Engineering science researches and effective government (Part 1.)

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Abstract:

By the Research, Development and Innovation Strategy of the National University of Public Service "State and Governance Sciences" deal with the existence, operation and key aspects of the state and governance with common application of state oriented researches of different branches of sciences. Methodology of state and governance researches can be characterized with comprehensive approach and transdisciplinarity.
The aim of the authors is to investigate the relationship between state and governance sciences and engineering sciences and present the main areas of international technical researches focusing on coherence with state and governance. Based on this the authors specify the main state and governance related domestic technical research directions concerning the operation and security of the State.
Because of the size of the material the paper is published in 2 parts. This first part covers the introduction, the description of the relationship between engineering researches and state and governance sciences and the summary of related present international engineering researches in the fields of ICT technologies, information (cyber) security and environmental security

Keywords: State and Governance Sciences, Engineering Sciences, Horizon 2020

INTRODUCTION

The impact assessment of the technical improvement's impact on the operation of the state is very important from a scientific point of view. The radical transforming effect of the internet for example swept through more and more industries from the middle of the nineties, completely reshaping their structure and operational model. The media industry, vehicle industry, retail, tourism, education, and healthcare were greatly changed in the last 25 years. The technical improvement changed the method of production, the interest ratio of the participants, the characteristics of the products and services, and the skills and knowledge required for employment. By investigating this area we can see that the operation of the informational economy and the increase of wealth have a narrow cross-section, which is the deficiency in the reflection of the operation of the state in the informational age.

The relations between technological-technical improvement and state and governance science are not free from problems at all. On the one hand, the government's and state's demand does not generate technical improvement necessarily. On the contrary: long historical periods passed without significant technical improvement reflecting on the state's demands. On the other hand, the technical improvement does not increase automatically the infrastructural power of the state either (think about the everlasting circulation of the fight between high-tech criminals and high-tech police). [1]

In the relationship of state and governance science and technical improvement it is important to mention the relation system that the governments have a great influence on the systems of scientific discoveries: significant geographical discoveries (e.g. Columbus' journey), whole branches of mathematics and game theory (operation research), or supersonic flying, are the "civilianized" results of government and military purpose developments of computers and the internet.

The research of technological and techno-economical paradigms [1] is lie on the periphery of state and governance science and public administration science, hence understanding many narratives and phenomena related to the changing role of the state and its relation to the different systems of society and the economy may be quite difficult [2].

The scope of science-technique theories[1] is one of the trans-disciplinary directions that could strengthen and make it relevant again, and can also evolve its added values in contrast of other sciences (eg. of law science, political science, or management science) [3]. The researches in these areas systematically examine the two way relations between the expansivity, depth, and nature of state power, the particular technical inventions, and the technical improvement in general [1] [4].

[1] Science Technology Studies

Based on all this the aim of the study is to examine the relation of state and governance sciences and engineering sciences, present the main directions of international researches in the areas of engineering sciences, focusing on the relationships with state and governance sciences, and to define the main directions of local researches in relation to the operation and safety of the state based on this.

1. THE RELATIONSHIP OF ENGINEERING SCIENCE RESEARCHES AND STATE AND GOVERNANCE SCIENCES

According to the Research – Development and Innovation Strategy (RDIS) of the National University of Public Service (NUPS) state sciences are dealing with the questions of the existence, operation and government of the state, which can be examined trough the combined appliance of all the researches of social sciences related to the state. [5] The method and results of state research is characterized by comprehensive approach and transdisciplinarity. The new frameworks of state and governance science are characterized by the research of the questions related to law, public administration, defense (law enforcement, national defense, disaster protection), public order and safety (national security), and other questions related to state and society. Based on this approach we can see that the state sciences mainly prevail in the area of social sciences, however, it must also be seen that to ensure the efficient, sustainable and safe operation of the state technical researches and the use of their results were always necessary. This is only intensifying in the 21st century, because significantly new technologies and challenges appear during the operation of the state. The use and exploitation of all these technologies, and the handling of the challenges cannot lack the use of up-to-date engineering scientific results. Based on all this although the engineering sciences are not a part of state sciences, however, thanks to the close relationship system of these two even the RDIS treats technical researches as a priority.

One of the important appearances of the results of university level research is education, improving its quality and constantly and gradually integrating the results into the curriculum. One of the parts of technical nature education development pointing towards a good state is referring to the development of the role of already existing curriculums in higher education, and it also focuses on the possibilities of its IT based usage outside of higher education. The previous, by the reinforcement of the technical nature – in accordance with the university's strategy – is a mostly evolutional development, which is based on the new approach of the public service system, which is IT based (e-learning, webinary), it also prepares the opportunities of education out of the bounds of traditional

higher education in both local and international scenes. Forming a suitable infrastructure and humane environment, referral and attendance of respected guest lecturers, and the improvement of the preparedness of our own lecturers, their international reinforcement is also necessary.

The education developments towards a specified direction include the evaluation and processing of the early experiences of bachelor and master courses, their adaptation and correction to the current conditions, its development, its internationalization, preparation of the opportunities of education beyond universities, overall, further developments aiming to reach the future's strategic goals. All these tasks have to be carried out in the courses where technical questions are relevant, and within the boundaries of the university, in accordance with its strategy, by the reinforcement of the technical nature.

The relationship of state and governance sciences and engineering sciences can be best observed in the usage of information and communication technologies (ICT), and the examination of their effects in the broader areas of public service. In the central and local public administration this mainly aims the to improve the efficiency of the processes, to reshape administration culture, to reduce the administrative burdens of civil and corporate clients and to introduce new services.

In this regard the research field is in close harmony with the "National ICT Strategy 2014-2020", the pillar of the so-called digital state, but it also fits into the other three directions of development mentioned in the strategy, namely into the digital infrastructure, digital competencies, and the development of digital economy. [6] From these the NUPS educational mission specifically helps the adaptation of SMEs and public administration ICTs – improving the so-called e-acceptance - by the development of digital abilities. Horizontally at this point a very tight coordination and cooperation is possible with the organizational innovation and human resource workshops of the research community.

The "Public administration and service development strategy 2014-2020" document and the Public Administration and Service Development Operational Program priorities derived from it designated two important areas in correlation with the digital state. The implementation in the broadest possible range of the interoperability of the specialized systems, the modernization of registers, and the elimination of data redundancy are priorities.

The international trends in addition require the research workshop to ground the subsequent strategies which are capable of making e-democracy, e-attendance, e-vote and an intensive civil participation possible in virtual space too.

The increasingly intensive presence of the state's operation in the virtual space elevates information security and cyber protection the most important horizontal research fields amongst ICT applications not only in Hungary, but also internationally. The "National ICT Strategy 2014-2020" fitting horizontal factors emphasizes that the maximal protection of the handled data and the critical informational infrastructures from the viewpoint of e-public administration services must be achieved; safety consciousness must be evolved; user groups must be prepared in terms of actual safety hazards and their handling methods, with special attention to the safety of the children. [6]

In parallel with this (amongst other things) the NUPS developed serious capacities in the past few years in the areas of civil public administration, home defense and policing, based on which the research community wishes to connect to other workshops by special researches: general security studies, cyber warfare, and cyber crime. It must be emphasized that information protection in addition to safety questions also includes data and information protection, in which the Faculty of Science of Public Governance and Administration and the Faculty of Military Sciences and Officer Training have high capacities and is capable of connecting the technical challenges of the virtual space with the legal regulation, security awareness and the tasks of leadership and organization in relation to the modern state administration.

In the field of environmental safety there are excellent examples of the cooperation between the different fields of public service. Trough the research of the technical questions of environmental safety certain elements appear that can also be used in several fields of state and governance sciences. The performance of public service tasks and the two way relationship system of environment safety can be observed in any field, so certain activities cause environmental impact and risks, where the research task may be to improve environmentally friendly technologies, to reduce the ecological footprint, to develop and operate environmental management systems. On the other hand, the environmental damages, environmental challenges, global environmental problems cause such a constantly changing conditionality, that affects the entire verticality of public service, and for the sake of planning and completing the tasks they require the proper handling of effects such as the reduction of environmental effects (fossil fuel, drinking water, soil, air, biodiversity), the pollution of environmental elements, global climate change, increased noise, the dangers of vibration or radiations or the problems caused by waste.

For completing the tasks of the broader interpretation of the defense sector (home defense, law enforcement, disaster recovery, and national security) – as the depository of the safe operation of the state – a wide range of technical tools and systems and technological methods are used. These

technologies cover the whole spectrum of engineering sciences, starting from electronic, communication and IT systems, trough engineering to architectural and logistic systems. Military engineering is a separate special field, in which the researches related to the use of other engineering sciences for defense purposes take place. The research directions and their results materialize in the broader interpretation of defense and public administration sector and in the modern, new method- and toolkit of the application areas. Here belongs the defense industry, defense electronics, IT and communication; national defense; law enforcement; environmental security; environmental protection; protection against chemical, biological, radiological and nuclear weapons and non-proliferation; fight against terrorism; disaster recovery; protection of critical infrastructures; energy safety; and safety technology. [7]

For the development and improvement of the cooperation of organizations responsible for the defense against disasters the support of researches related to the coordinated and effective implementation of disaster recovery tasks of preparation, protection, and reparation phases is needed. The research activity primarily concentrates on law administration and technical researches related to the development and improvement of the law and institution and tool system establishing the operation of fire safety, citizen safety, and industry safety specializations. The disaster recovery researches must adhere to the research activities of universities on state and governance sciences, public security, and home security. The disaster recovery technical researches must serve the purpose of increasing the society's abilities against disasters, reducing its vulnerability, helping it to return to its normal operating order as soon as possible, and increasing flexibility.

The classification and subdivision of disasters may differ depending on literature; however, the researchers mostly accept that considering the way of generation there are natural, and man caused disasters. Within these the classification may differ, but they mostly follow the everyday comprehensible divisions, even until total simplification; such as floods, flash floods, earthquakes, the release of radiating or dangerous substances or disasters caused by large-scale forest fires.

Considering the characteristics of disasters, we can almost always associate to significant dimensions, the delay in time of the disposal, the mandatory cooperation of different organizations taking part in the disposal (federal, civil, voluntary), or the requirement of surplus resources. These latter statements have a privileged role from the perspective of technical researches, because although the resources at hand are always scarce, this is particularly true in the time of disasters. The degree of scarceness fundamentally defines the effectiveness of the intervention and the reparation, so its reduction – with the use of new technical tools, technologies, methods and regulations – is not only an opportunity for

professionals and researchers, but – in favor of reaching the goals of a good state – its also a moral obligation.

The social expectations of a good state definitely require the effective prevention of disasters, fast intervention in case of occurred events, and the fastest possible reparation, in other words greater resilience against disasters, less vulnerability and greater flexibility required for adjusting back to normal life. From the background of these the technical and methodological improvements and their related training tasks are indispensable, thus the social expectations from a good state and effective disaster recovery are inseparable. This is why it is declared in the law of Disaster recovery that the defense against disasters is a national matter. [8] [9]

The elimination of disasters is always tool and technology demanding task. However, the development level of the used tools, technologies and methods also determine the abilities of the intervening; and this latter strongly correlates with the effectiveness of elimination. It follows from the above mentioned that engineering sciences require an interdisciplinary approach from the side of disaster recovery; however, it is clear that they are also inseparably linked to state and governance sciences, and they contribute to the improvement of the qualification of a good state.

The multiplication of extreme weather phenomena caused by the global climate change, the higher level and constantly changing technical standard, the local and international commitment to protect the environment, economical and social globalization, and the increasing social sensitivity of the developing world are all suggest that the duties of the efficient disaster protection cannot be treated as a onefold act. The renewal and constant improvement of courses is indispensable for effective protection and prevention, which must be connected to higher education. In the light of these, the improvement of and education technology and course management providing an environment conducive to more effecting learning, and its increase to an international level improves the efficiency of defense against disasters.

2. MAJOR RESEARCH PRIORITIES APPEARING IN CERTAIN FIELDS OF ENGINEERING SCIENCES

The emphasized role of technical nature researches can be observed in the European Union's Horizon 2020 (H2020) K+F program, because they are present in every pillar of the H2020, so also in the areas of excellent science, industrial leading role and social challenges.

The H2020 covers the development of the innovation chain from base research to product development. In line with this a significant part of the H2020's work program wishes to support near-

utilization innovations. The technical subject researches also have a fundamental role in the field of EU policies, such as healthcare, aging society, climate change, environment, energy, traffic, and the modernization of the public sector.

From the perspective of the relationship system of state and governance sciences and technical researches we can highlight "excellent science" and "social challenges" pillars. The excellent science supports the research of new technological opportunities in the field of emerging technologies[2], while on the field of research infrastructures dedicated sources supply the development of e-infrastructures. The aims of future's aspiring technologies are expanded with the multidisciplinary, technology-oriented, long term European researches. Amongst its highlighted areas there are cognitive ICT; quantum simulation; the science og global systems; and high performance IT.

The social challenges pillar also shows a close relationship with technical field researches, because the application of different technologies is one of the important elements of the treatment of challenges. In this field the technical technological development can be associated among others with the safe, clean and efficient energy; the intelligent, environmentally friendly and integrated traffic; the climate change, environmental protection; and safe societies research fields. [10] Amongst the aims formulated in the latter field are:

- improvement of society's resistance against man-caused disasters;
- the research of new critical infrastructure defensive solutions;
- strengthening the fight against crime and terrorism, for example development of new criminal technology tools, new protection solutions against explosives;
- increasing cyber security, from safe information sharing methods to the development of new information safety models. [11]

2.1. ICT technologies

The ICT plays a key role in the EU's society and economy. The ICT sector gives 4,8% of the EU's economy, and it produces 25% of business research input. [12] The priorities related to the future of e-government are summed up in e-Government Action Plan, which aims to create a knowledge based, sustainable, inclusive economy. [13] The actions of e-Government Action Plan can be classified into four categories:

[2] Future and Emerging Technologies - FET

- involvement of users: services accustomed to the demands of users, improvement of transparency, involvement of citizens and companies in the formation of the regulation environment;
- internal market: barrier-free services for enterprises, mobility, implementation of cross-border services;
- the efficiency of the public sector: electronic acquisitions, faster evaluation in competitions, reduction of administrative burdens, "green" government;
- development of the electronic government and the creation of its preconditions: open specifications, helping interoperability, revision of the directive about electronic signature, mutual recognition of electronic identification and electronic verification.

Currently one of the most important EU strategic documents is the Digital Agenda for Europe (fitting with the Europe 2020 strategy), which aims to create a unified digital market, which would help Europe to take the road of an intelligent, sustainable and inclusive growth. The actions of the Digital Agenda among others:

- creating a unified digital market;
- to the field of interoperability and standards;
- strengthening trust and internet safety;
- providing high-speed and super fast internet access for everybody;
- furtherance of digital proficiency, digital skills, and digital integration. [14]

The H2020 defines these priority areas within the ICT program:

- new generation components and systems: creating developed and intelligent, energy-sufficient, and resource friendly embedded systems, components, systems;
- new generation IT: modern and safe IT systems and technologies, grid and cloud based technologies;
- future internet: software, hardware, infrastructure, technologies and services, Ubiquitous Computing, Service oriented computing, semantic web, 3D internet, Internet of Things, visual information request, smart home, smart city, etc;
- content management technology and information management: the digital content, information and communication technologies supporting culture and the creative industry, e-public administration technologies;
- developed interfaces and robots: robotics and intelligent spaces, autonomic robots, artificial intelligence;

- micro- and nanoelectronics, fotonics, and quantum technologies. [12]

Most of these, for example the ICT systems aiming energy efficiency, modern and safe IT networks, cloud based systems, the use of digital content management systems in public administration etc. also fit into the circle of technical researches aiming the operation of the state.

2.2. Information security – cyber security

Thanks to the significant forging ahead of the ICT, information safety and cyber safety became one of the most important security questions of today. The already mentioned Digital Agenda for Europe is an emphatic element of the cyber protection policy of the European Union. Amongst the seven key action areas the question of trust and safety is one of the pivotal issues.

- creating a network of groups managing computer emergencies around Europe;
- simulation of large-scale internet attacks, and testing threat mitigation strategies;
- creating a hotline-network for reporting illicit and offensive content;
- creating a cautionary platform against computer crime, or its adaptation to the Europol's system. [14]

The European Union's cyber security strategy summarizes the EU's comprehensive vision regarding the methods to efficiently prevent and fend off the vulnerability and network disturbances caused by ICT technology. The new strategy emphasizes five priorities, which also represent research priorities:

- creating resistance against cyber attacks;
- drastic suppression of IT crime;
- developing a cyber protection policy and abilities related to common safety- and protection policy;
- obtaining industrial and technological resources needed for cyber security, and lastly
- elaborating a unified, international policy for the cyber space represented by the EU, and disseminating basic EU values. [15]

The requirements expressed in this strategic document naturally assume that serious technical researches must happen in the areas of information security and cyber security in the following years, which would serve as a basis for the feasibility of strategic requirements.

All this also appear in the H2020, inside the pillars of "Societal Challenges", in the research area of secure societies. In the work program of "Secure Societies" for 2016-17 on the critical infrastructure protection and digital safety focus areas the following main research directions can be recognized:

- preventing and detecting physical and cyber threats against the critical infrastructures, responses and the mitigation of damages;
- developing safety and certification methods for reliable and safe ICT systems, tools and services;
- the cyber safety of government and council administrative ICT systems and SMEs and the ICT systems of individuals;
- developing the system level digital safety of healthcare data;
- cipher;
- handling developed cyber safety threats (ATP attacks, zero-day exploit, etc.);
- protecting personal data. [16]

2.3. Environmental security

Into the concept of environmental safety such events and processes fall that can be classified into three groups. Into the first group belong possible damages of natural origin, such as earthquakes, floods, destructive wind storms, forest fires, etc. Into the second group belong damages of technical origin, i.e. when man-made dangerous materials unexpectedly and in a large extent get out into nature, causing undesirable effects. Into the third group belong such social related events, which cause environmental damage either directly or indirectly. These events or processes can be local or regional war, migration – including war refugees – the dominance of poverty or classical economic robber management. [17]

From the unfavorable economical effects the increase of soil erosion, quality deterioration of water resources, unfavorable changes in radiation conditions, the increase of background radiation, the disruption of the temperature equilibrium, the drastic decrease of biodiversity, plant pathogens and animal pests, and the passage of illnesses from one country to another may be mentioned.

To its research and application areas belong waste management, protection of polluted settlements, species and habitats, soil science, recycling, agriculture, landscape architecture, nature protection policy, water.

The main research areas of today are:

- the social effects of environmental changes;
- today's environmental changes, such as global warming;
- pollution and environmental damages;
- environmental effect assessment;

- reconstruction of previous environmental effects. [18]

About the issue of environmental safety narrowed down for the environment of the European Union the EC Contract states that the goal is to reach high level environmental protection. Environmental policy must take scientific facts, the environmental state of the Commission, the cost and benefit of the activities in this field of the Commission, and the economical and social state of the Commission and the given region into account. Union researches shown that the environmental tension can contribute to the emergence of serious conflicts under certain economical and social conditions. Some of the environmental factors:

- global environmental problems mean a greater danger than regional problems or problems within the country;
- it is not easy to define individual responsibility in the emergence of global environmental problems;
- four groups of environmental changes, such as degradation, pollution, shortage, bad distribution or disaster or accident can cause potential cross-border effect.

In the H2020 "Societal Challenges" pillar, in the “Climate Action, Environment, Resource Efficiency and Raw Materials” actual work program there are a great number of themes related to environmental security, and its technical aspects. Here are some of the more important research topics:

- integrated European regional climate modeling and prediction system;
- robust and overall system for the supervision of greenhouse gases;
- a million and a half year retrospection to improve the efficiency of climate prediction;
- eliminating and making the European economical coal dependency flexible for the 2030-2050 time period and beyond;
- coordinating and supporting research and innovation activities for the elimination of European coal dependency;
- new solutions for the sustainable production of raw materials;
- modern environmental surveillance systems.[19]

The LIFE program started in 1992 is the European Union’s financial tool for funding environmental protection, which Hungary joined in 2001. [20] The general goal of LIFE is to support the modernization and implementation of environmental politics and legislation. The “LIFE program 2014-2017 multiannual work program” approved by the EU’s Committee achieves the EU’s environmental protection policy trough two subroutines. These are:

- Environmental protection subroutine and

- Climate policy subroutine.

The Environmental protection subroutine contains three emphasized areas: Environment and resource efficiency, nature and biological diversity, and Environmental protection control and information. Within these it defines such thematic priorities, as water (including maritime environment), waste, resource efficiency (including soil and forests, and green and all-round economy), environment and health (including chemicals and noise), the quality of air and emissions (including urban environment), nature, biological diversity, information, increasing awareness, etc.

The subroutine of Climate policy supports the implementation of a low carbon-monoxide emission union economy resilient against the effects of climate change, strategically supports the execution of the 2020 climate change and energy package, and prepares the EU for climate policy challenges until 2030. Besides it also supports the better climate policy management on every level, including the increased inclusion of civil society, nongovernmental organizations and local personas. [21]

The safe, clean and efficient energy production is one of today's extremely important issues, which shows a close correlation with the operation of the state. The Unites States Department of Energy formulated their related notion titled "National Electric Delivery Technologies Roadmap" after consulting 200 energy industry experts in the beginning of 2004. This document draws up the main aspects of a long-term (25 year) research-development strategy. Its point is that a new electricity system's possible architectures suitable for the challenges of the future, and a sustainable, stable system of its structure and operation must be developed. The conclusions and suggestions of this document can be summarized as follows:

- the improvement of so called "critical technologies" is needed:
  - different capacity, efficient energy storages;
  - divided and intelligent measurement and control: intelligent measuring equipment; new, task specific data transfer architectures and protocols; new perspective protections and system rescue automatics; market dependent consumer side intervention;
  - high temperature supraconductive material and appliances based on them;
  - further development of high power appliances for the connection of the distributed energy producer and storage appliances, for the development of voltage quality, and for the more reliable automation of transmission and distribution;
- for the sake of accelerating the technological transfer, the following are needed:
  - development of new business models, the support of regulating authorities;
  - development of new university curricula, further development of the current ones;

  - further development of professional training, development of simulation software systems replicating the nature of new technologies;
- for the more efficient operation of the energy market the following are needed:
  - development of an information system suitable for collecting and forwarding large amounts of real-time data;
  - revision of law and regulation background regulating the market. [22]

The resolutions of the European Union (e.g. SET-Plan) put a great emphasis on the following topics:

- efficient integration of renewable energies in favor of reducing the dependence on carbon-based primary energy sources;
- development of so called Micro Grids in favor of avoiding system malfunctions, which are capable of forming viable islands independently as needed, then automatically reconnecting;
- the importance of the development of high level specialization and multidisciplinary education. [23]

One of the important issues of the framework program of EU H2020 is the support of energy sector researches. The work program titled "Safe, clean and efficient energy" contains many related research topics, from which some of the most important ones can be found in the following:

- recovery and recycling of waste heat energy from urban facilities to increase the efficiency of communal and individual heating and cooling systems;
- increasing the efficiency of outdated communal heating systems;
- standardized installment packages for the establishment systems providing integrated and energy efficient heating, cooling, and/or hot water utilizing renewable energies;
- new heating and cooling solution utilizing low quality heat energy sources;
- models and tools that can be used for assessing and planning the establishment of heating and cooling systems;
- assessing waste heat generated in industrial systems;
- increasing the share of renewable energies by using new generation innovation technologies, intelligent networks, integrating storage and energy systems, distribution networks;
- development of new generation bio fuel producing technologies;
- precompetitive solutions for the utilization of solar energy in industrial processes;
- demonstrating the most promising development directions in bio fuel production;
- high efficiency and flexibility power plants utilizing fossil fuel. [24]

SUMMARY AND PRELIMINARY TO PART 2

Instead of conclusions, we would only like to give a short summary here, to the end of the first part. The detailed discussion will be at the end of Part 2 (to be placed in the next journal edition).

What we have done so far is the introduction of state and governance researches running at the National University of Public Service especially with their interconnection with engineering sciences. A lot of points of common interest could be found and this first part of our paper focused on these. Findings of ongoing engineering researches and cutting edge technologies can serve as tools for the problem solving in case of many domestic and international state and governmental programs. A detailed overview has been planned to give in this paper from several areas of engineering researches. In this first part the fields of ICT technologies, information security and environmental security were introduced. The upcoming second part of the paper will cover the fields of disaster management, defense oriented technical researches, logistics and transport.

Based on the displayed international trends, in the final part we will summarize the promising technical research possibilities on certain areas at the NUPS and final conclusions will also be placed there.

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