SOCIO-TECHNICAL IMPLICATIONS OF DIGITIZATION IN THE MAINTENANCE OF AIR SURVEILLANCE SYSTEMS

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Abstract: *Digitisation has become a topic of debate and a challenging topic of interest in increased fields. The transition from analogue to digital aerial surveillance systems has been a particularly major step as aerial surveillance has as a major requirement the provision of real-time airborne situation information. The maintenance of these systems is essential as their active operational status and their resilience to intentional disruptive factors, depends on their proper performance. The article treats the socio-technical relationship through the lens of digitisation with elements on blockchain, cloud, Big Data, Industry 4.0, IoT (Internet of Things), AI (artificial intelligence), AR (augmented reality). Through the SWOT analysis conducted the article identifies key points on the proposed topic and draws guidelines towards a bright digitalization horizon.*

Keywords: *digitization, human factor, air surveillance system, socio-technical relationship*

1. INTRODUCTION

We survived what we considered to be a tumultuous period, in which the pandemic was for each of us a challenge, a challenge to adapt to a completely unique environment, with the redefinition of inter-social relationships. Megginson wrote in 1963, "According to Darwin's Origin of Species, it is not the most intellectual of species that survives; it is not the strongest that survives, but the species that survives is the one that is best able to adapt and adjust to the changing environment in which it finds itself. " [1] The current period is by no means more relaxed but a particularly unstable one, with the military conflict in Ukraine being a catalyst for the European and global energy crisis. We are struggling to cope, adapting ourselves, our behaviour, our relationship to the environment.

Aerial surveillance systems are a particular facility with their early warning component. It is obvious that they need to be operational 24/7 and this can only be achieved with optimal maintenance. Digitisation, in successive stages, comes as a response to the challenges - a tool with which each of the daily processes that take place can be made easier. Digitisation must be seen not only as a component of information technology with its hardware and software components, but in direct connection with information and communication technology specialists and operators trained to operate technical systems.

The analysis of the socio-technical implications of the digitization of air surveillance system maintenance processes, sediments into a particularly important and topical topic. In order to identify the aspects that contribute to the fragility of air surveillance systems and to what extent their resilience can be improved, I have chosen to go one by one

through the aspects related to digitisation at the European Union level by treating the topics related to the integration of digital technology and human capital from the perspective of digitisation and ending with a SWOT analysis of the socio-technical relationship on the digitisation of air surveillance maintenance processes.

2. DIGITISATION IN THE EU

To better visualise the components involved, we have turned to some reports carried out at European Union level. In Fig. 1, the digital economy and society index [2] in 2021 can be seen by component. We can see at the top of the ranking with percentages between 60 and 70% countries such as Denmark, Finland, Sweden, Netherlands and at the bottom of the ranking with a level between 30 and 40% countries such as Bulgaria and Romania. The EU average for the Digital Economy and Society Index is 50%.

FIG. 1 Digital Economy and Society Index 2021

Romania, although it has recorded minor developments [3] in its score (Fig. 2), fails to outperform any of the EU countries and for the fourth consecutive year remains at the bottom of the ranking. This is partly due to political instability and poor governance.

	Romania		EU
	place	score	score
DESI 2021	27	32,9	50,7
DESI 2020	26	40,0	52,6
DESI 2019	26	36,5	49,4
DESI 2018	26	35,1	46,5

FIG. 2 Romania's digitisation situation

Another especially important aspect to consider is that Romania scores well in terms of the infrastructure needed for digitisation - connectivity. Romania ranks 10th in terms of connectivity. In 2020, it has improved its performance in terms of coverage, but stagnated in terms of overall usage. Broadband coverage has increased to 87%, reaching the EU average. Strong infrastructure-based competition in Romania, especially in urban areas, is reflected in the Very High Capacity Fixed Network (VHCN) coverage indicator of 76%,

well above the EU average of 59%. On the other hand, the components of human capital, digital technology integration and digital public services are at an extremely low level compared to the results recorded by other EU countries.

3. HUMAN CAPITAL FROM A DIGITISATION PERSPECTIVE

At EU level, we can see from Figure 3 that the number of employees specialising in information and communication technology (ICT) has remained constant, with the graph showing the percentage of these employees according to the size of the enterprise given the total number of employees.

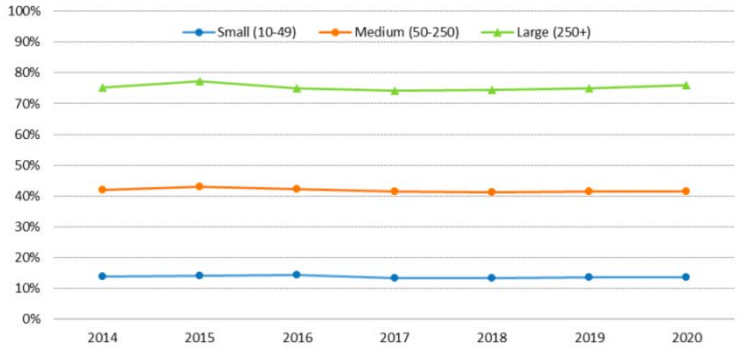


FIG. 3 Enterprises employing ICT specialists (% of enterprises), 2014-2020

An information and communications technology (ICT) specialist designs, maintains, and services systems used to store, retrieve, and send data. A broad spectrum of careers is available in this field, ranging from supporting a library's collection to running the technology used in military operations. Career qualifications can vary depending on the specific industry and the job, but may include a degree in computer science or a related field.

Using the simulator on the DESI platform of the European Union we have extracted data (Fig. 4) on the number of graduates with studies in information and communication technology from which we can notice that in the last 4 years there has been a more pronounced increase compared to other countries in the percentage of these graduates although Romania has a large number of graduates in ICT (4th place), the shortage of specialists keeps at a low level the country's ability to create innovate and take advantage of the benefits of digital transformation.

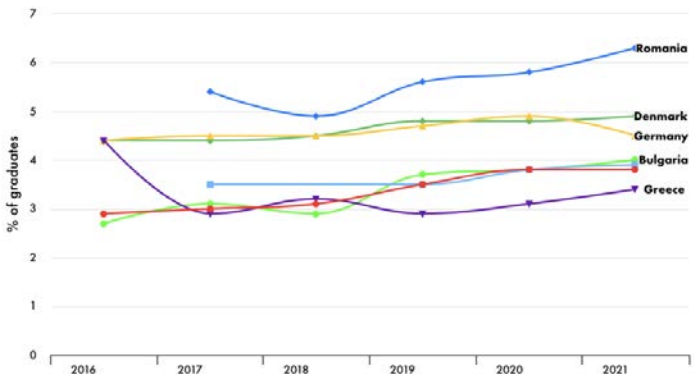


FIG. 4 Percentage evolution of ICT graduates

4. INTEGRATION OF DIGITAL TECHNOLOGY

To create the digital economy and society index in the chapter on digital technology integration (Fig. 5), three elements were considered, namely the intensity of digitisation of digital technologies for making and e-Commerce.

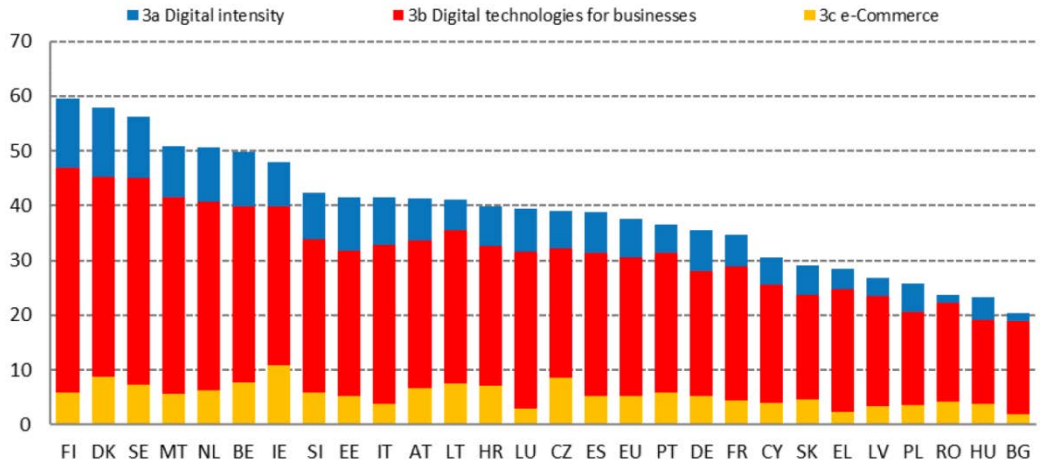


FIG. 5 Digital Economy and Society Index (DESI) 2021, Integration of digital technology. Source: DESI 2021, European Commission.

Romania ranks 25th in the EU in terms of integrating digital technology into business activities. Most indicators in this dimension are well below the EU average. Only one third of SMEs have at least a basic level of digital intensity, compared to the EU average of 60%. Although 17% of Romanian SMEs take advantage of the opportunities offered by online trade, more cross-border sales could be recorded. Only 17% of businesses issue e-invoices, well below the EU average of 32%. Around 8% of businesses use social media platforms (low compared to the EU average of 23%), 13% use **cloud** services (EU average: 26%) and only 5% of businesses analyse **large volumes of data**. At the same time, 31% of businesses use **artificial intelligence**, well above the EU average of 25%. The percentage of businesses using ICT for sustainability is 68%, slightly above the EU average of 66%.

5. DIGITALIZATION IN THE MAINTENANCE OF AIR SURVEILLANCE SYSTEMS

Logistics at the level of air surveillance systems has developed increasingly since it had to align the interoperability and capabilities of the structures of which Romania. Maintenance as part of logistics increasingly needs the benefits of digitisation in the sense that the costs involved are extremely high and need to be optimised. Maintenance has evolved from scheduled and corrective maintenance to predictive and reliability-based maintenance. Maintenance has always involved collecting data on temperature and noise levels, all of which was done with sensors interpreted by human factors. Digitisation has shown its benefits one by one as sensor data and signals could be monitored recorded and compared automatically with reference/catalogue data, the novelty of predictive maintenance being achieved by the predictive capability through Big Data analysis, using elements of artificial intelligence, able to provide decision support to decision makers.

Predictive maintenance insights are an extremely asset in improving the overall maintenance and reliability of an operation. Benefits include:

-minimize the number of unexpected breakdowns;

-maximize asset uptime and improve asset reliability;

-reduce operational costs by performing maintenance only when necessary

-maximize production hours;

-improve safety;

-streamline maintenance costs through reduced equipment, inventory costs, and labour.

6. IDENTIFICATION OF OBSTACLES IN AI IMPLEMENTATION

Following the analysis, we have identified several shortcomings, most of them related to the human factor at both the executive and decision-making levels. We have thus sought to identify the obstacles to the implementation of artificial intelligence as a way of supplementing the shortcomings previously identified. Based on surveys conducted by the Ipsos company [4], we identified four such obstacles highlighted in figure 6, as follows:

- difficult to hire new staff with the right skills;
- the cost of adoption;
- the cost of adapting operational processes;
- lack of skills among existing staff.

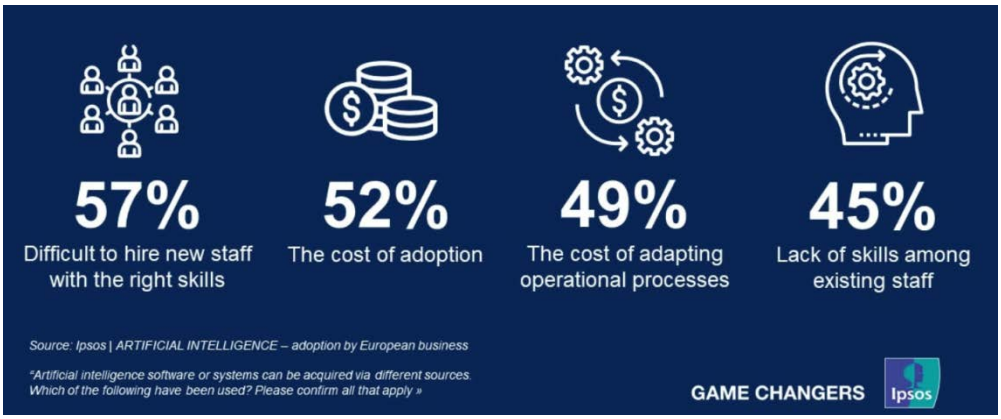
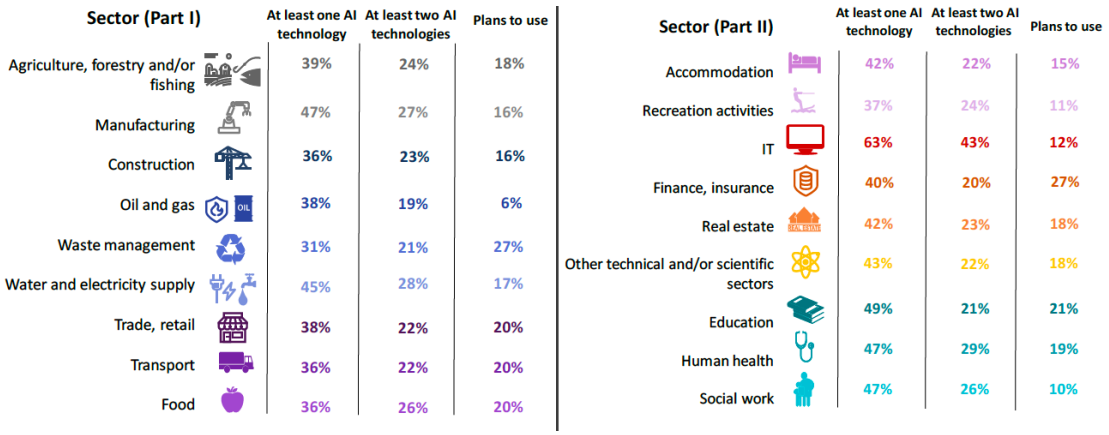


FIG. 6 Obstacles identified in implementing IA

To get a more eloquent picture of the implementation of AI technology, we have taken the results of Ipsos' survey [5] of companies in the EU27 (excluding the UK, Iceland and Norway) in which respondents (8861) were asked "What is the state of implementation of AI technology in your company?" The results (Fig. 7) were categorised into two sectors by business area (the first part with technical profile companies from agriculture, construction, transport, waste management, sales and food, and the second part with social-human profile companies from hospitality, IT, real estate investment, education, health, research sector).



Sector (Part I)	At least one AI technology	At least two AI technologies	Plans to use
Agriculture, forestry and/or fishing	39%	24%	18%
Manufacturing	47%	27%	16%
Construction	36%	23%	16%
Oil and gas	38%	19%	6%
Waste management	31%	21%	27%
Water and electricity supply	45%	28%	17%
Trade, retail	38%	22%	20%
Transport	36%	22%	20%
Food	36%	26%	20%

Sector (Part II)	At least one AI technology	At least two AI technologies	Plans to use
Accommodation	42%	22%	15%
Recreation activities	37%	24%	11%
IT	63%	43%	12%
Finance, insurance	40%	20%	27%
Real estate	42%	23%	18%
Other technical and/or scientific sectors	43%	22%	18%
Education	49%	21%	21%
Human health	47%	29%	19%
Social work	47%	26%	10%

FIG. 7 Status of AI implementation in EU27 companies

We conclude that Artificial Intelligence, although it is so much in the news, is to a small extent embedded in companies and society. Its potential, together with the benefits of Big Data with entry item collection and analysis, the use of cloud servers, the interconnection of devices at the IoT level, bringing us closer to Industry 4.0, integrated and exploited to their true value, give a clear direction where we are heading.

7. SWOT ANALYSIS ON THE SOCIO-TECHNICAL RELATIONSHIP DIGITALIZATION IN THE MAINTENANCE OF AIR SURVEILLANCE SYSTEMS

The human-machine relationship has always been a challenge because man is prone to reluctance to new things, to a reluctance to leave his comfort zone. The proposed SWOT analysis (Table 1) aims to identify the strengths and weaknesses and opportunities of this relationship so that we can chart a bright digitalisation horizon.

Table 1 - SWOT analysis of the socio-technical relationship on the digitisation of maintenance processes

STRENGHTS - Digitising maintenance increases the accuracy of identifying components at risk of failure; - Reduces maintenance times; - reduce the time it takes to bring the technique out of service; - Increasing the processing power of collected data using elements of artificial intelligence and self-learning;	WEAKNESSES - Staff training is slow due to a reluctance to learn; - The lack of simulators makes it difficult to train operators; - Staff shortages at instructor level for operator training; - Staff shortages at operator level;
OPPORTUNITIES - Using augmented reality to train operators; - Stimulating staff to fit specific maintenance structures to the air surveillance system; - Covering the full spectrum of faults requiring maintenance, using simulators and augmented reality techniques; - absorption of funds for equipping repair workshops and improving operator training laboratories; - Using block chain for maintenance processes;	THREATS - securing the digital infrastructure against cyber-attacks; - Possibility of remote penetration of computer systems and disruption of power chains required for maintenance; - malicious delays in maintenance processes by affecting logistics steps;

Analysing the strengths and weaknesses we see once again that the problematic element, without which maintenance cannot be achieved, is the human factor. Firstly, we are faced with a shortage of staff due to the unattractive environment and secondly due to their poor level of training.

8. CONCLUSIONS

The current energy crisis, catalysed by the conflict in Ukraine, is urging and forcing us to rethink our systems and identify and exploit conventional and renewable energy sources. Air surveillance systems, with their obligation to be able to provide 24/7 airspace information, require maintenance under any conditions and at any cost. Predictive maintenance is preferable, where sensor data is integrated into digitised systems, to make the necessary valuable predictions and provide decision-makers with viable options. At the same time, we note the difficulties in recruiting appropriately trained personnel and the difficulty with which digitisation solutions are accepted and implemented in aerial surveillance systems.

We propose the following directions:

- Develop the selection base of young people by stimulating education, technical training hubs;
- Stimulating the training of young people with potential for personal and professional development;
- Increase the attractiveness of maintenance jobs by clearly demarcating administrative and bureaucratic tasks;
- Filtering staff through regular testing and re-staffing on a grading scheme that clearly demarcates staff by competence levels;
- Material and financial incentives for maintenance staff who perform to the highest standards;
- Provide training opportunities with external partners;
- Implementing innovative technologies as quickly as possible, like our partners in more developed countries, while maintaining stability, physical and cyber security, and air surveillance systems.

Rigorous planning that will consider the relevant wishes of the executive staff in the maintenance of aerial surveillance systems, allocation/access to investment funds, organic implementation of new technological solutions, will ensure that in the future the depreciation of equipment will be rapid and the resilience of aerial surveillance systems will be at its maximum.

ACKNOWLEDGEMENT

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