Investigation of Relationship Between Trust in Automation and Human Personality Traits Among Air Traffic Controllers

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***Abstract*— The constant growth of air traffic will lead to greater complexity of the Air Traffic Controller (ATCo) tasks. The greater complexity is followed by increasing workload that will affect ATCo's task performance. To cope with that it is necessary to develop a new generation of the Air Traffic Control and Air Traffic Management automation technology, both airborne and ground-based. The proper use of automated technologies should be ensured by the appropriate level of ATCo's trust in automation. The research examines the relationship between ATCo's level of trust in automation and its personality traits when one specific contemporary system is being used by two air traffic control centers. It was found that ATCo's trust in an automated system depends on their age and work experience, as well as on the personal traits that stand out for their openness to new things, both in technology and in everyday situations. The research participants understand how the system behaves by using all appropriate methods to provide the outcome, but they still rely on themselves in the ultimate decision making. They define system's reliability as the most important system's characteristics.**

Keywords - trust in automation; personality; air traffic controller

I. Introduction

The major challenge of Air Traffic Management (ATM) industry is to adapt and handle air traffic safely, efficiently and at an economically acceptable cost during its constant growth. It is estimated that by 2035 the air traffic will increase to 15.7 million flights in the European Civil Aviation Conference (ECAC) region, which is 5.1 million flights more than in 2017 or in total of 50% of increase [1]. More airspace and airport capacity, more staffing, as well as new procedures and technology, is required in order to cope with traffic increase. Among that, traffic increase will lead to greater complexity of Air Traffic Controller (ATCo) tasks followed by increasing of ATCo's workload which may affect their task performance. To solve this issue, possible solution is development of new automation tools for ATCos to properly handle given traffic and to identify and mitigate air traffic conflicts. Nowadays, Single European Sky Air Traffic Management (ATM) Research (SESAR) and Next Generation Air Transportation System (NextGEN) are working on such developments aiming to improve overall ATM performances.
A new series of automated solutions are deployed to provide ATCo's more accurate information earlier, help increase visibility at airports and enhance help of ATCo's tools for communication, navigation and surveillance (CNS) in order to provide safe and efficient coordination of air traffic. However, the level of automation differs between various Air Traffic Control (ATC) centers. There are some ATC centers that use electronic strips, while some of them still work with paper strips. Among that, the implementation of automated tools is violated by lack of a robust digital data link [1].

The automation may bring some benefits providing improvements to safety, capacity, efficiency and the environment. The use of automation may change the human role in ATC system. It can facilitate ATC task management and improve human performances which can minimize human stress and fatigue, influencing decrease of ATCo's workload. On the other hand, it can create new human weaknesses or intensify the existing ones [2]. Based on that, it is crucial to identify all benefits and risks of implementation of new automation tools.

The new ATCo's role is to supervise the automation and to intervene manually if it fails. The ATCo's choice of automatic or manual control has important consequences for the system performance. One of the useful components of using the automation is how much ATCo trusts these systems to perform tasks effectively. For example, ATCos are not willing to use automated system if they feel the system is unreliable or there is a high rate of false alarms [2].

The factor that may affect ATCo's trust in automation is its personality. The work of an ATCo can be characterized as cognitive process very often affected by their personality traits [3]. ATCo's personality traits may have a great influence on their reasoning about traffic situations, choice of a proper action to solve unsafe situations and their acceptance of a new technology and tools. In order to analyze an ATCo's personality traits, it is important to find an appropriate tool for its assessment.

The objective of this research is to investigate relationship between ATCos' trust in the automated system and their personality traits. Subject of the research was current system in which ATCos work. The research was conducted as a case study in Serbia and Montenegro Air Traffic Services (SMATSA) and Croatia Control Ltd. (CCL), covering ATCo's working in terminal and en-route units.

In order to achieve objective, a dedicated questionnaire was designed to collect the subjective judgments of the ATCos regarding their trust in the system and their view of its personality.

The paper is organized as follows. Section II defines system automation in ATC. Section III defines trust in general as well as in automation. The explanation of personality traits among ATCos is also presented in this section. Section IV presents research methodology with some basic results, while in Section V detailed statistical results were discussed. Section VI provides conclusions and further research steps.

II. System automation in ATC

In order to understand ATCo's role in automation, it is first important to explore what is meant by the term "automation". A variety of meanings may be found in different literature. In general, automation can be related to some technological change which results in the replacement of humans by machines. Automation is associated with the computer software including 'intelligent' systems that are capable of self-operating [4].

In ATM systems, automation may be defined as a device or a system that accomplishes (partially or fully) a function that was previously done (partially or fully) by human operator. A high number of different parameters and data required might lead to a serious problem of making a decision of the appropriate level in ATC [5]. The level of automation should be modified to the characteristics of specific airspace. Therefore, the lowest level represents the full absence of automation where the operator performs all the functions, while the highest level of automation corresponds to the fully automated system and full absence of human performing [6]. According to ATM automation model under development in the context of the European ATM Master Plan, five levels of automation are assumed: from 0 - no automation to 5 - full automation (Figure 1). It goes from full time human performances to full system performances in all aspects of operations [1].

One of the benefits of automation is in saving humans of consuming time and hard intensive work. The automation is expected to improve the operators' performance by reducing operator's errors and their workload [7]. However, the automation can increase the workload if it is not designed in a proper manner (an automated function requires some additional data entry or other cognitive effort) [8]. Automation often has the ability to perform routine tasks, but there is still a need for a human to be in the loop to face with unexpected situations [4].

Another problem can be the operators' trust in automation, and their dependence on automation. It is important that automation is properly used by the operator in order to avoid any failures or errors through its work. Sometimes, the operator does not use the automation in the way designers intended, just because they believe in their own abilities rather than in an automated system [2]. Good knowledge of the automated system and better implementation by the operator can be accomplished by appropriate initial training, with the continuous additional courses and training, especially if the system has new updates. In that manner, the operator will improve their knowledge of the automated system performances and gets the feeling of the type of reaction needed in a given situation [4].

Currently, under the ATM developments the improvement of automation has the central role. The goal is to increase safety, efficiency and the capacity of overall ATM system while the task complexity is balanced [9]. The human role will vary with the level of automation of the system being used. For example, in high automated system the ATC system may develop the necessary actions for the safely and orderly traffic management, informing ATCo of the actions developed if requested. In that case, the monitoring and/or approving the required actions will be the responsibility of an ATCo [9]. On the other hand, in less automated system the responsibility of an ATCo may increase, with their active role in performing the task with the support of ATC tools. According to the above mentioned, the assigned responsibilities between humans and automated systems should be carefully considered in designing and implementing new automation solutions.

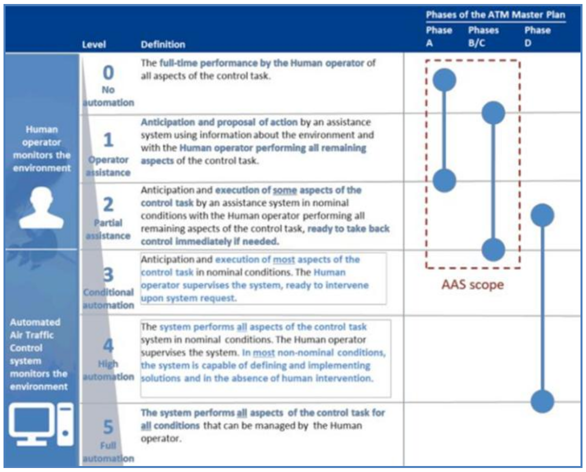

Figure 1. Automation model under development for the Master Plan Edition 2019 [1]

The level of automation anticipated for each phase of the European ATM Master Plan is depicted in the Figure 1. The final target, equivalent to phase C of the Master Plan includes technical solutions that can execute a subset of controller tasks in nominal conditions under the supervision of an ATCo (Level 2 in Figure 1) [1]. It is important to note that the higher level of automation will be needed to accommodate traffic growth through capacity optimizing. To achieve that, there is a need for automation support for ATCos as the most important part in reducing ATCo's workload per aircraft. Therefore, numerous automation solutions are foreseen through the Master Plan in order to gradually increase overall performance of the ATM system.

III. Trust in Automation

A. *Definition of Trust*

Generally speaking, trust is naturally associated with something positive and it can be defined as a "multidimensional psychological state involving beliefs and expectations derived from the experience and interaction with the target relevant to the trustworthiness" [10]. On the other hand, trust is an issue in situations that involve risk, uncertainty, vulnerability and the need for independence [11]. Trust is especially important in systems with higher level of automation. Very often, the automation may make complex tasks easier and to promptly perform them. At the same time, the operator is dependent on automation to function efficiently in every desired situation.

During the past years, many studies tried to define why the automated system and its progress need to be trusted by the person working on it. There are several different views and explanations of why the trust has such importance. For example, Muir (1994) [12] claims that the operator bases his belief upon the properties of automation. That means, if all properties work well, the operator will use them. Apart from that, the performance, process, and purpose of an automated system can have a role in constructing trust [13]. In the first stage of building trust in an automated system, the purpose of developing the automated system has the advantage over the performance that includes current and historical automation abilities to obtain the operator's goal. Considering that, the purpose and the faith in automation may first create the operator's trust in the automated system [14]. Same to that, the human-system trust may be based on the operator's faith despite the real evidence [15], and with the increase of its experience, the operator may have the feeling for the automation predictability and dependability [14].

Trust is a dynamic concept that reflects a set of mutually connected human actions and perceptions [16]. The trust may be defined as an extent to which the user is confident in, and fully agrees to implement any recommendations, suggestions, and actions received from any computer-based tool or decision aid [17]. In some situations of the highest level of trust, the operator is willing to believe fully in the automated system and go beyond the lack of information about it.

The trust in automation can be compared with interpersonal trust. Hoffman (2013) [18] claims that interpersonal trust may depend on perceived competence, benevolence, understandability, while the factors which influence the trust in automation are reliability, validity, utility, robustness and false alarm rate. The trust in automation is a dynamic process in the same way as intrapersonal trust [19]. That means, if the automation performs reliably over time, the operator's trust will increase and vice versa, the human-automation performance will improve with increase of automation reliability [20]. However, trust in automation is not a product of the operator's need to make personal contact with it, but it is a result of the operator-system interaction to perform required tasks [11].

B. *Trust in automation related to the ATCo tasks*

The nature of the ATCo's work is cognitive with the constant need to make diverse decisions in real-time situations through extracting the information from the environment [11].

In defining the trust in automation, it is very important to take into account three elements: an ATCo, an automated system and required tasks. It is important to see what the relationship between those three elements is. An ATCo has some tasks to perform daily. Those tasks require his cognitive attention where the good health state is implied. The automation can be one of the "helpers" in the performance of those tasks. The automation is expected to work properly and purely, as well as to help ATCo in every situation. In some cases, trust can be based on a judgment that the automation functions as predicted and that the ATCo can rely on it [12]. Therefore, a proper connection should be made between an ATCo, who is the user of the system, and the automated system, a tool that would make his job easier on a daily basis.

When introducing changes to technology, ATCo's trust in new tools plays the main role. It can modify their expectations of how the system works and may cause a feeling of uncertainty of responsibilities in terms of air traffic situation control [21]. Further on, ATCo's openness to a new situation or new technology, and its ability to adopt all new changes may affect its trust in a new system. Therefore, the ability to learn new processes and rules, producing new solutions from numerous sets of information in such a task-procedural working environment is related to ATCo's trust in new technology [22].

The other personal dispositions, such as motivation, personality, and contextual criterion, should be taken into account as well [23]. The ATCos' trust in automation will rise if they are willing to advance themselves [22]. Among that, the ATCos' personality should be taken into account as one of the main causes of ATCos' confidence or distrust in the automated system.

C. Personality Traits

Overtime, the interest in defining the personality impact on people's behavior in different occupations has grown broadly. Personality is a set of internal and external traits that influences the behavior of an individual. In evaluation of personality, the personality traits should be considered first [24]. A personality trait can be seen as "a pattern of behaviors which are related and carried by the person who is showing the consistency of such pattern from situation to situation" [25]. The personality traits can be analyzed by explaining the individual behavior to make a future prediction, or by summarizing the individual's behavior to create an individual's profile for the present [26]. Also, psychologists who were interested in consistency of personality traits and behavior impacted by them claim that the change of the behavior pattern of an individual is a little or none across the lifespan [25].

There are different explanations of the nature of personality traits. The most used classification is Broad and Narrow Personality traits [27]. The Broad Personality traits explains a trait as a main personality dimension that makes a predictions about general aspects of behavior [25], while the Narrow is seen as a specific component of broad personality trait [27].

In order to analyze an individual's personality traits, it is important to find an appropriate tool which will be used in its measurement. Questionnaires, self-reports, inventories and other forms are developed to assess it. The most popular taxonomy of personality traits is a hierarchical model of personality traits with five broad factors, which represent personality at the broadest level of abstraction, called Big-Five Personality approach or Five Factor [28]. The framework was developed in the late 1980s [29] as a short model that consists of five traits named as extraversion, conscientiousness, agreeableness, neuroticism and emotional stability [24].

Recently, due to the lack of available test time, researchers prefer to take measures that shorten it. The most prominent short personality traits measurement is the Ten Item Personality Inventory (TIPI) [28]. The TIPI represents self-reporting personality scale which enables learning about personality traits directly from the investigated subject. The scale can be completed in approximately 1 min: each of the 10 items consists of two adjectives and each of the Big Five factors is represented by two items. The TIPI has attracted a good deal of interest from many researchers and has been used in diverse fields [30].

IV. Research Methodology and Results

The objective of the reserach presented in this paper is to investigate how much and in what way ATCos believe in the use of automated system. The special attention was given to the influence of personality traits on ATCos' perception of the automated system. The research was performed in SMATSA and CCL in order to examine influence of different operational environments using the same ATC system. It was conducted in two time periods of 5 working days (April and May 2019). The research participants were terminal and en-route ATCos. In total, there were 86 participants (75 men, and 11 women) from SMATSA, and 24 (22 men and 2 women) from CCL. Because of the small share of women in the sample, the analysis covers male and female participants together.

The ATC system used by both groups of participants is TopSky automated system by THALES that plays leading role in SESAR and NextGen developments in airspace operations. TopSky-ATC is advance ATC automation solution, designed to control en-route, approach and oceanic traffic, both in civil and military environments [31]. Note that the TopSky system was not presented as the subject of this research, but was given only as an example of an automated system used.

A. Questionaire design and Survey procedure

The questionnaire called "TRUST IN AUTOMATED SYSTEM" was designed for this research consisting of four sections and it is used in an anonymous survey. The sections are as follows: A) Demographic information (7 questions), B) ATCos' view of used automated system (4 subsections, 22 questions), C) ATCos' preference of using an automated system (10 questions), and D) ATCos' personality measurement.

A questionnaire was based on the SHAPE Automation Trust Index (SATI) questionnaire [32], Human Computer Trust (HCT) [17], and Human-Automation Scale (HAT) questionnaire [33].

The Personality traits are investigated by TIPI [28], which consists of 10 items, each consisting of a pair of descriptors that were scored from 1 (Strongly disagree) to 7 (Strongly agree). Each dimension of the Big Five framework (E-Extraversion, A-Agreeableness, C-Conscientiousness, ES-Emotional Stability and O-Openness) was presented by two statements: positive view of dimension vs. negative view.

The questionnaire contains closed questions to satisfy clarity of every question asked, and the opened questions given to encourage the participant's willingness to share its own opinion on the discussed topic through additional comments. A training (explanation) session with participants was conducted before the study.

In this survey participants were asked to give their opinion on questions/statements related to trust in automated system using 7-point Likert scale. For each statement, there are seven possible ratings, starting from 1 (Strongly Disagree) to 7 (Strongly Agree).

B. Statistical Methods

The data is presented in a form of mean and standard deviation. The Mann-Whitney nonparametric test was used to investigate the differences between mean ranks of participants. In order to explore influence of ATCo's characteristics on their view of automation and personality traits, the Kruskal-Wallis test was used. Spearman's coefficient of correlation was applied for evaluating the statistical significance of coefficients of correlation between variables. The nonparametric methods are used because of data nature and its distribution. Data preparation, as well as statistical analysis, was performed using SPSS Version 20. Differences were considered to be statistically significant at $p<0.05$.

C. Demographic information (Section A)

SMATSA: The research study included a total of 86 participants from SMATSA. Most of the participants were between 35-50 years old (expressed as mean ± standard deviation 41,0 ± 8,27). From total of 86 participants, 22 (22,6%) work as approach and terminal air traffic controllers, while 64 (74,4%) of them work as en-route air traffic controllers.

Period of working at current position is 14,20 ± 9,37 years for the most of the participants (40,7%) for which first working position was tower controller, while 34 (39,5%) of them are still working at their first position. Working period at previous position is 3,15 ± 4,02 years, while maximum years of working is 20 (approach and terminal control). Average period of work at previous and current working position, in total, is 17,35 ± 9,64, where maximum number of working years is 40 (approach and terminal control), while minimum is 3 years of working experience at current position (1 year en-route position and 2 tower control). Most of the participants have high school diploma (60,5%), while no one has PhD diploma.

CCL: There were 24 participants from CCL who participated in the questionnaire study. Most of the participants were between 35-50 years old: 40,16 ± 2,01. Also, almost all of them (23) currently work as an en-route air traffic controller, while only one works as approach and terminal ATCo.

Period of working at current position is 15,29 ± 2,16. Only one of the participants had previous working position as a tower ATCo (4 years period), while the others are still working at their first position as en-route ATCos. Average total working period of all participants is 15,46 ± 10,85, where maximum number of working years is 33 (tower and en-route control), while minimum is 1 year of work experience at a current position (1 year en-route position). Most of the participants have master's degree (37,5%). The rest of the participants belong to the group that received a high school diploma (33,3%) and a bachelor's degree (25%). The PhD diploma was received by one participant.

D. The analysis of sections B-D of the questionnaire

Section B is divided into four subsections that examine Reliability, Technical Competence and Accuracy, Understandability, and Faith and Confidence of the used system.

When it comes to system reliability, both groups of participants (SMATSA and CCL together) agreed that the system's outcome is the same in every situation and that they can rely on its functioning. However, both groups of participants think the system may behave sometimes in an underhanded manner (differences between mean ranks is statistically significant between groups, p<0,05) (Table I - Item B4). That means they believe in the system outputs but with a dose of caution.

TABLE I. ITEMS WITH STATISTICALLY SIGNIFICANT DIFFERENCES BETWEEN MEAN RANKS BETWEEN GROUPS

Question		Mean ± standard deviation	The most common answers	
			SMATSA	CCL
B4	The system behaves in an underhanded manner.	3, 68 ± 1,66	5 (30,2%)	4 (30,4%)
B16	I am wary of the system.	3,65 ± 1,85	4, 5 (18,6%)	2 (29,2%)
C5	I would feel a sense of loss if the system was unavailable and I could no longer use it	5,60 ± 1,48	6(24,4%)	6(33,3%)

NOTE: no statistically significant difference was found in evaluating other questions between groups

Participants are generally positive about system technical competence and accuracy. They both agreed that the system has integrity and uses appropriate methods to reach some decisions. The participants are sure that the system will not create any harmful outcome or injuries. Both groups of participants are very positive in the case of their familiarization with the system and its behavior in decision-making assistance. It was found that there were statistically significant differences (p<0,05) regarding the caution in using the system between the two groups of participants (Table I - Item B16). The SMATSA participants are concerned or indecisive about the system, while the CCL participants are not alerted about the functioning of the system.

Both groups have declared that they are not convinced in the work of the system, and they are not always confident in its advice. They rather believe themselves in case of decision making in every day operations. The CCL participants were mostly indecisive on this subject.

Both groups of participants think that the system is good in decision making and is suitable for the ATCos' style of decision making. The statistically significant difference regarding the absence of the system in daily tasks was found between the group (differences between mean ranks is statistically significant between groups, *p<0,05*)(Table I - Item C5). The system reliability is the most important for them, while the system liking is the least important. In the case of the system accuracy, the SMATSA participants have marked it as the most important system characteristic (in addition to system reliability), while the CCL participants were indecisive about it. Easiness of the system use is a more important feature for SMATSA participants than those from CCL (statistically significant difference between groups mean ranks were found) (Table II).

To investigate ATCo's opinion on the level of automation of the system they use and the future system automation, they were asked to rate the level of system automation. Both groups agreed that the current system is moderately automated (3-the most frequent rate on Likert scale) because some tools are missing and the system should be improved when it comes to automation. They note the experience as one of the reasons for their grades to system automation. Further, from a total, 50% of SMATSA and 87% of CCL participants think that the ATC system will not be completely automated by 2035. Based on their comments, they believe that humans will still remain an essential factor in the human-system relationship.

TABLE II. SECTION C: PERSONAL VIEW OF AUTOMATED SYSTEM

Question	Mean ± st. deviation	The most common answers	
		SMATSA	CCL
Usefulness	3,17 ± 1,05	3(45,9%)	3(45,7%)
Reliability	3,75± 1,42	5(39,5%)	5(54,2%)
Accuracy	3,50± 1,30	5(32,6%)	4(29,2%)
Liking*	2,17± 1,52	1(55,3%)	1(54,2%)
Easiness of Use*	2,86± 1,17	2(35,3%)	2(41,7%)

* *p<0,05*

The personality (section D) may impact ATCos' trust and view of the automated system. The group results and TIPI dimensions norms are showed in Table III. The answers obtained from SMATSA participants are lower than the given norm [33]. The answers are classified as 'Medium-Low' concerning the given norm of 'Extroversion', 'Agreeableness' and 'Emotional Stability' dimensions, and 'Low' in case of 'Conscientiousness' and 'Openness' dimensions. On the other hand, the responses of CCL participants are slightly higher than the norm. The answers are classified as 'High' in case of 'Emotional Stability', 'Medium-High' in case of 'Extroversion' and 'Conscientiousness', and 'Medium-Low' in case of 'Agreeableness' and 'Openness.

TABLE III. TIPI RESULTS-NORMS [7] VS. GROUP SCORE

TIPI Dimensions	Norms	Group Score	
		SMATSA	CCL
Extroversion	4,44	4,32	4,99
Agreeableness	5,23	4,68	4,58
Conscientiousness	5,4	3,84	6,00
Emotional Stability	4,83	4,04	5,58
Openness	5,38	4,27	5,27

V. DISCUSSION

The Kruskal-Wallis and Mann-Whitney tests have been applied first by comparing the responses of one group of participants with another (SMATSA vs. CCL) and then individually within the group. The analysis showed that there is statistically significant difference (*p*<0,05) of level of education between the two groups of participants (Sig.=0,001). Compared to the total number of participants per group (see subsection C), CCL participants have a higher level of education than those from SMATSA (the most of participants have master's degree and there is one participant with PhD). On the other hand, there is no statistically significant difference between the age and total work period compared.

A significant statistical difference was observed in terms of expectations of the level of future automation between the two groups of participants (Sig. p=0,001). Also, the easiness of use of the system is more important for the SMATSA participants than for those from the CCL (Sig. p=0,018) (Table II). This can be explained by the fact that SMATSA participants are older and for them easiness of use of the system is essential to make faster decisions without any mistakes.

The relationship between participants' age and their evaluation of total scales were examined individually within the groups. A statistically significant difference was found at the (p<0,05) level only for the total scale of faith and confidence (Sig.=0,002) in SMATSA case. This means that faith and confidence depend on ATCos' age. Statistically significant difference between CCL participants was not found.

The further analysis of SMATSA group showed that the statistically significant difference in evaluating the total scales between the first and second age category exists (Sig=0,024). That means that the confidence and faith is different for the participants who are 35 years old and less, and the others who are in the group between 35 and 50 years old. A similar situation can be seen between the first and third group. The difference in evaluation between these two groups is confirmed by the value of (Sig=0,003).

The second test is used to investigate the relationship between participants' total period of working and their evaluation of total scales individually by the group. A statistically significant difference was found at the (p<0,05) level only in SMATSA case of evaluating the total scale of faith and confidence (Sig.=0,008). This means that faith and confidence depend on ATCo's working experience. Statistically significant difference between CCL participants was not found.

The statistically significant difference was found in evaluating the total scales between the first and third categories of the total working period (Sig=0,017) in SMATSA case. That means that the confidence and faith are different for the participants who have more working experience than the ones who are beginners. A similar situation is between the second and third categories. The difference in evaluation between these two categories is confirmed by value (Sig=0,034).

On the other hand, if we asses the impact of SMATSA participants' age to their view of their personality traits, the Kruskal-Wallis test (p<0,05) has discovered that the participants' age can impact their assessment of two personality traits from the open-mindedness group: open to new experiences (Sig.=0,041), complex and conventional, uncreative (Sig.=0,022). There is no statistically significant difference between the CCL participants' age to their view of their personality traits.

The Kruskal-Wallis test showed that participants' working period doesn't have an impact on their view of their personality traits in both SMATSA and CCL case of evaluation. However, there is a statistically significant difference (p<0,05) between CCL examinees with the Bachelor's degree and Masters's degree (Sig=0,032) in the personal evaluation of personality trait "Reserved, quiet".

The Spearman's coefficient of correlation was used in examination of relationships between the participants' characteristics and their answers. The statistical significant correlation was found only in the case of SMATSA participants. Although medium, a statistically significant correlation (r=0,379, p<0,01) showed that participants' faith and confidence in advice and solution obtained by the system can be increased with age, while negative correlation (r=0,258, p<0,01) is obtained between their age and view of system accuracy. That means that with age the confidence in system accuracy may decrease - the younger participants may believe more in the system accuracy than the older ones. On the other hand, small, but statistically significant correlation (r=0,257, p<0,05) showed that the older participants prefer to use the automated system in stressful situations than to be without it, while the participants with more years of working experience would not feel a sense of loss of a system (r=-0,253, p<0,05). There is no statistically significant correlation between participants' characteristics and remaining questions.

VI. Conclusion and Further research

The ATCO trust study was deemed necessary because of the continued advancement of technology that accompanies the steady growth of air traffic. It was found that the ATCos understand how the automated ATC system works, and that they are sure that the system outcome is the same under the different conditions. The system gives them a sense of security, but they still rather believe themselves than the system in decision making. Also, the analysis showed that ATCos are not so satisfied with the reliability of the system they are using and that any improvements to the system tools would greatly improve their own performance. They agreed that the reliability is the most important system feature. The personality traits ratings suggest that SMATSA participants were more self-critical than CCL participants.

Among SMATSA participants, the analysis showed that ATCo's trust in an automated system depends on their age and work experience, as well as on the personal traits that stand out for their openness to new things, both in technology and in everyday situations. Among CCL participants there is no statistically significant difference between ATCO's answers.

However, there are some limitations encountered while conducting the study. First, the number of females was in both ATCo groups, so female ATCos were examined together with male ATCos. Second, because of the limited time to conduct the survey, a choice of short measure of the ATCo personality was made. This measure is based on self-reporting, creating the risk of not obtaining completely honest responses due to a lack of self-awareness approach. Finally, examined groups are not well balanced - there is a lack of beginner controllers, but also those who are older and have more work experience.

Focus of trust research in further steps, will be on the most commonly used tools by ATCo, i.e. to study how they could be improved leading consequently to improvement of trust. Also, the more detailed comparison of answers between two groups would be applied to determine what had a greater impact on differences between groups (e.g. using bi-factorial analysis of variance - ANOVA test). Further analysis of the personality traits using another type of measure is also planned. Those results should be compared with the already obtained ones to demonstrate the reliability of the results obtained in the previous research.

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