the performed work, it is possible to observe that the implementation of direct and hangar servicing predominantly involves non-commissioned officers (71.43% and 74.14%, respectively), as well as civilian workers (22.08% and 17.24%). On the other hand, planning and maintenance management is mostly provided by officers.

In the execution of direct services, workers with a wide range of experience dominate (five to 10 years: 28.21%, above 10 years: 48.72%), while hangar services are performed by those with varying degrees of seniority. This is rather surprising, as it is commonly believed that hangar maintenance should involve the most experienced and highly qualified staff, due to a much wider scope of work performed on the aircraft.

It was also noteworthy to observe the distribution of respondents' opinions with regard to where training was conducted. The vast majority of the respondents underwent training in Poland (69.81% on direct maintenance and 86.67% on hangar maintenance), although both groups also included staff trained in the USA (3.77% and 2.22%, respectively). A larger proportion of the commanding personnel underwent training in the USA.

Tab. 3

Distribution of respondents' answers with regard to equipment (findings in %)

Military employees	Workplace: F-16 home base		
	I do not know	Yes	No
Officer	6.25	**93.75**	-
Non-commissioned officer	0.92	**68.80**	**30.28**
Civilian worker	-	**100.00**	-
Military employees	Workplace: a base that maintains F-16 aircraft		
	I do not know	Yes	No
Officer	6.25	**93.75**	-
Non-commissioned officer	2.78	**68.52**	**28.70**
Civilian worker	-	**100.00**	-
Military employees	Workplace: a base that can receive and maintain F-16 aircraft		
	I do not know	Yes	No
Officer	6.25	**93.75**	-
Non-commissioned officer	9.35	**74.77**	**15.88**
Civilian worker	-	**100.00**	-
Military employees	Workplace: an air force base that possesses well-trained staff to receive and maintain F-16 aircraft		
	I do not know	Yes	No

Cont. tab. 2

Officer	6.25	**93.75**	-
Non-commissioned officer	7.48	**68.22**	**24.30**
Civilian worker	-	**100.00**	-

Source: own work

The opinions of respondents on the base's infrastructure, taking into account the nature of the tasks performed by them, are shown in Table 4. It is characteristic that the large percentage of those surveyed who were involved in hangar servicing appreciated the functioning of the base's infrastructure. The positive opinions regarding the preparation of security staff were typical for both direct and hangar personnel, as well as those involved in service supervision.

During the implementation of activities, it is highly important to maintain good cooperation between organizational units and individual specialists. The cooperation between maintenance personnel and support personnel was appreciated by 51.28% of direct maintenance personnel and 50% of hangar personnel. In addition, a large percentage of respondents rated cooperation no higher than insufficient.

Adequate base facilities, equipped with necessary equipment to maintain aircraft stationed at the base, were usually referred to by those performing direct maintenance and hangar servicing. Those surveyed who were responsible for maintenance planning as well as supervising the maintenance executions were critical with regard to the above. In a comparable way, we assessed the cooperation with other air force bases with regard to aircraft maintenance.

Tab. 4

Distribution of respondents' answers with regard to the functioning of the airbase infrastructure (findings in %)

Nature of the executed work	Functioning of the airbase infrastructure (airfield, social, taxiways, hangars, aprons etc.)				
	Very bad	Insufficient	Satisfactory	Good	Excellent
Direct servicing	2.63	6.58	**38.16**	**48.68**	3.95
Hangar servicing	5.36	1.79	**19.64**	**48.21**	**25.00**
Maintenance planning	-	-	-	100.00	-
Maintenance supervision	11.11	33.33	-	44.45	11.11

Source: own work

While referring to the issue of personnel training, it is possible to observe a certain degree of dualism. On the one hand, maintenance executors, while making a self-assessment, regard the item highly. On the other hand, those responsible for planning and task execution noticed a great deal of imperfections, indicating that training is barely satisfactory.

In terms of the organization of training courses devoted to aircraft maintenance, most respondents indicated that the acquired knowledge proved useful. Another opinion in this respect was expressed by those who were involved in service planning and service supervision. In the opinion of the majority of respondents, the tasks that they performed allowed them to make use of their qualifications to a large extent. To some degree, this points to a process of personnel improvement for working with the aircraft. From the perspective of the executed processes, this is a vital element. The responses are listed in Table 5.

Tab. 5

Distribution of respondents' answers with regard to knowledge acquired during training and developmental activities (results in %)

Nature of the executed work	Knowledge gained during training				
	Very bad	Insufficient	Satisfactory	Good	Excellent
Direct servicing	1.32	-	**14.47**	**60.53**	**23.68**
Hangar servicing	-	5.45	**23.64**	**63.64**	7.27
Maintenance planning	-	100.00	-	-	-
Maintenance supervision	-	11.11	11.11	**66.67**	11.11
Nature of the executed work	Training to raise qualification levels				
	Very bad	Insufficient	Satisfactory	Good	Excellent
Direct servicing	3.77	13.21	**32.07**	**32.07**	18.88
Hangar servicing	7.14	2.38	21.43	**59.52**	9.53
Maintenance planning	-	100.00	-	-	-
Maintenance supervision	14.28	**42.86**	-	**42.86**	-

Source: own work

While analysing the responses of those surveyed in light of their length of service, it is possible to observe that, as the length of service extends, the percentage of those dissatisfied with the base's equipment grows (Table 6). It can also be seen that the opinions of those surveyed with regard to the air force base's technical equipment are typical of professionals who maintain different aircraft (F-16 or MiG-29).

Tab. 6

The distribution of respondents' answers with regard to the base's technical equipment (findings in %)

Length of service in a military unit	Technical equipment on the base (modernization level)				
	Very bad	Insufficient	Satisfactory	Good	Excellent
Up to three years	4.54	9.09	18.18	22.73	45.46
From three to five years	3.22	3.22	22.58	**54.85**	16.13
From five to 10 years	-	4.65	**34.88**	**44.19**	16.28
More than 10 years	5.45	12.73	**45.46**	**29.09**	7.27

Source: own work

A variety of opinions among respondents in terms of length of service and place of duty can also be observed when they were asked about the preparation of the base infrastructure to maintain the F-16 (Figs. 9 and 10). Those surveyed clearly assessed this issue as a low priority.

When asked for opinions on the geographical location of the base, in terms of the speed of delivering spare parts required for troubleshooting, the majority of respondents indicated the situation as "satisfactory". However, dissatisfaction with the delivery of spare parts for aircraft was rather striking. The personnel involved in F-16 and MiG-29 maintenance were somewhat critical of this situation.

According to the opinions of most respondents, work and experience gained on other aircraft was considered as being very useful preparation for working on the F-16. Such a response was often indicated by those with many years of experience. On the one hand, it is difficult to compare such structurally different aircraft; on the other hand, the organization of their service is not particularly different.

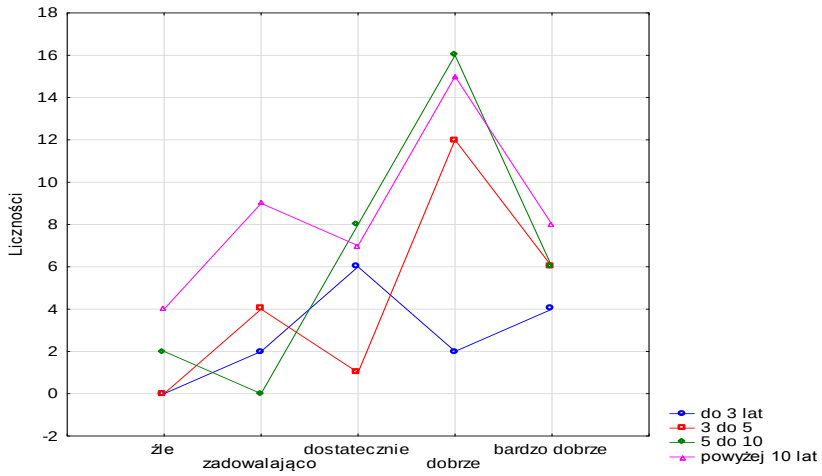

Fig. 9. Assessing the preparation of the base infrastructure

Taking into account the last adopted criteria, i.e., varied responses of those surveyed about the preparation for F-16 maintenance, it can be seen that, in terms of the geographical location of the air force base as a criterion of the speed in delivering items necessary for maintenance, the "satisfactory" rating was only indicated those who had undergone training in Poland (Fig. 10).

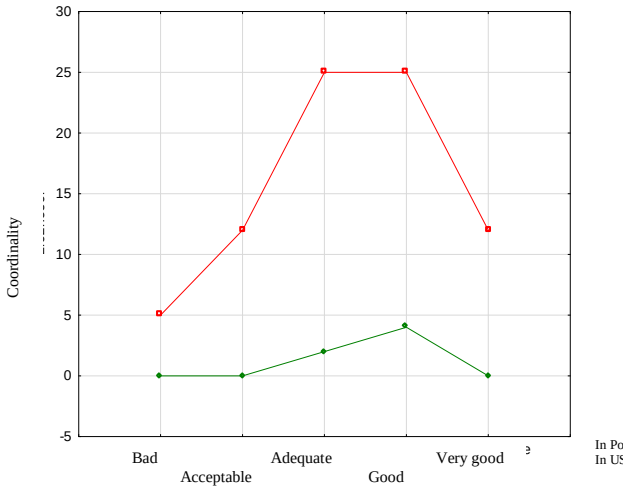

Fig. 10. Air force base geographical location (delivery rate)*

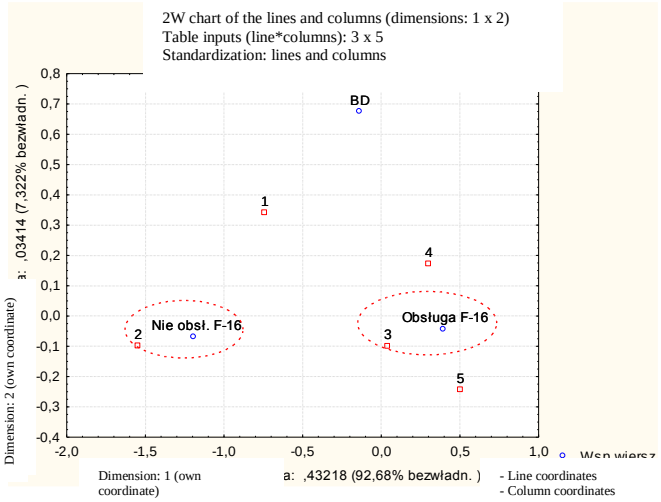

Fig. 11. Distribution of respondents' opinions on the preparation to maintain the F-16, where 1 equals very bad and 5 is excellent*

*Source: own work

The distribution of ratings in terms of the base's technical equipment (modernization level) from the perspective of a training site indicates that those who underwent training in the USA assessed this element negatively. Further, this test group (respondents trained in the USA) was more critical than the group trained in Poland concerning the preparation of personnel to maintain F-16 aircraft on the air force base.

Taking into account the negative feedback from untrained personnel about maintaining the F-16, particularly the way in which the case prepared for maintenance of this aircraft, it should be noted that the maintenance on this base is dubious. Figure 11 shows the distribution of responses of those surveyed.

The opinions of those trained in the USA with regard to cooperation with other air force bases were clearly different than those of the other respondents (see Table 7).

Tab. 7

Distribution of respondents' answers with regard to cooperation with other air force bases (findings in %)

Preparation for F-16 operation	Cooperation with other bases on the maintenance of aircraft				
	Very bad	Insufficient	Satisfactory	Good	Excellent
Not applicable	-	15.38	34.62	34.62	15.38
At home	1.32	10.52	**42.11**	**40.79**	5.26
In the USA	25.00	25.00	50.00	-	-

Source: own work

All respondents positively assessed the flow of information between particular servicing times, which allows us to conclude that the planning and implementation of maintenance activities should be coordinated.

The opinions of all respondents, regardless of their place of training, generally indicated that the method of maintenance for the F-16 is good and should not be changed. However, it can be seen that those who underwent training in the USA were more likely to call for changes in the fields of specialization.

4. CONCLUSION

Airbases, as organizational units of the Polish Air Force, perform a wide range of complex and responsible tasks, including peacekeeping missions and flight training, with a particular emphasis on the preparation for performing tasks in wartime, within the territory of the home country or on deployments abroad either independently or in cooperation with allied forces.

It is necessary to maintain the current level of training on airbases providing maintenance of multirole aircraft, while addressing the risk of being understaffed and raising the qualification levels of the staff who have already been trained. Understaffing concerns all airbases, as they experience a high turnover of staff, mainly due to the retirement of skilled personnel and a long-lasting process of training new candidates.

Raising skill levels and providing developmental opportunities to the personnel already employed on a base are positive ways to deal with the aforementioned issues. However, gaining new specialities will not compensate for the known shortcomings, since one person, even if they possess several specialisms, cannot replace a group of specialists who are needed at work.

It is also critical that the available technical equipment is sufficient to maintain the aircraft stationed on the bases. Regarding the handling of aircraft from other bases, it is necessary to redeploy personnel and equipment in order to provide maintenance of these aircraft.

On airbases, there should be trained personnel who can receive and maintain operations of multirole aircraft and the necessary minimum ground support equipment (towing, ground power units), as well as a well-equipped emergency group.

The level of safety depends on the personnel skills, aircraft construction and infrastructure. Regarding the factors related to the means of transport or infrastructure, currently being conducted worldwide research significantly contribute to the reduction of their participation in contributing to the accident or increase its negative effects. An interesting non-invasive diagnostic method is presented by the author in his work [9-19]. However it remains, the human factor, which at present we are not able to eliminate.

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