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FAAI:

The Future is in Applied Artificial Intelligence
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01.09.2022 – 31.08.2024

Methodology

to examine methods, tools,
and frameworks for
collecting industrial data
regarding recruitment,
competencies required, and
talent needs in the field of
AI: WP2





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Summary: The work is fulfilled within the framework of Erasmus+ project “The Future is in Applied Artificial Intelligence” (FAAI) and devoted to the development the methodology for collecting and analyzing good practices in the field of applied artificial intelligence (AAI) regarding the competences, training, existing solutions and real cases, which can be used for developing training courses of competence based education. Here we propose the definition of good practice in the field of AAI together with the corresponding criteria and features. The offered methodology uses system research based on the data gathered from existing training courses in AAI, labor market, surveys filled in by academics, students and employers, AAI use cases in science and industry.

Keywords: applied artificial intelligence, good practices, training, FAAI

I. INTRODUCTION

Good practices in applied artificial intelligence (AI) are one of the most practical sources of new ideas, approaches and technologies [1-4]. Therefore, most often the pedagogical and socio-pedagogical search is based on or under the direct influence of specific good practices. Since it is possible to borrow it effectively only creatively, the development of experience in AI turns into its processing, modification, in essence, into the process of developing one's own, author's version based on a known sample. In this case, it is quite legitimate to consider its study and use as an independent research methodology.

Scientific study, analysis and generalization of experience in AI serve various research purposes:

- identifying the current level of solving educational, educational, social and preventive and other tasks,
- bottlenecks and conflicts that arise in practice,
- studying the availability and effectiveness of scientific recommendations,
- revealing the elements of the new, rational, born in the everyday creative search of advanced teams and workers.

The subject of study when using this method can be mass experience (to identify leading trends), negative experience (to identify characteristic shortcomings and errors that, as you know, should be learned from), but the study of good practices is of particular importance, during which Grains of the new, original ideas and ideas, effective combinations of methods, new forms of organization of training and education are generalized, become the property of science and practice.

There is every reason to single out good practices from the whole complex of sources and conditions for restructuring education and upbringing and to focus on methods of studying and using it.

This is due to the fact that pain points of practice are groped and revealed in advanced experience, practical projects of imminent transformations are born, and in this sense it turns out to be indispensable as a guideline for mass practice. It is further known that pedagogical science often does not have enough time to respond quickly enough to the demands of practice, and the live experience of masters and innovators turns out to be the most efficient way to solve acute practical problems. Finally, it is known that the recommendations of science themselves, for a number of reasons, are not easy to implement. Living experience, the example of colleagues is clear, it is

easier to borrow, distribute, it is more instrumental, its results are visual and tangible. Therefore, scientific recommendations go better into mass practice, being mastered first in best practices.

What kind of experience do we have the right to qualify as advanced? According to the qualitative characteristics, the advanced experience is not only opposed to the negative one, but also does not completely coincide with the positive experience closest to it.

Good practice is an experience that allows, relying on traditional approaches, to obtain results that meet modern requirements. This experience, as a rule, is ahead of the level achieved in mass practice.

Good practice is an experience that implements progressive trends in the development of education and social assistance, based on scientific achievements, creating something new in the content, means, methods of the socio-pedagogical process and, therefore, allowing to achieve the best possible results in specific conditions and situations.

II. METHODOLOGY FOR GOOD PRACTICE STUDY

Although a lot has been done to study and disseminate best practices, there are still a number of serious shortcomings in this work. A unified system for identifying, registering (patenting), storing and disseminating best practices has not been created.

A complex, holistic procedure for its study, including identification, description, analysis, generalization, interpretation, correction and dissemination, has not been mastered.

The functional and causal relationships between the tasks, design, means, methods of activity of the teacher and pupils and the results achieved are poorly disclosed.

The objective connections and patterns underlying the achieved successes, the connection of experience with the advanced ideas of modern pedagogy, psychology, sociology, the theory of social work, on the one hand, and the subjective forms of their implementation associated with the personality of the teacher, on the other, are insufficiently singled out and shown.

As a result, individual external attributes, methods of pedagogical activity are described and disseminated, at best a system of methods, but not its leading ideas, not the pedagogical system as a whole.

The psychological conditions and mechanisms of the birth of the new are not disclosed.

In order to overcome the noted shortcomings and provide a scientific approach to the organization, identification, study and dissemination of good practices, it is useful to base the work on the following requirements arising from theory and proven by practice:

1. The study and dissemination of experience should be based on *modern concepts* of education, training and business such as “competencies”, “labor market”, “hard and soft skills”, “real cases” and assume a developed independent pedagogical thinking of leaders, methodologists, teachers, educators who understand the real needs in AAI of a particular educational institution or enterprise and its readiness to perceive and creatively process experience.

2. It is necessary to disseminate and implement not the experience itself, but, first

of all, the idea, the thought extracted from the experience, approaches, patterns. The set of techniques and methods used in advanced experience should organically flow from the idea, design and be used creatively, taking into account the accumulated experience, capabilities, work style of the subject adopting the experience. It is possible, we will add, to isolate and transfer (or borrow) technology, that is, a structured system of actions and operations, if it turns out to be suitable for other conditions. To do this, you need to master the methodology for identifying, describing, analyzing and summarizing experience.

3. Good practices should be studied and disseminated in a comprehensive manner, taking into account the requests of a particular addressee, real problems and tasks, the conditions of the region (country), and the preparedness of personnel. New techniques, private improvements should organically fit into the existing system of work, strengthen and improve it. If we are talking about replacing inefficient systems with new ones, then a logically substantiated integral system is to be introduced, covering both goals, ideas, content, and means of pedagogical activity.

4. The introduction of a new one is effective when this work stimulates the creative activity of both trainers and trainees, when a collective search arises, when an author's version of innovation is nurtured and born.

It must be borne in mind that the concept of "good practice" has not only an absolute, but also a relative meaning. What has long been mastered by one team may be promising, advanced for another. When implementing, it is necessary to take into account the actual (today's) and promising capabilities of the team and its individual members, ensuring, if necessary, a phased and variable introduction of the new, to differentiate the goals of turning to experience: initiating creativity in the team, borrowing ideas, using technology, complex use of experience, etc.

The good practice itself is not the same in terms of its degree of novelty and significance.

Innovative experience is the experience of developing and implementing new pedagogical systems of education and upbringing, or, in any case, systems containing essential elements of novelty.

The modifying experience contains less pronounced, less original elements of the new. It is built on a serious improvement, the development of existing forms and approaches, but it is useful and relatively easier to spread.

In order to identify truly good practice, to distinguish it not only from projecting and speculation, but also from positive, but traditional experience, it is necessary to highlight the criteria, the distinguishing features of advanced experience.

In the works of teachers and methodologists, a number of criteria for good practices have been identified. Let us name the criteria that seem to us indisputable and the most important.

Relevance and prospects, compliance with the requirements of life, trends in social development and scientific and technological progress. Experience helps to solve the most topical and difficult problems of practice, but at the same time, it should contain a "backlog", work for the future, open up new opportunities for improving the pedagogical process, developing social and pedagogical conditions for educational work.

Novelty in goal setting, selection of content, choice of means and forms of

organization of the pedagogical process. This sign can manifest itself in varying degrees: from introducing new provisions into science to more effective ways of applying in practice already known provisions and modernizing certain aspects of the pedagogical process.

Compliance with the fundamental provisions of modern social sciences. Truly humane results, deep positive shifts in the development of the individual can be achieved only on the basis of humane means, genuine cooperation and co-creation, only on the basis of a combination of an individual approach with participation in collective life, only on the basis of the development of the vigorous activity of the educated and the constant introduction of new things into this activity. content and newly mastered methods of activity, etc. Of course, these and other fundamental provisions of progressive pedagogy, sociology and psychology are changing, deepening, and improving in some way. But this is happening slowly, gradually. Failure to take into account or ignore these leading provisions always leads to failure or pseudo-success, to imaginary or unstable results.

Sustainability, stability of positive results. Best practices should bring significant results: significant changes in the nature of socialization, the level of upbringing, in the overall development of schoolchildren, a decrease in delinquency, team building, an increase in the prestige of educational institutions, etc. Under the stability of experience, we mean the confirmation of its effectiveness under some change in conditions, the achievement of positive results for a sufficiently long time, with a different composition of pupils.

The possibility of creative application of good practice in similar conditions, its portability to other objects. Any creative experience is closely connected with the personality of its creator, with the individual style of the teacher, with the traditions and the so-called creative style of the team. However, when analyzing in experience, ideas, means, technologies should be singled out that can be conditionally “separated” from their creators, which are not associated only with their personal characteristics and can be reproduced by others.

Optimal expenditure of effort, money and time of teachers and pupils to achieve positive results. If positive results are achieved by increasing the workload, significant additional time, loss of health of teachers or pupils, then such experience cannot be attributed to the best.

Optimality of experience in a holistic socio-pedagogical process. It is supposed to be possible to enter specific experience into the existing system of work, without sacrificing the solution of any of the other upbringing and educational tasks, but ensuring their more effective solution.

The application of these criteria provides a comprehensive assessment of experience and gives grounds for its qualification as advanced. If we are talking about the search for opportunities to organize new centers of experience as future strongholds for its dissemination and implementation, then the criteria for good practices may be presented partially and incompletely.

The sequence (procedure) of working with experience consists of four main stages:

1. Identification, primary diagnosis and evaluation of experience (according to the above indicators)
2. Description of socio-pedagogical phenomena (or their reconstruction according

to documents and evidence) in their real sequence, based on the accumulated factual material and its systematization

3. Theoretical and methodological analysis, the main content of which is the selection of non-dry ideas, ideas, technologies for its implementation.

4. Generalization and recommendations related to the identification of the factors that led to success, the natural relationships between innovations and results, the scientific foundations of experience, with the qualification and evaluation of results and the definition of the conditions for their dissemination.

The greatest difficulties in the study and generalization of experience are encountered in the implementation of the last two stages, and often they are actually not carried out at all. Let's describe the procedure for working with experience in a little more detail.

The description of socio-pedagogical phenomena begins with a description of the described object (class, school, club, family, etc.), its social environment, characteristics of the composition of the class (group), includes the content of the work, its structure, methods of activity of the teacher and pupils, achieved results.

Usually, the *description of the educational process* includes a description of the updated content, methods, equipment, the nature of communication between teachers and students, learning outcomes.

The description should not be based on external impressions, but on the accumulation of factual material (a set of facts), which, in turn, is associated with fixing the results of specially organized observations, conducting surveys, studying essays, reviews, texts of reports and speeches, minutes of councils and meetings, work of pupils, development of events, plans, etc.

The *systematization of the accumulated material* consists in the selection and establishment of the most characteristic and interesting facts that reveal the system of work of the teacher and the team (the trusting nature of relations, joint creative search, the security of the individual in the team, etc.), as well as in establishing temporary and cause-and-effect relationships between observed events.

Theoretical and methodological analysis consists in the selection and special consideration of individual aspects, connections or links of experience. This is connected either with the consideration of the pedagogical process itself, for example, with the allocation of its goals, content, system of relations, pedagogical means, forms of organization, ways to increase interest, motivation of activity, or with the allocation of interests, pedagogical "kitchen", creative workshop of the teacher.

First of all, it turns out what *real contradictions, inconsistencies, difficulties of mass practice gave rise to the need for the experience being studied in AI, that pedagogical search that gave positive results*. For example, the presence of incomplete, conflicting, pedagogically untenable families, the employment of parents, the loss of family traditions gave rise to a clear contradiction between the desired and real role of the family in education, a social need either to strengthen the educational functions of the family, or to compensate for them in the system of other educational institutions.

Further, the *real life problem and the tasks arising from it* are clarified. In our example, the problem is the restoration of the educational functions of the family in the new social conditions and partial compensation for them by a full-time (or extended) day school, a system of teams of different ages, club work, and other forms

of out-of-family communication and education. It turns out what specific tasks were set by the teacher (or teaching staff, psychologist) to solve an urgent problem, to resolve actual contradictions.

It is especially difficult to identify *the pedagogical idea of the creators of excellence*, who often cannot isolate and formulate their own idea. It appears, and often originates in the form of an idea, that is, a certain methodological form. The pedagogical idea, as already noted, is an assumption about the most effective ways to achieve pedagogical goals, about ways of contact, mutual understanding, and joint activities of the teacher and pupils. The idea embodies the idea (while mentally) in specific ways of activity, methods and techniques. Of course, the ideas of the creators of excellence are not always original, the important thing is how modern they are, how the teacher (psychologist, social worker) uses them, how he interprets and concretizes the idea in the area in which he works, and in those circumstances in which it is placed. Naturally, the originality of ideas and designs makes the experience especially valuable.

Let's go back to the **example** we've already used. The pedagogical idea of restoring the upbringing potential of the family can be expressed in a plan: to organize joint activities of parents and children at school or at a club, to gain experience in such activities in order to awaken the parents' taste and help develop the ability to communicate with the child, to transfer his knowledge, experience, attitudes to surrounding. Another idea may be to compensate for the shortcomings of intra-family influence by the "family" atmosphere of groups of different ages at the place of residence or associations of different ages by interests.

Only a well-analyzed experience can be somewhat deeply generalized, because generalization is based on the establishment of regular connections, through lines between the tasks, ideas, ideas of educators, means, methods of activity, various aspects of the pedagogical process and the inner world of pupils, their activities and the results obtained.

Generalization can be achieved in different ways. It is advisable either to describe the achieved positive results, and only then to find out the ways and conditions due to which they were achieved, or to describe the content, means, methods of activity of educators and pupils, environmental conditions, and then talk about the patterns of the results achieved. But in both cases it is necessary to give a socio-pedagogical and psychological interpretation of the observed phenomena and processes, their qualification.

For example, find out that the researcher uses the method of organizing collective creative activity, or, in another case, to restore the educational functions of the family, the method of gradually weakening assistance and intensive psychological support for both children and parents is used. Then it is necessary to identify significant links between the conditions, factors that determined success, the nature of the activities and relations of the pupils, and the results obtained. At the same time, attention is focused on the personality of a developing person, on shifts in his motivational, intellectual, emotional and volitional spheres.

Sources of experience should be discovered (an example of colleagues, publications, own searches and thoughts, etc.), its scientific foundations should be identified, i.e. patterns, approaches, principles, the conscious or unconscious use of which led to

success. It is useful to identify and emphasize the role of the personal qualities of a teacher or leader, his enthusiasm, dedication, efficiency, ingenuity, to highlight the original, original that is inherent in this particular teacher and the experience created with his direct participation. A competent, specific description of the experience, its element-by-element analysis and generalization make it possible to identify the links between objective contradictions, ideas and intentions of the creators of the experience, the nature of the activities and relations of the educators and educators, the results obtained, to show the originality and scientific foundations of the experience. It is not always possible to fulfill these requirements.

The point, of course, is primarily in *the quality of the described experience, its social value and novelty*. But I would like to pay attention to the other side of the issue - the quality of its analysis and generalization, the ability to see the unity in the diverse (general ideas, approaches, patterns) and the diversity in the unity (different solutions, variability of pedagogical means, flexibility of tactics in achieving the goal, realization of ideas and plans, etc.).

As a result of the work on generalization, it is useful to evaluate the experience in terms of its social significance and novelty (innovative, modifying experience), in terms of targeted orientation (for whom the experience is suitable, the conditions for its use), as well as to make suggestions for adjusting the experience, its improvement and development.

III. GUIDELINES FOR COLLECTING GOOD PRACTICES IN APPLIED AI

The empirical methods used in the research of good practice in AI include a group of methods associated with the study and generalization of competencies, advanced pedagogical experience, as well as with the study of AI solutions in the science and industry (Fig. 1). The approach used in the given methodology was earlier developed in [5]. Let us briefly characterize each of these methods in terms of their significance for obtaining reliable information about the object and subject of the study.

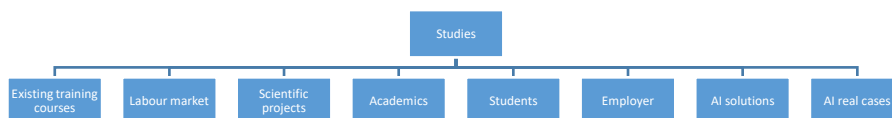


Fig. 1. Studies conducted for the research of good practices in applied AI

IV. METHODOLOGY FOR RESEARCH OF COMPETENCIES IN THE FIELD OF APPLIED AI

The method of studying the products of activity is a research method that allows you to indirectly study the formation of knowledge, skills and abilities, interests and abilities of a person, the development of various mental qualities and personality traits based on an analysis of the products of his activity. The peculiarity of this method lies in the fact that the researcher does not come into direct contact with the person himself, but deals with the products of his previous activity or reflections on what changes have occurred in the subject himself in the process and as a result of his involvement in some system of interactions and relationships. Objects of study:

- Existing training courses in applied AI
- Solutions based on applied AI
- Scientific projects in the field of applied AI

Comparative analysis allows you to more specifically identify the conditions and prerequisites for improving the efficiency of a certain type of activity. It is important for the researcher to correlate the product of activity with the motives, conditions of this activity, with the behavior of the person, the target group.

At the same time, the study of the products of activity makes it possible to judge the level of activity achieved and the very process of fulfilling the set research tasks. At the same time, it is important to get an idea about the level of ability of the trainee for certain types of activities, about the nature of the tasks and the conditions in which they were performed. With this information, the researcher can judge conscientiousness and perseverance in achieving the goal, the degree of initiative and creativity in the performance of work, i.e. about shifts in personality development.

A. Methodology of research of good practice of training in the field of Applied AI

The methods of studying the products of activity include the method of studying educational materials (syllabuses, guides, tutorials, etc.). In the process of work, the researcher is faced with the need to study various documents. The analysis of these documents makes it possible to reveal the dynamics of the development of the trainee's competencies, to compare official opinions, to obtain objective data characterizing the actual practice of organizing the educational process. It should be noted that the information obtained from various documents is usually extensive and voluminous. When dozens and hundreds of people are examined, this task becomes more complicated to the limit. In addition, characteristics and other documents are written in an arbitrary form, which creates difficulties in their comparison, analysis and evaluation.

As one of the methods of working with documents, in particular with texts, the method of **content analysis** is widely used in psychological and pedagogical research, which makes it possible to obtain reliable information through its special selection. Content analysis is a method for identifying and evaluating the specific characteristics of texts and other information carriers (video recordings, interviews, answers to open questions of the questionnaire, etc.). When it is used on large amounts of information (for example, texts), in accordance with the objectives of the study, certain semantic units of the content and form of information are distinguished (for example, individual psychological characteristics, types of interaction between people, etc.). Further, to identify existing trends, the frequency and volume of their use are determined. Content analysis makes it possible to identify individual psychological and

pedagogical characteristics of an individual, a team, etc. in texts. Unlike content analysis, this scientific method is used to obtain information that meets certain qualitative criteria - objectivity, reliability and validity.

B. Methodology of collection of good practice of the Applied AI solutions

The line between high-performing and erroneous AI/ML models is created by the quality of their training data. While some organizations have a minefield of data they have been generating throughout the years, others are just starting their journey.

Companies need to develop or implement digital solutions to survive in this volatile business environment, and data is the only thing that can help them do that. For example, to develop an inventory scanning computer vision system, companies need a big dataset to train the model. Collecting this data can be challenging if you do not have the right tools and knowledge in hand.

This approach explores the tasks that we should consider for study

1) Understand the problem

It is important to articulate the requirements of the AI/ML model. Understanding what your algorithm will do can be a best practice before categorizing the data that will be required. You can consider the following points to understand what data will be required for which tasks:

- Whether the algorithm will perform simple classification tasks such as yes/no, black/white, good/bad, cat/dog questions, or multi-classification tasks with multiple objects such as cats, dogs, birds, etc.
- Whether the algorithm will require numeric data for tasks such as product pricing.
- Whether the algorithm will perform ranking tasks such as product ranking based on specifications and purchase history of the customer.

These considerations can give you a clear picture of what is required from the AI/ML model and which data needs to be collected.

2) Establish data pipelines

Almost every business activity generates data. How a company gathers, manages, and leverages that data makes the difference. Creating a data pipeline can enable efficient movement and management of data in the organization.

A data pipeline enables the movement of data from a source to a destination. Sometimes when the data architecture is complicated, it can make data pipelines more time-consuming. In this situation, DataOps can be established to enable employees to work with data in real-time and collaborate on data management.

3) Establish storage mechanisms

The following mechanisms of data storage can be used:

Companies can use a *data warehouse* and store their data through the extract, transform and load (ETL) method. In this method, you know which data you will use, so you extract it, transform it and load it. However, with this method, sometimes it's hard to know in advance which data will be useful in the future. This method works best when data security is the priority, and only unstructured data is being managed.

Data lakes can also be used in which both structured and unstructured data can be stored. This can be coupled with the ELT method, in which the transformation stage is done after the data is loaded. This enables the engineer to transform the data on-demand in the future. This method is better when real-time decision-making is critical, scalability is required, and the project involves big data.

4) *Determine a collection method*

Determining a method is also one of the most important steps of data collection. The following methods can be used:

a) *Public crowdsourcing*

Public crowdsourcing is a participatory method of data collection that involves working with a large group of participants. For example, to train a computer vision system for reading road signs, the system requires road sign image data to be trained. Through public crowdsourcing, the company can obtain these images from the public by providing some instructions and creating a sharing platform.

b) *Private sourcing*

Private data sourcing includes collecting data through an internal team. An example of private data sourcing can be surveying. This method is better for projects which required small datasets and do not have complicated models. This method is also good for projects with higher privacy and security levels.

c) *Customer data*

Businesses can use the internal data that is generated by their customer base. This data is relevant to the business and available for free. However, this can be challenging for SMEs or startups since they might not generate sufficient data.

d) *Prepackaged data*

Prepackaged data is a cheap option for data collection and easy to implement. However, this sometimes can create more complications for companies due to the lack of customization it offers.

e) *Web scraping*

If the required data is available online, web scraping can be an effective method of collecting it. This method involves making requests to the page and extracting machine-readable data from it. To learn more, check out our comprehensive article on the roadmap to web scraping.

5) *Evaluate collected data*

Data quality is paramount to a successful AI/ML model. Therefore, an organization should consider the following points to ensure that the data quality is sufficient and that the data can be trusted.

If the data is being collected by humans, evaluate how tangible it is. This can be done by analyzing a subset of data and identifying how often errors are made.

Evaluate the data transfer process for any technical issues and the impact of those issues. Search for data duplications, server errors, storage crashes, cyberattacks, etc.

Analyze to see if any data is left out and how critical is the number of the data omitted.

Ensure that the data is balanced. Collected data should cover all required outcomes of the model. For example, while collecting data for a supplier evaluation system, the dataset should include a balanced amount of good supplier and bad supplier data.

a) *Collect concise data*

It can be tempting to collect all the data that is available. However, this can cause unnecessary complexity in your AI/ML model. It is important to reduce the horizon of data collection to specific and concise data that is aligned with the goals of the AI/ML model.

b) *Attribute sampling*

For example, for a forecasting model which predicts which customers make more purchases, the bounce rate and the age of the customer can be relevant; however, credit card details can be irrelevant. This approach is called attribute sampling, where the data is sampled based on its attributes.

c) *Record sampling*

This is another approach to making the data more concise. In record sampling, the data with missing, erroneous, or doubtful values is removed from the collected dataset to improve the accuracy of the trained model.

d) *Determining AI task*

It can be the problem of regression, classification, clusterization, surviving analysis, reinforcement learning etc.

e) *Choosing AI model*

It can be linear model, multilayer perceptron, decision tree, classification rule, convolutional or recurrent neural networks etc.

V. METHODOLOGY OF THE RESEARCH OF LABOR MARKET IN THE FIELD OF APPLIED AI

The study of the labor market and employment issues is one of the priorities of the research of good practice in area of AI. These studies are relevant not only at the state level for the formation of policy in the relevant area, but also for companies that seek to attract the best personnel for the development of their business in the field. When studying the labor market in applied AI, we focus on such issues as the balance of supply and demand, qualifications of personnel, the level and ratio of wages in the context of specializations and activities, labor mobility, characteristics of human capital in a particular region, etc. Results of the study of labor markets should be reflected in the regular monitoring.

The main tasks implemented in this area include:

- Marketing research of the *AI-labor market of the region* (country) allows us to work out in detail the issues of interest to the IT company in the selection, hiring and determining the working conditions of personnel of the required skill level in AI, including taking into account the practices of competing companies, as well as sources of attracting such personnel.
- Assessment of the *level of provision with local labor resources for AI area*. As part of this work, an assessment is made of the level of unsatisfied demand for labor in AI area of the region (country), an assessment of the possibilities of filling the shortage of qualified personnel in AI at the expense of internal and external sources

of labor resources.

VI. CONCLUSIONS

For the reasons given, the work offered the methodology for collecting and analyzing good practices in the field of AAI regarding the competences, training, existing solutions and real cases, which can be used for developing training courses of the competence-based education. Here we proposed the definition of good practice in the field of AAI together with the corresponding criteria and features. The offered methodology uses system research based on the data gathered from existing training courses in AAI, labor market, surveys filled in by academics, students and employers, AAI use cases in science and industry.

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