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INNOVATION PRIORITIES OPTIMIZATION IN THE CONTEXT OF NATIONAL TECHNOLOGICAL SECURITY ENSURING

The article is devoted to the main aspects of technological security providing through increasing the efficiency of innovation development priorities selection. The features of impact of technological security for national security and international experience of its software were analyzed. The scheme of determination of innovation priorities, based on the assessment of critical technologies and strategy of socio-economic development, were proposed. The scheme of innovation priorities based on “deployment policy” concept was developed.

Keywords: technological security, national security, innovation priority, technology, strategy.

Problem statement. In present conditions technologies become a leading factor of economic development, and therefore the economic competition is increasingly defined by scientific and technological competition. Accordingly, technological security currently is critical component of economic security, which aims to ensure the sustainability of used technologies in some problem situations, that arise due to adverse events or trends in state or abroad. Also in the context of accelerating the pace of scientific and technological progress technological base changes become large-scale and multi-dimensional in nature, increasing the mobility of forces balance, discussion of problems of technological security, its providing and communication with other components of national security in general form of innovation economy development is relevant and timely.

Analysis of recent researches and publications has shown that technological factor is increasingly considered as factor of national security and its components (economic, information etc.). This aspect we already can observe from Harold Brown approach, U.S. Secretary of Defense in 1977-1981, who enlarged the national security definition by including particularly economic and environmental security elements: “National security then is the ability to preserve the nation's physical integrity and territory; to maintain its economic relations with the rest of the world on reasonable terms; to preserve its nature, institution, and governance from disruption from outside; and to control its borders” [1, p. 281]. In the same context He Chauncey compares technological modernization of economy with the “peaceful world war”, winner of which will become the world market leader, controlling access to global resources and establishing new economy rules. If the country loses this war, then it will be depend on other countries [10] or it will be not independent. As a result, we come to the necessity of the analysis of technology interdependence – symmetrical or asymmetrical. So we face with the important task of technology development within the national innovation system that will support technology security through first of all targeting expenditure to priority areas which can best generate innovation and other activities [8, p. 25].

In research [2] the relations between the creation of knowledge, innovations and advancement of regional and national competitiveness based on “smart specialization” is analyzed. It presents six major steps that need to be done by each country or region to develop a strategy of “smart specialization”, based on basic principles outlined in EU Research and

Innovation Strategies for Smart Specialization. Particular attention is given to the use of four-link spiral concept (Quadruple Helix). This concept extends the Triple Helix paradigm, focusing on the fact, that along with science, industry and state, society also plays a key role in innovation process which is often the end-user of innovations and therefore significantly influences on the creation of knowledge and technologies across the supply and implementation of custom function [4]. So we see that technologies and its base are also closely involved in national security through different macroeconomics mechanisms.

In our previous studies [5; 7] we have underlined that Quintuple Helix and extends International Helix (that additionally reflects factors of innovation globalization) models of the ecosystem of innovations as the self-organizing system, where is available all complex of the resources, necessary for creation and growth of the innovative and technological companies, and the relationships between participants of innovative process are harmonized.

So the analysis of recent researches and publications has shown that today conceptual development of technological security problems is rather incomplete and at uncertain stage. This is caused by problems in study of technological interdependence of problems of symmetry and asymmetry of states [9], insufficient search of ways of generation (determining) the optimum ratio of national development priorities and the most efficient ways of state integration into the international labor division. In addition, comparative analysis of global experience, that takes into account peculiarities of the national innovation system, is important.

So, **the aim of research** is to analyze the characteristics of selection of innovative development priorities in context of implementation of technological security policy providing. As a basic methodology of this research we propose to consider (1) cross-sectoral linkages as a tools of technologies analysis and (2) policy deployment (original – Hoshin Kanri concept) as a system approach that ensures the integrated development of high-tech products and associated processes from product concept development to disposal stage. Indicated approach is very important for establishing integrated national innovation systems as it was noted by us in previous studies [7] on example of cross-sectoral intercluster cooperation that is an important part of innovation and technological security policy.

Main material. Based on results of previous studies [9] we propose to consider technological security in the context analysis of relationship of autonomy and competitiveness of innovation system. For the more accurate understanding of the role of technological security we illustrate its impact on the national security on example of communication equipment.

Operators of transmission networks that provide a full range of modern multimedia communication services as for society and for state and military control institutions, build their networks exclusively using equipment from companies such as Cisco (US), Siemens (Germany), Huawei (China) and others. Equipping of stationary communication centers with modern digital communications and a large number of equipment, that was purchased from foreign firms – NEC (Japan) and Juniper (USA) of high technological level, which can't be doubted, did not ensure the national information and technological security. This can lead to loss of control and the handling of national information and telecommunication networks, which, in turn, leads to serious consequences for economy, lower defense capability to critically dangerous levels and serious restrictions of national interests. US State Department understand it and in 2012 and prohibited the use in public communication networks equipment of Chinese firms Huawei and ZTE, which was recognized as some kind of “cyber weapon”, which deals with the threat to national security. As a result all developed countries are trying to prevent the presence on their networks of foreign telecommunications equipment. In US the

whole telecommunications network is based only on national facility, in leading EU countries the non-residents share in networks is less than 10%.

In Ukraine approximately 90% of telecommunications equipment is supplied by foreign producers [9]. This is caused by the fact that since the early 90's of XX century domestic market was actually closed for domestic producers and for development of modern telecommunications equipment practically any budgetary resources were not allocated. This area is still not included in the public interest area despite the current situation in the country. It should be noted, that not all leading countries have their own rockets, planes, tanks, but all of them has modern communication industry and heavily invest in its development.

This example clearly shows the importance of only one type of technologies for national security. Not reducing the value of armed forces, it is quite clear, that the issue of national security is moving into economic and social sphere ("soft power"), and technological field takes priority position. But the full range of R&D can't afford any country, and the question of increasing the share in local and global high technology market segments is constantly solved in developed countries, but the topic of import substitution as a kind of task is not considered.

In Fig. 1 we show the evolution directions of innovation system, which can be the basis for the technology roadmap for purpose of securing by country the leading positions in technological chain. This scheme allows to analyze the relationship between the emerging prospects of product development towards independence in critical components.

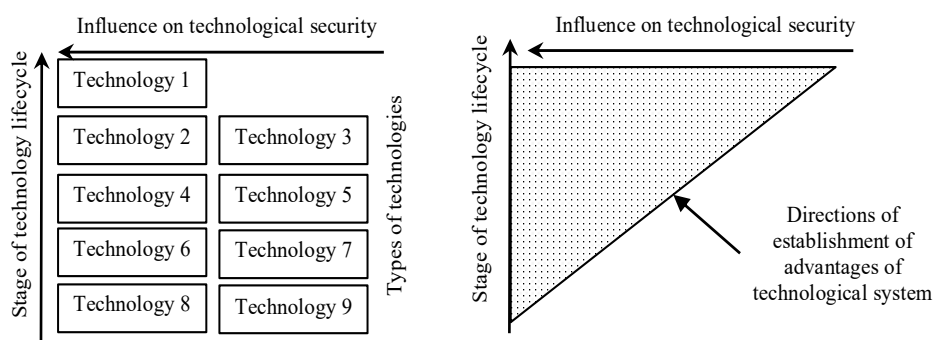


Figure 1 – Technological linkages priority evaluation (author's development)

Also we propose to consider global trends. In last two decades there it has been an active transition from "technological self-reliance" towards "technological interdependence". And this process is gaining even in military-oriented R&D. That's why it's important to note that growth of interdependence in many ways, including the key areas of scientific and technical progress, doesn't exclude independent scientific and technical innovation system. Therefore, based on the analysis of competitiveness, we propose to consider strategic economic security as a process of long-term monitoring of the evolution of economic and non-economic aspects of the market and identify potential markets and their opportunities and threats.

The similar approach can be applied for technological security. We believe that the fundamental base of technological security is highly efficient national innovation system, possibly including an effective system of technological forecasting. Among the most important factors of efficiency of national innovation system from a position of technological security we underline necessity to provide effective interaction between military and civilian

sectors of economy, creating high-quality technology transfer mechanism and so on.

Considering the scope of scientific and technical relations in Ukraine according proposed approach we can note the presence of such internal threats:

- absence of clear priorities of science and technological policy;
- destruction of scientific and technological potential, especially in the basic sciences;
- reducing the efficiency of transfer of scientific and technical achievement for development of economic, social and defense capabilities;
- increasing of scientific and technological backwardness and loss of leading positions in number of priority areas of science and technology;
- transfer for low price (up to 5-10%) abroad scientific and technological developments;
- external outflow of specialists with high professional readiness (up to 100 thousands).

To the most actual external threats we should include:

- destruction of international scientific linkages (innovation and production chains);
- expansion of scientific and technical intelligence from foreign countries.

Also among the system threats towards technological development of Ukraine we can name so-called “traps” of “technological backwardness”, “technological borrowing”, “coordination trap” (issues a command economy and corrupt bureaucratic capitalism, characterized by rent-oriented behavior) and other institutional problems. Also challenging is management and measurement of condition and effect relationships in innovative structures.

Based on analysis of possibilities of using the capacity of international environment, eliminating the technological gap between Ukraine and leading countries in framework of technological security provision should be implemented not by increasing the one-side transfer of foreign technologies, but with the improvement and development of national critical technologies based on foreign experience. Also positive balance of international technology transfer in future can't be achieved the growth of dumping policy with the expansion of volumes of these technologies only when the country has to spend a resources, which is beneficial only for foreign partners. This balance should be focused on system-level processes, it is necessary to speed up the development of its own technology base, that can eliminate existing or possible “technological blockade”.

Protection of sensitive technology systems and intellectual property in the first place should apply 15-20% of systems from the list of critical technologies (for Ukraine it includes special electronics, defense, security and space technologies, micro- and nanotechnologies, self-learning technological complexes and energy saving technologies). All these directions in our opinion can be successfully developed within the intersectoral clusters (for example space technologies for high-tech agriculture, self-learning complexes for space engineering etc.).

In analyzing the technological security, we should take into account the fact, that significant impact on international relations restructuring and world dynamics deals with the technological developments and changes in different states. For example, developing countries (China, India, Brazil etc.) are actively exploring the advantages of new technological structure (nano-, bio-, cognitive and information technologies, NBIC), searching for new competitive advantages and begin to displace the former leaders. US, UK and other leading EU countries have to make great efforts to overcome the negative consequences of systemic crisis of capital overaccumulation in areas of previous industrial and technological structure and its structures.

So, we can conclude, that in Ukraine state regulation in field of forecasting, international technology cooperation and technology transfer will play a significant role for technological security. The perspective way is to integrate basic technologies and dual-use technologies in a single high-performance system through intersectoral linkages. Based on mentioned above, we propose a mechanism of technological security providing, based on socio-economic importance and intersectoral aspects (Fig. 2).

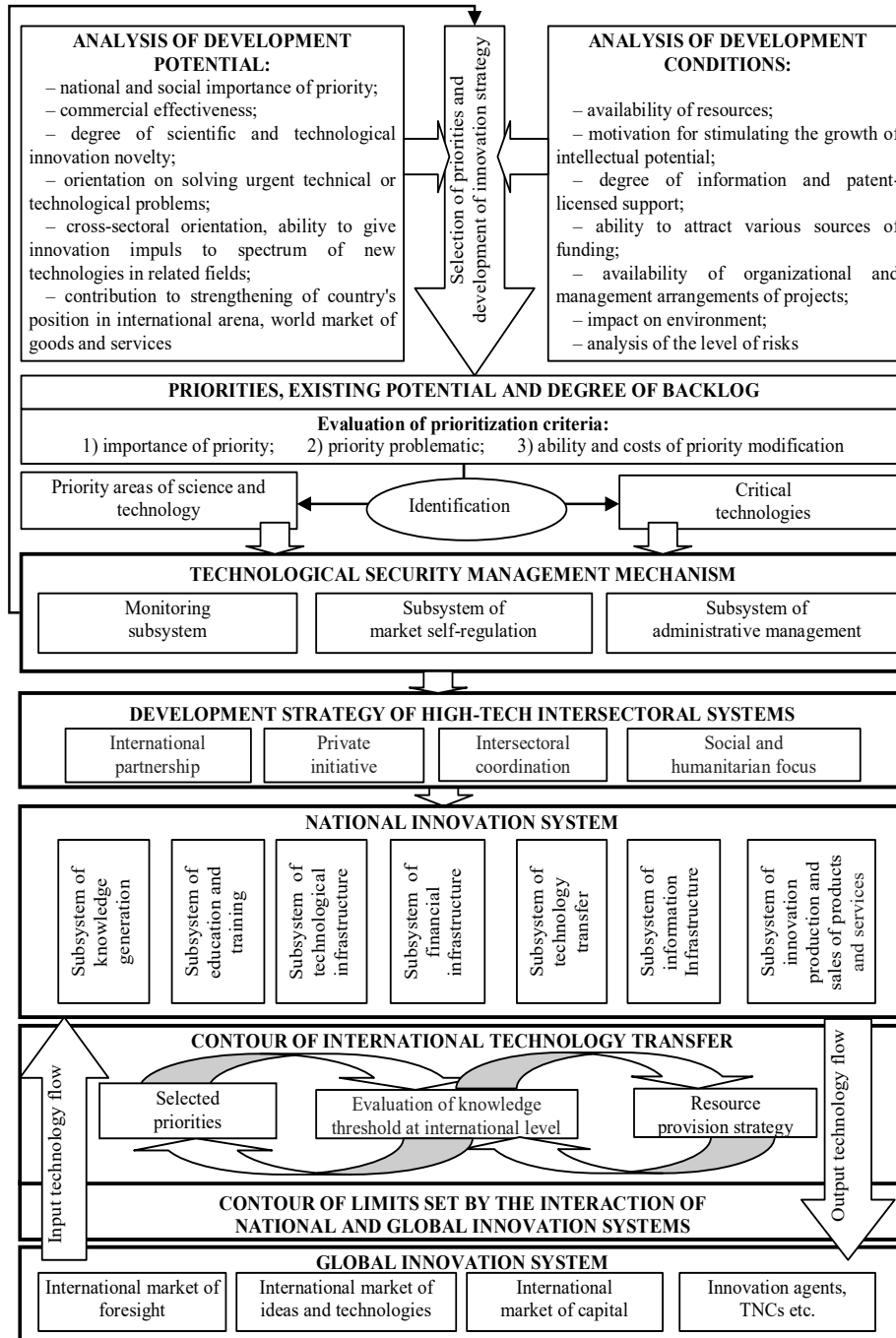


Figure 2 – Technological security and priorities interrelation (author’s development)

When process of technological security provision, we suggest to use the methodology deployment policy (Hoshin Kanri concept), that is applied for planning, establishing and implementing the objectives of analysis and development of technologies, which ensures the coordination of all actions aimed at achieving a properly formulated strategic goals.

The action plan of technological security providing through the evolutionary strategy includes a number of stages, at which information spreads from the top level management to lower-level management positions and other economic agents, and then generalize from the bottom up through the hierarchical management structure several times:

1. Selection of key challenges.
2. Selection of the strategic directions of development and support of strategic change.
3. Approval of operational management strategy.
4. Management that is based on elaborated policy.
5. Deployment the policy and implementation of chosen strategy.

Thus, according to this scheme the first step is to identify the threats to technological security (vulnerability) with its future projection on an innovation system for the next stages of the analysis.

The second step is the analysis of the priorities is applying the principle of Pareto “20 to 80”, according to which from the all the priorities that have been allocated we need to select 20%, analysis and optimization of which that we need to do in the first place (they can give up to 80% of the results and threats). To solve this problem in practice, we propose to use following prioritization criteria (priority importance; priority problematical; the possibility and the cost of the state changes in priority).

Importance of priority is the first criteria, characterizing the extent of its contribution to the achievement of strategic objectives. For innovation system optimization first of all we need to choose the most important (or critical) priority, because it's improvement will provide the greatest result for technological security.

The second criteria used for priorities allocation is its degree of problem level. If priority is important, but at the same time its indicators are at fairly good level, there is no reason to deal with its optimization. The classic definition of problem in the case of this research can be formulated as the gap between aspiration and reality. In other words, the problem is the difference between the target and current state and therefore priority with problem is characterized by the difference between the desired and current indicators of its performance have to be formed based on situational analysis according to sectoral specific and influence on other types of security.

Here we can name an example of priority selection in Ireland, which is an case of successful integrated approach based on technology and market foresight as well as public-private partnership [6, p. 6]:

1. The priority area is associated with large global market (markets) in which domestic-based enterprises already compete or can realistically compete.
2. Publicly performed R&D is required to exploit the priority area and will complement private sector research and innovation.
3. State has built or is building strengths in research disciplines relevant to priority area.
4. The priority area represents an appropriate approach to recognized national challenges and/or global challenges, with which state should respond.

On the basis of the use of international experience we offer strategic approach to developing and implementation of technological security providing policy:

- analysis of strengths, weaknesses, threats and opportunities of country's and

technological sectors competitiveness to ensure security;

- definition of overall development priorities and objective (target) function;
- specification of criteria of selection of priorities based on creation of intersectoral linkages map;
- determination a set of available support tools;
- determination of necessary costs for use of each instrument (the necessary budget and possible indirect public losses), as well as the benefits derived from the use of tool (social benefits – direct and indirect revenues, cross-sectoral effects etc.);
- determination of effectiveness of each instrument and possible synergies (multiplier effects) in optimal conditions of use;
- planning of available resources (including future opportunities for additional revenue);
- selection of optimal set of tools, maximizing the objective function for given level of funding or minimizing costs subject to achievement of objectives;
- assessment of effectiveness of policy implementation and course correction.

Conclusion and perspectives for further research. The state's ability to engage in complicated tech activities is a characteristic of scientific, technical and technological level of its development as well as has great impact on economic situation and national security and assists enhance its international prestige. However, the development of such industries and requires the creation of efficient innovation system and international cooperation mechanisms to compensate for negative effects of unilateral scientific and technological development based on priorities, that reflect the existing potential and strategy goals.

In further researches it is necessary to develop methodological approaches to address specific issues, related to objectives of uncertainty and appropriate criteria of innovation priorities selection, in particular to solve such problems of optimization:

1. The problem of normalization of criteria of priorities selection, that is to bring selection criteria to common (dimensionless) measurement scale.
2. The problem of choice of optimality principle, that is to establish in what way an optimal set of priorities is better than other solutions.
3. The problem of accounting criteria priorities.
4. The problem of calculating the optimum of tasks, based on combination of linear, nonlinear, discrete optimization methods etc. for optimum calculation.

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Оптимізація інноваційних пріоритетів у контексті забезпечення національної технологічної безпеки

У статті розглянуто основні аспекти забезпечення технологічної безпеки країни через підвищення ефективності вибору пріоритетів інноваційного розвитку. Проаналізовано особливості впливу технологічної безпеки на національну безпеку, а також світовий досвід її забезпечення. Запропоновано схему визначення інноваційних пріоритетів виходячи з оцінки рівня критичності технологій та стратегій соціально-економічного розвитку. Розроблено схему розвитку інноваційних пріоритетів на основі концепції “розгортання політики”.

Ключові слова: технологічна безпека, національна безпека, інноваційний пріоритет, технологія, стратегія.

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Оптимизация инновационных приоритетов в контексте обеспечения национальной технологической безопасности

В статье рассмотрены основные аспекты обеспечения технологической безопасности страны через повышение эффективности выбора приоритетов инновационного развития. Проанализированы особенности влияния технологической безопасности на национальную безопасность, а также мировой опыт ее обеспечения. Предложена схема определения инновационных приоритетов исходя из оценки уровня критичности технологий и стратегий социально-экономического развития. Разработана схема развития инновационных приоритетов на основе концепции “развертывание политики”.

Ключевые слова: технологическая безопасность, национальная безопасность, инновационный приоритет, технология, стратегия.

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