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# Adoption of Artificial Intelligence in Romania: Innovative Policies to Overpass Vulnerabilities with TRIZ and Deep-Thinking Tools

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**Abstract.** Adoption of artificial intelligence (AI) in all aspects of society and the economy is a major desiderate at the EU level. Nevertheless, this demarch is influenced by a series of contexts and endowments, such as talents, sophistication, and specificity of the business models, maturity of public processes, social mindset, etc. This paper analyzes opportunities and threats associated with AI adoption in Romania, possible measures to improve the predicted outcome together with lessons learned at the global level. The research methodology includes analysis of the current situation and formulation of innovative solutions to overpass various barriers and constraints. Based on TRIZ and deep-thinking approaches we formulate novel policies to overpass the status of evolution and create a new foundation for AI development and adoption in the Romanian ecosystem, with implications at the EU level. TRIZ and the deep-thinking systematic approach reveal several healthy patterns of evolution to deviate the current course of actions toward better results and outcomes. Critical findings relevant to AI at the EU level are also underlined in relation to the conclusions at the national level.

**Keywords:** Artificial Intelligence, Public Policies, TRIZ, Deep Thinking, Critical Analysis.

## 1 Introduction

Artificial Intelligence has become a disruptive factor in the global arena of economic and geopolitical competition. US, China, and Russia are all defining their own strategies and taking decisive measures to ensure their competitive dominance in this area [1]. European Union recognizes this fact and aims to become a major global player: *“The EU should be ahead of technological developments in AI and ensure they are swiftly taken up across its economy. This implies stepping up investments to strengthen fundamental research and make scientific breakthroughs, upgrade AI research infrastructure, develop AI applications in key sectors from health to transport, facilitate the uptake of AI and the access to data.”* [2]. European Union is also aware that not fulfilling these objectives will have severe long-term detrimental effects: *“Without such*

*efforts, the EU risks losing out on the opportunities offered by AI, facing a brain-drain and being a consumer of solutions developed elsewhere.” [2]*

In this context Romania must have a clear and sound strategy for Artificial Intelligence adoption, finding the relevant niche that fits its national strengths and capabilities. Failing to do so will drastically reduce Romanian’s economic competitiveness and will lead to long-term underdevelopment of the Romanian society.

## **2 Methodology**

Our approach applies deep thinking [3] to identify causes, and TRIZ [4] to propose proper directions of interventions. Deep thinking is a thinking process that reveals something beyond what we can simply see and sense of. Deep thinking includes the following steps: analytical thinking, communication, creativity, open-mindedness, problem-solving. Analytical thinking focuses on gathering and breaking down of information into small, till relevant parts. Communication gives us access to the thoughts of people and experts. Creativity helps us to make new models and associations. Open-mindedness reveals new possibilities, helping us resolve matters in a manner that doesn’t hinder interested parties. Problem-solving indicates appropriate patterns of action. TRIZ and 5Why can be some of the supporting tools in problem-solving.

## **3 Systematic analysis**

For approaching the analytical thinking of the AI landscape in Romania, we consider a model proposed in AI Watch Index, which is a report generated by the Joint Research Center of the European Commission [5]. The core of AI Watch report is based on several high-level dimensions: global view on the AI landscape (G), industry (I), research and development (R), technology (T), society (S).

Based on this model we investigate the Romanian landscape. Results reveal several challenges that are further tackled with TRIZ and deep-thinking models. This creates the space for formulating smart public policies to accelerate AI adoption in Romania.

### **3.1 Core Dimensions**

We will further refine the AI Watch report’s set of dimensions to be better contextualized for Romania. We will consider the following dimensions:

*Data:* The data dimension measures the availability of data along with its quality and dynamics. Ensuring that the data is properly collected, processed, and utilized is a prerequisite for developing a relevant, high impact, AI industry.

*Infrastructure:* The infrastructure dimension measures the availability of infrastructure for developing AI applications. The infrastructure consists in essential elements such as data storage & processing services, computing resources or access to AI services; a good infrastructure is a very important accelerator for the AI industry.

*Business:* The business dimension analyses the applications of AI in the business domain and in the creation of economic value. AI needs to provide relevant business value in order to become adopted at large scale in the economy.

*Society:* The society dimension measures the social impact, acceptance, and adoption of AI, along with the education of society in regards with AI concepts, benefits, and threats. Acceptability of AI at social level, perception of AI as a positive factor in the workplace and in the day-by-day life will strongly accelerate the adoption of AI in society.

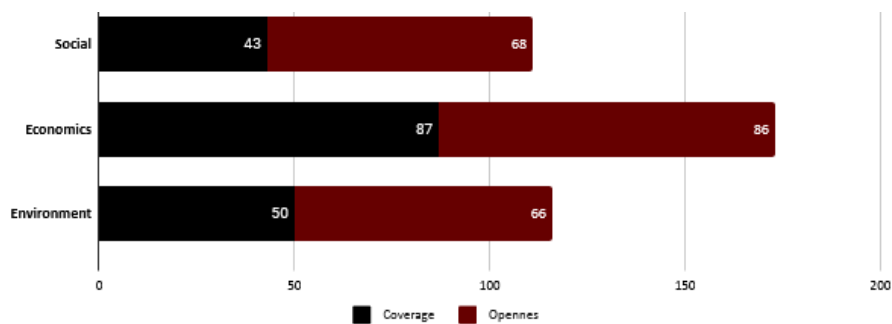
*Talent:* It reflects the availability of qualified personnel (be it developers, data scientists or AI engineers) capable to sustain the dynamics and complexity of an AI-based industry. The availability of talented people is essential for creating a sustainable AI industry.

*Governance:* This dimension measures how well the Artificial Intelligence is governed. A good Artificial Intelligence governance promotes ethical and beneficial use of Artificial Intelligence, along with the necessary regulations protecting the citizens and the state against malicious and unethical utilization of Artificial Intelligence.

### 3.2 Data Dimension

We will focus on two major concerns related to data: how easily is to access it (open data) and how meaningfully is the data utilized (collected, processed, or further utilized in the value creation). For measuring the data access, we are using the Open Data Inventory [6] from Open Data Watch which puts Romania on rank 37 out of 187, with a score of 73 out of 100 in regards with data openness. Romania scores very well on open data for population & vital statistics, national accounts, and financial data. It scores very low on food security & nutrition, crime & justice, and built environment.

Romania achieves 69% of maximum score according to the DESI 2021 country's profile, well below the 78% value representing the Europe's average [7]. A quick overview of Romania's Open Data Inventory scores in terms of data coverage and openness on several areas is presented in Fig. 1.



**Fig. 1.** Sub-scores by statistical subcategories, Romania Open Data Inventory, 2020.

Regarding data processing, Romania has a below average performance, only 5% of SMEs analyze big data (compared with an average 15% at the European level) [8].

Furthermore, according to Eurostat, only 4% of Romanian SMEs analyzed big data in 2020, well below the 12% average of EU27 zone [9]. Therefore, Romania has at best a modest performance in the area of data, especially usage of big data for analysis. On a positive note, based on the DESI 2021 Index, 31% of the Romanian enterprises are using AI – higher than the 25% European average value.

### 3.3 Infrastructure Dimension

The infrastructure dimension covers aspects such as connectivity, usage of cloud computing services, storage services or dedicated edge computing hardware. From the perspective of technology enablers, we can observe that in 2020 Romania outperformed the global average in the area of Broadband connectivity and underperforms in the area of Cloud, AI and IoT [10]. This is highlighted in Fig. 2.

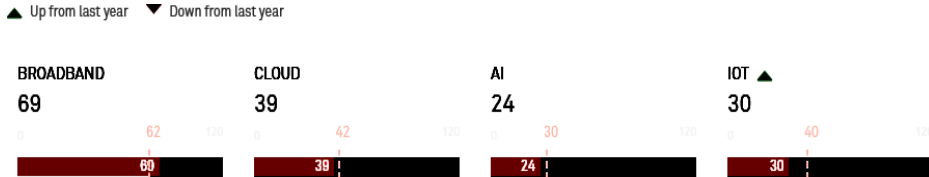


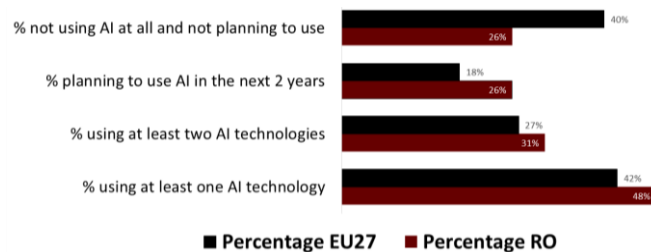
Fig. 2. Huawei GCI 2020, Romania County Profile.

Regarding the usage of cloud computing services, in 2021 only 14% of the Romanian enterprises used cloud services over the internet, compared to the EU27 average value of 41%. Compared to 2020, the trend is decreasing (in 2020 the percentage was 16%), even if the EU27 average is increasing (36% in 2020). This value is positioning Romania towards the lower end of the ranking among the EU27 countries [11].

An important aspect of the infrastructure is connectivity; here Romania outperforms the EU27 average. According to DESI 2021: “(...) while progress continued in 2020 for fixed broadband coverage, take-up of broadband services progressed at a slower pace. Nonetheless, Romania ranks 7th thanks to the high take-up of at least 100Mbps broadband (52%)” [12]. Therefore, Romania has a very good performance in terms of connectivity and a below average performance in terms of Cloud, AI and IoT infrastructure usage. A good connectivity allows Romanian companies to use global services solutions (such as Microsoft Azure or Amazon AWT) in order to compensate for the lack of competitive computing resources present at the national level.

### 3.4 Business Dimension

Adoption of AI by the business is a critical success factor for a competitive AI economy and market. The Romanian businesses are very open (above EU average) for adoption of Artificial Intelligence elements in their business processes [13] (see Fig. 3).



**Fig. 3.** AI adoption by enterprises, European Union, 2020.

Almost 50% of the Romanian companies are using at least one AI technology, the number of companies not planning to use AI are in minority (40%). From the standpoint of AI domains relative comparative advantage, Romania offers a very good performance in the area of automation [14].

As a consequence, Romania presents a very favorable climate for the adoption of AI at the business level, especially for the business oriented towards automation.

### 3.5 Society Dimension

Ensuring that AI is adopted at the society level creates the premises for a strong AI market backed up by a large mass of AI technology consumers. It is important to understand the social sentiment in relation to AI technology (expectations and emotions) along with the social opportunities created for AI utilization.

In a study on the Romanian generation Z and its positioning versus AI it was discovered that “... *the Romanian students’ knowledge about AI is fairly limited and does not stream from formal education but rather is founded on social media finds.*” [15]

Regarding the adoption of AI at the workplace, the Romanian society displays a low level of concern [15], less than 15% of the respondents feel threatened by the changes brought by adopting AI at the workplace.

From the standpoint of the AI education offer, Romania performs very well. In terms of relative importance of AI education, approximately 14% of all the Bachelor and approximately 18% of Master places are dedicated to university education in AI [16]. With these values, Romania ranks 2nd and 1st place in AI intensity for Bachelor and Master level of studies in university.

As a conclusion, the Romanian society is relatively uninformed in regards with AI, most of the information being gathered from social media. On the other hand, the Romanian society is very open to including AI at the workplace and preparing for the knowledge necessary to do it.

### 3.6 Talent Dimension

Talent is crucial in any information-based economy, especially when dealing with AI. The range of AI activities that can be performed with a low degree of skills is usually very limited, mostly focused on data manual annotation.

Romanian companies are mostly at the beginning of their journey in the area of AI, and they are looking for expert skills in the area of big data management, machine learning and programming. The two most important barriers to the AI adoption are lack of skills among existing staff and difficulties to hire new staff with the right skills [17].

Romania has a low proportion of ICT specialists in total employment (2%) compared to Europe's baseline value (4%) [16]. By extrapolation, this indicates a low performance in regard to AI talent. The situation is exacerbated by the negative outlook of the productivity of the future Romanian generations because a “(...) *child born in Romania today will be 58 percent as productive when he/she grows up as he/she could be if he/she enjoyed complete education and full health. This is lower than the average for Europe & Central Asia region and high-income countries*” [18].

In conclusion, Romania has a strong deficit of talent in regards with the AI-related skillset. AI companies are identifying that lack of talent is one of the major barriers to growth, yet the projection for AI skillset demand fulfillment have a negative outlook.

### 3.7 Governance Dimension

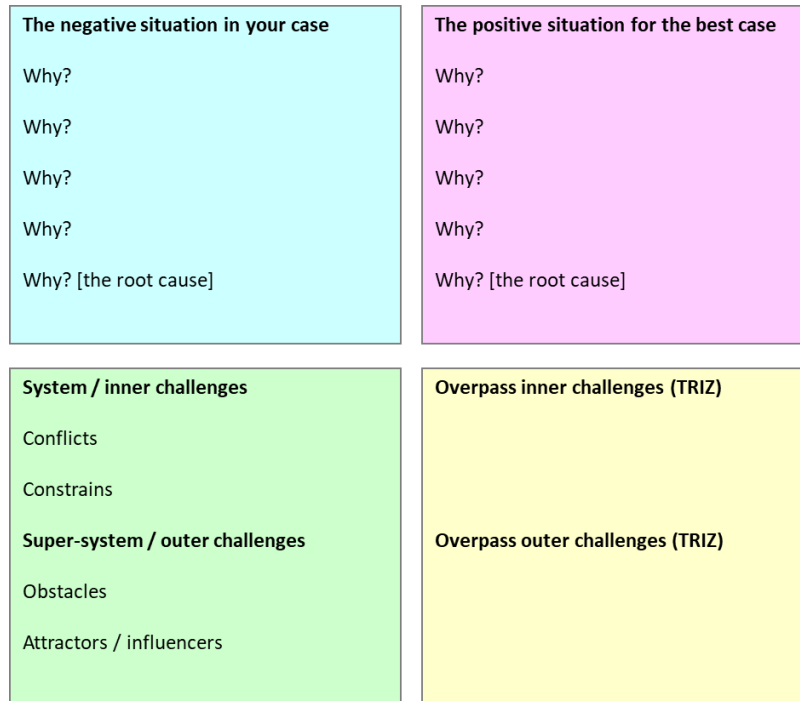
A good governance will ensure that the moral, ethical, and legal criteria usage will be applied consistently for AI usage. Failing to do this will create rejection of technology, fears, algorithmic discrimination, or social bias. The Romanian legislation does not grant any legal status to, nor does it recognize the “Artificial Intelligence”-related profession. Therefore, any content produced by Artificial Intelligence is not protected by the copyright law. There is also no special liability provision for damages generated by the usage of AI. Damage and liability are covered by the provisions of the Civil Code, which in itself is poorly adapted to an environment heavily infused by AI. Also, from a strategic perspective there is no official strategy for AI yet. There is however an official initiative directed by the Authority for the Digitalization of Romania to create a first AI strategy together with the Technical University of Cluj-Napoca [19].

In conclusion, Romania is lagging behind in the area of AI Governance. While there is a general consensus in Romania that there should be a better governance (strategy, legislation, ethical framework, etc.), real results have still to be achieved.

## 4 Tackling with Challenges

The analysis highlighted in the previous subsections indicates several challenges for Romania in adoption of AI by both public and private sectors. It is obvious that a natural direction of intervention is to improve conditions towards creation and adoption of AI solutions and to use them for generation of public and private value. But this is not the right way of action, because it reflects a wish, not a smart, realistic strategy. This leads to the need for identifying causes of the observed situation and afterwards to the foundation of policies capable to tackle causes in an intelligent way, meaning to overpass barriers in an “out-of-the-box” way. Here we consider the other four steps of deep thinking, specifically communication, creativity, open-mindedness, and problem-solving. These steps are aggregated in a structured framework, illustrated in Fig. 4.





**Fig. 4.** The 4-window framework for designing smart policies.

#### 4.1 Application of the 4-window framework

Because of the space constraints, we will introduce in the followings only one example about how the problems can be tackled with the roadmap from Fig. 4. In this respect, we have selected the situation “Romania has a strong deficit of talent in regards with the AI related skillset”.

Usually, such ascertainment is reflected in a strategy under the form of “increase the number of training programs in AI” or similar policies. But this is a very wrong approach because the problem is not necessarily created by the lack of training programs in AI. The lack of sufficient training programs in AI is the effect, not the cause(s), and the lack of talent in regards with the AI related skillset is actually one of the negative impacts on data-driven innovations.

With these remarks, the subsequent part of this section will illustrate the 4-window framework application for the above-mentioned situation.

*Window 1: The negative situation in our case.* Romania has a strong deficit of talent in regards with the AI related skillset.

*Why?* – Because there are no trained personnel on the workforce market.

*Why?* – Because there is an imbalance between demand and supply for AI skillset. The AI skillset supply capabilities significantly lagged behind the demand curve generated by the disruption brought in by AI.

*Why?* – Because the mass education system (e.g., high schools or universities) cannot supply enough trained personnel to cover in due time the surge in demand for AI skilled personnel.

*Why?* – Because the mass education system has a significant inertia, and it is unable to adapt quickly to disruptive events.

*Why?* [root cause] – This is a systemic issue, mass education system – by design – takes a significant amount of time (e.g., years level of magnitude) to adapt to changes in the industry/market demand. It takes time to develop and approve specialized new learning curricula, to hire or retrain teaching personnel, to perform organizational/administrative changes or to open new educational lines. When a disruption happens, the mass education system is unable to respond quickly enough to make a difference.

*Window 2: The positive situation for the best case.* There will be an influx of skilled AI personnel that will cover the demand of the industry. A good example is US which “... has a substantial lead over all other countries in top-tier AI researchers ...” [20].

*Why?* – Because US has the largest contingent of top AI researchers (59% of the global researchers) [20].

*Why?* – Because US is attracting and retaining the large majority of the AI talent (~80% of the international AI PhD students intend to stay in US after graduation) [21].

*Why?* – Because both the top 3 AI university programmes (Carnegie Mellon University, Massachusetts Institute of Technology and Stanford University) and the top 3 AI research centers (Google, Stanford University, Carnegie Mellon University) are in US.

*Why?* – Because there is a strong entrepreneurial approach towards both education and research; thus, providing the most competitive services and ensuring a viable supply chain - from education to work.

*Why?* [root cause] – Because the US society and economy have an entrepreneurial nature, seizing opportunities and having the necessary agility to provide the services that are in high demand on the market.

*Window 3: Challenges that create difficulties to jump to the target result.* Here we analyze the conclusions from window 1 (top-left in Fig. 4) in conjunction to the conclusions from window 2 (top-right in Fig. 4). Thus, the gap analysis is clearly focused.

*Inner conflicts:* Two major conflicts are highlighted in relation to our case.

- (CF\_1) We want to increase the agility of programs in the mass education system (to include new courses, such as AI), but this requires a fast expansion of the pool of highly trained teaching staff in AI, with a balanced distribution at the national level and less inertia of the higher education programs. Thus, our challenge is how to increase the basin of highly trained teaching staff in AI at national level and how to introduce AI courses in all higher education specializations (from engineering to medicine, biology, fine art, social, etc.), without creating harmful side effects in the current study programs (e.g., additional costs, removing of current courses, etc.).
- (CF\_2) We want the formation of AI skillset taking place as early as possible (e.g., high school), but this clashes with the lack of skilled teachers capable to teach AI for kids. Thus, we face with the need to motivate existent computer science/STEM teachers from schools to learn AI and teach it to young students from high school with no complicated efforts.

*Inner constrains:* Three major constrains are illustrated in this case.

- (CO\_1) The number of students in the Romanian universities that attend and are passionate of AI is limited (even if it is growing).
- (CO\_2) The skillset required to follow of AI curricula is too high for the majority of Romanian students.
- (CO\_3) The availability of AI-oriented academic staff in the Romanian universities is still limited.

*Outer obstacles:* From the level of supersystem we extracted three obstacles.

- (OB\_1) The vast majority of Romanian students trained in universities abroad (e.g., US, UK, France, Germany, the Netherland, etc.) are not returning back in Romania.
- (OB\_2) Romania fails to attract foreign AI talent (e.g., see the couple of weaknesses in the Romanian ecosystem highlighted in section 3).

*Outer influencers / attractors:* Three attractors have been seen as critical in our case.

- (AT\_1) AI salaries and bonuses outside Romania remain very attractive.
- (AT\_2) AI work and research opportunities are higher outside Romania (e.g., other workforce markets (such as US, Germany, France, Canada, UK) are more attractive from a professional perspective for good AI specialists).
- (AT\_3) The number and quality of foreign AI startups is higher.

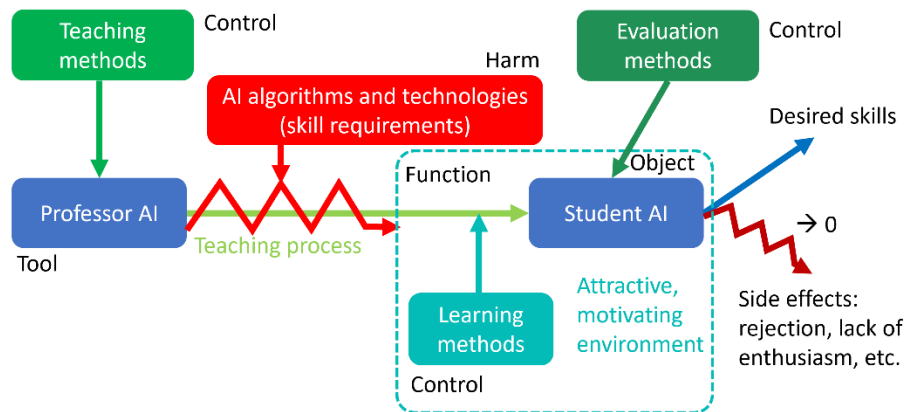
*Window 4: Innovative solutions.* At this phase, we consider the determined conflicts, constrains, obstacles, and attractors as major areas of investigation to formulate innovative solutions to our problem. For this job we use basic TRIZ tools.

*TRIZ generic areas of intervention to overpass inner challenges:* To tackle the conflicts CF\_1 and CF\_2, TRIZ contradiction matrix is very suitable. Thus, CF\_1 can be expressed in TRIZ language as “Increasing <26. Amount of substance>” vs “Reducing <31. Harmful factors>”. CF\_2 is described in TRIZ as “Increasing <39. Capacity>” vs “Minimal <19. Energy spent>”. Inventive principles related to CF\_1 that emerge from this situation are “Local quality”, “Parameter changes”, “Composite structures”, and “Inert environment”. In the case of CF\_2, inventive principles are “Preliminary actions”, “Periodic actions”, “Parameter changes”, and “Strong oxidizers”.

Constrains limit the space of action for policies. To manage constrains, we consider the ASIT method [22] and Su-Field method [23] from the TRIZ toolbox. ASIT operates with two powerful principles: the principle of “closed universe” and the principle of “qualitative change”. To convert a problem into a solution, the “closed universe” principle looks for smart reconfiguration of the current system at the level of subsystems, properties, objects. The “qualitative change” principle searches for the factors causing the problem and operates in a way that changes the direction of these factors for annihilating or dramatically reducing their effects. The *list with problematic objects and properties inside the system* is [“students”, “migration”, “academic staff”, “complexity of AI – mathematics and programming”]. The *list with objects and properties outside the system* is [“demography”, “focus of local companies on AI”]. Complexity of AI reduces the long-run interest of students on this subject. Also, the limited focus of local companies on AI usage narrows the interest of many students to specialize in AI. *Unwanted effect:* low adoption of AI in economy and social spaces (note: adoption of AI

increases public and private value because of optimization of systems, better predictions, acceleration of structural transformation for social and business models, etc.). *Derived action to overpass unwanted effects*: acting such that complexity of AI not representing a barrier for students, professors, and companies. *Selected objects to be transformed*: the most critical objects to be transformed are the students and professors. If they will adopt more openness to AI, the other objects can be positively altered in the chain of influences. *Main resources of the selected objects*: motivation, time, mindset, methods, and tools to learn or teach. *Application of operators*: ASIT uses five operators to act upon the system (i.e., division, elimination, unification, breaking symmetry, multiplication). We can use any of these operators to produce transformations in the system. Our analysis indicates that “breaking symmetry” is the most appropriate operator in this case. *Application of operator*: we imagine that asymmetry is applied on resources associated to students and professors (e.g., motivation, time, mindset, methods, and tools to learn or teach). *Scenarios*: (a) asymmetric effects on AI graduates; (b) asymmetric effects on AI professors; (c) non-conventional methods and tools to teach; (d) non-conventional methods and tools to learn; (e) asymmetric triggers on students; (f) asymmetric triggers on professors. *Basic idea*: certificate for AI graduates; salary bonus for professors; associate trainers from industry; online platform with video training materials accessible to everyone; video training materials with simple-terms explained AI; examples of use cases from the national ecosystems; learning by doing projects; compensate complex mathematics with libraries provided by various technologies; exercises with gradual complexity; inclusion of chapters about deployment into production.

The Su-Field method is applied on the three constrains CO\_1, CO\_2, CO\_3, in the form of “object-function-tool”. Object is associated to CO\_1 (# students attending AI courses), function is associated to CO\_2 (skillset required for AI courses), and tool is associated to CO\_3 (#AI-oriented academic staff) (see Fig. 5).



**Fig. 5.** Su-Field model for our case.

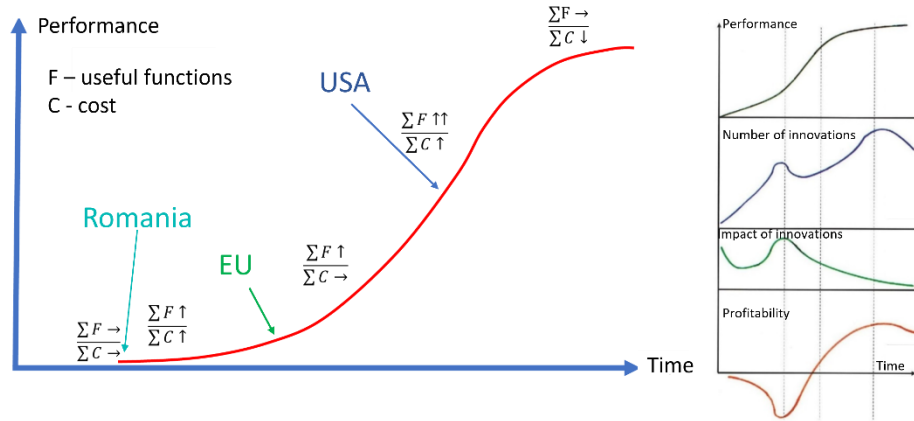
We can consider several standards to tackle CO\_1-CO\_2-CO\_3 model. *Investigation of the Su-Field standards* indicates the following possible ways of action: (a) Standard 1-1-1: introduce a new substance or field in the model (see Fig. 5, teaching methods);

(b) Standard 1-1-2: introduce an additive in the model to increase control (see Fig. 5, leaning methods); (c) Standard 1-1-3: introduce a new substance to an external substance (see Fig. 5, evaluation methods); (d) Standard 1-1-4: add a substance from external environment (e.g., trainers from industry); (e) Standard 1-1-7: add a substance to one of the substance to intensify the effect (e.g., prizes from industry in a graduation contest); (f) Standard 1-2-3: to minimize the undesired effects introduce an additional substance that attracts the negative effects (e.g., grants from industry for graduates in AI with high quality results).

*TRIZ generic areas of intervention to overpass outer challenges:* Obstacles require for more resources in the system to make it capable to move forward. Attractors generate new behavioral patterns that interfere with traditional patterns and lead to disruptions in the system, mostly with harmful effects that require reinventions in the current system to move it forward. In our case, both obstacles OB\_1 and OB\_2 relate to the same generic challenge: attraction of AI talents. To tackle this challenge, we selected the ARIZ method from the TRIZ toolbox. ARIZ encourages us to look first for the ideal final result (IFR). This messages us not falling into the trap of predefined actions. From this angle, we will look for the solution by investigating the four rules of ARIZ: (a) rule I (separate opposed properties in time); (b) rule II (separate opposed properties in space); (c) rule III (separate opposed properties between the system and its parts); (d) rule IV (coexistence of opposed properties in the same substance in different contexts). One idea emerging from these rules is about not necessary having these AI talents located in Romania, but rather to have them working for or running businesses located in Romania. The second idea is working in virtual companies, who have locations in more countries, thus fitting for each problem the best location (e.g., headquarter in country X, R&D in country Y, education in country Z, etc.). The third idea is to involve trainers from abroad using blended learning approaches.

All three attractors, AT\_1, AT\_2, and AT\_3, are generically related to the same issue: other locations in Europe and Northern America have more incentives to attract talents in the field of AI than Romania. This is about clustering effect, and it cannot be compensated on short term with local alternatives.

From a TRIZ judgement, we have to analyze the S-curve of the ecosystem and to understand the place of the Romanian ecosystem on this curve and the adequate direction of evolution [24]. Here we have the law of ideality [24], which can help us to position the ecosystem on the S-curve based on the ratio between the performance of useful functions and the level of costs involved. Our analysis is graphically illustrated in Fig. 6. This indicates that the AI ecosystem in Romania is at its very early stage on the life-cycle curve, far away from the reference (US). This is mostly related to the number of local innovations in AI, level of maturity, number of adopters and effects on their businesses, as well as maturity of the innovators. One of the big barriers, as it was already highlighted is the lack of adequate data in the private sector. However, not even in the public sector there is no relevant data. For example, initiatives such as smart cities are still at their bottom level of maturity, meaning that solutions that collect massive data in cloud are only few, and in few places.



**Fig. 6.** S-curve of the AI ecosystem (comparative analysis).

Based on the laws of evolution and patterns of evolution [25], we can indicate that the AI ecosystem from Romania is very young. From the eight laws of evolution, it is actually marked only by static laws, still missing any kinematic or dynamic law at the level of every subsystem. The most striking law is in fact the law of the “completeness of the parts of the system”. Thus, in terms of patterns of evolution, we indicate the need to evolve towards more useful functions in the ecosystem, with a careful attention paid to a balanced evolution of all subsystems, followed by the evolution of applications. Any other strategy of evolution is not effective from the perspective of TRIZ philosophy. Thus, ambitions to invest at this stage of evolution in sophisticated technologies, such that micro/nano-electronics for AI or quantum computing will be “black holes”, because of many gaps currently present in the ecosystem. This kind of mistake was already done with the megalomaniac project of “laser valley”, which is not capable after more than 15 years to produce something and which dramatically lowered the country’s funds in other research areas.

## 4.2 Proposed solutions

Based on the insights from section 4.1, we can formulate more argued and grounded public policies on the dimension related to “AI talents”. Similar approaches can be applied for the other remaining five dimensions (see section 3). These public policies will be based two strategic pillars: (a) full spectrum coverage and (b) talent retention.

**Full spectrum coverage.** AI (both as a discipline and an industry) requires a variety of skills - such as data annotation, data modelling, data engineering or machine learning model creation. The full spectrum coverage principle considers the fact that Romania should be able to provision the full spectrum of AI skills needed by the industry – both from timing and volume perspectives. Romania lacks the capabilities of supplying these skills internally, especially via mass education system; therefore, we should look for a blend of education suppliers and innovative teaching tools (see the S-curve from Fig. 6). We are proposing the following main lines of action:

*Early development of generic AI skills*, these skills should be taught the latest in early high school - with a focus on practical applications of AI for solving general problems. The curricula for generic AI skills should focus on fundamental data skills (such as collection, exploration, visualization, and transformation) and black box utilization of Data Science and AI for solving practical business and industry challenges. Furthermore, the curricula for study specializations should consider applied AI as a core element for specialization's business processes augmentation [see the TRIZ principle "parameter changes" proposed in section 4.1].

*Externalization of specialized AI skills* which are too expensive or too rare for extensive usage, thus ensuring a better cost control and a better availability of these skills. This externalization may be done towards specialized research institutes, digital innovation hubs, consulting firms or via outsourcing/near shoring. We also include here the invitation of trainers from abroad in blended learning programs [see ARIZ recommendations from section 4.1].

*Creation of complex educational networks*, thus reducing the reliance on an inertial mass education system. This complex education ecosystem should consider both an extensive blend of education suppliers (such industry trainers, consulting companies or digital innovation hubs) and agile/innovative learning methods (online training, collaborative AI application development or learning by doing). We encourage the creation of AI courses and exercises by the best experts and professors, record and disseminate them in all universities as basic teaching materials [see from section 4.1. the TRIZ results about local quality, inert environment, parameter changes, and ASIT conclusions] and renewal at every two years [see TRIZ in section 4.1 about periodic action]. It is also important the creation of training programs delivered by private academies and companies, combined with tests and recognition organized in universities [see in section 4.1, the TRIZ results about composite structures and Su-Field and ASIT conclusions]. In the same context, public policies should consider salary bonuses for teachers that are trained with certificate and teach AI in schools [see in section 4.1. the TRIZ results about preliminary actions and strong oxidizers], as well as dedicated grants, prizes, and certificates for students that graduate AI specialization, besides their core specialization profile [see the conclusions of ASIT and Su-Field in the section 4.1].

**Talent retention.** Due to a lower financial and professional attractiveness, Romania should find non-conventional solutions for retaining its talent. We propose the following measures:

*Incentivize the top AI performers*, such as AI researchers or inventors. This incentivization should be covered by subsidies for patent applications, simplification of access to public research funding or facilitation of interaction between researchers/inventors and companies/public bodies. We are advising against indiscriminate financing (e.g., first come – first served policies) in regards with AI research [see conclusions from section 4.1, ARIZ].

*Ensure fiscal stimulation of AI workers* via tax exemptions and deductibility of AI training and specialization expenses. This brings multiple benefits: it decreases the salary costs for companies, encourage continuous learning and motivates AI companies to relocate in Romania due to lower costs of the workforce. This measure was applied

with excellent results for stimulating the development of the ICT industry. This proposal is inspired from Su-Field standard 1-2-3.

*Promote the social value of AI related occupations* via measures such as social recognition, state recognized certifications and deductibility of AI grants/prizes offered by the industry to high performing AI graduates. This measure has a good synergy with the esteem and self-actualization needs associated with the high level of education of top AI performers [see ARIZ indications in section 4.1].

*Super-competitive grant schemes for attracting international talents* in the area of AI in innovation projects run by local SMEs [see ARIZ rule III from section 4.1 and Su-Field standard 1-1-4].

## 5 Discussions and Conclusions

Given the openness of society towards using AI and the interest from business towards including AI technologies in their business process, Romania shapes itself as a potentially significant consumer of AI technology and services.

Considering the lack of AI skills, the low degree of digitalization and a relative inability to process significant amount of data, the Romanian economy does not have yet the means to sustain any relevant portion of its AI demand. Therefore, without smart interventions, Romania will be determined to import most of the AI technologies and services because of lack of local capabilities.

Furthermore, taking into consideration the fact that the level of governance and regulations is extremely low, Romania's capabilities to protect its society against misuse of AI and to execute a meaningful steering of AI adoption is basically non-existent for now. To sum it up: "*Romania's profile is that of an importer of Artificial Intelligence solutions with a low level of protection for users and consumers*" [26].

However, with a proper stewardship, Romania may find its own niche for creation of custom AI solutions and possibly for AI integration in other systems (most probably with a focus on automation). That will however require a substantial focus and investment in the area of digital literacy and for building the spectrum of skills necessary for meaningful AI application development (such as data manipulation, domain modelling or machine learning skills).

This paper introduces TRIZ tools in designing smart public policies, with a particular application in the case of AI strategies. A 4-window framework has been presented in this paper for analyzing situations and formulating adequate spaces for innovation. Various perspectives from which the problem must be seen lead to the exploration of more TRIZ tools for solution formulation, such that the contradiction matrix, Su-Field, ARIZ, ASIT, directed evolution.

This research highlights the fact that many times we are trapped in preconceptions and biases both when we formulate the problem and the related solution. The use of deep-thinking and TRIZ breaks the psychological inertia and opens new views to see and tackle a problem. One of these traps is to think in terms of national borders for something that requires a global perspective. Smart specialization (i.e., specialization of innovation policies) is one of the suitable ways of action. In the case of AI strategy,



it is smarter to create niche competences at national level and cooperate internationally for other AI areas, including open polycentric innovation in virtual, distributed organizations. Polycentric sharing of resources, both in terms of talents, software and hardware at the EU level is the right approach to make a difference in AI at the global level. Therefore, Romanian AI strategy must be aligned and synchronized with the AI regulations and frameworks energized by the European Commission.

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