RESEARCH AND DEVELOPMENT TRENDS IN THE FIELD OF DEFENCE: EUROPEAN DEFENCE FUND

Professional Paper

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Abstract

The article presents trends in research and development projects within the European Defence Fund, for the purpose of national and international progress in the security and defense sector of the European Union member states. Following the described „Preparatory Action On Defence Research 2017 - 2019", the „European Defence Fund 2021 - 2027" with a budget of €8 billion (annual budget of €1.2 billion for 2021), is addressing fifteen categories in recent 2021 calls (sorted by belonging budget): Air combat; Ground combat; Energy resilience and environmental transition; Naval combat; Air and missile defence; Information Superiority; Defence medical response, Chemical Biological Radiological Nuclear (CBRN), biotech and human factors; Open calls for innovative defence technologies; Disruptive technologies; Digital transformation; Space; Force protection and mobility; Materials and components; Advanced passive and active sensors; Cyber. Further research should examine the benefits but also typical obstacles for joining and implementing such an international collaborative projects for research and development in the field of security and defence.

Keywords: Security, Project, International Cooperation, Innovation, Technology

1 Introduction: Project financing in the field of defence

In the beginning, nothing related to innovation is new, it is a product of deliberation of already existing components, but in a different way. Research and development are therefore preconditions for the creation of new value, the wider social utility which will sometimes be achieved with a prolonged passage of time. History testifies the realization of extensive infrastructure and other projects, which far exceeded the real capacities of their holders. For example, the complex construction of the Suez Canal caused the initially projected costs to be exceeded by 1,900 % (Flyvbjerg et al., 2009). In order to realize a larger number of important projects of various purposes for the wider social prosperity, the importance of consortium partnership and project type of financing was emphasized. According to the Project Finance International (2016), in 2015 alone, $ 275 billion was invested in project financing. Although

most projects are carried out in stable environments, some have been carried out in challenging destinations, such as the Chad-Cameroon pipeline or the Venezuelan oil fields (Esty, 2004a), where a numerous disruptive external factors are present.

Although eminent authors, such as Harvard professor Benjamin Esty or Oxford professor Bent Flyvbjerg, pointed out more than ten years ago the empirical advantages of the project method of funding for academic research and its usefulness in a broader social sense (Esty, 2004b; Flyvbjerg et al., 2009), project funding is still underrepresented in scientific research (Sawant, 2010). The origins of international project financing date back to the Middle Ages, when the British Crown financed silver mines with loans from Italian commercial banks (Esty et al., 2014; Kensinger and Martin, 1988). This article focuses on the importance of research and development, as a prerequisite for progress in a specific area of security and defense. The defense industry is certainly one of those from which, in terms of the innovations produced, overall society has benefited. In this context, it is worth mentioning the successful application of semiconductors, computers, radar, GPS, etc., in civilian space. Defense research and development is an important channel through which countries shape innovation in general. In the United States, annual defense research and development expenditures in 2016 were about $ 78.1 billion, which was 57.2 % of total research in the United States that year (Congressional Research Service, 2018). Some even argue that the role of the Pentagon, as the world's most willing investor in technological innovation during the Cold War, was the important reason that resulted in cutting-edge technologies and the dominance of American companies and their entire industry (Braddon, 1999). More recently, many point to Israel as an example in which defense investments have spawned a handful of successful high-tech start-ups and products (Senor and Singer, 2009). Of course, a proportionate part of research and development in the field of defense also includes investments in the development of military equipment, weapons and aids. Middleton et al. (2006) quantitatively showed that countries that have invested more in the development of military equipment, indeed, have achieved the set goals in the form of production of specialized products of this type. Furthermore, research and development in the field of defense also generates specialized human resources, increasingly recognized in the private sector. For example, Silicon Valley companies have recently increasingly considered Pentagon staff for potential employment. The primary topic of this article is to present trends in the research and development segment of the European Defence Fund, for the purpose of national and international progress in the security and defense sector.

2 European Defence Fund

According to Molenaar (2021), the strengthening of the European defense industry and defense policy is becoming a "paradigm that needs to be changed" in order to recognize the European Union as a serious global actor. In this context, it is useful to mention the Capability Development Plan, which is a list of all capabilities that support decision-making at EU or national level, with regard to the development of military capabilities, with a view to better coordinating Member States' defense planning. It emphasizes security and defense challenges from the perspective of developing European capabilities, looking at the future operational environment, and its importance is precisely in defining EU priorities for capability development agreed by Member States (European Defence Agency, 2018). Further, Coordinated annual review on defense (CARD) can be understand as a corrective-analytical mechanism that aims to show the actual state of existing defense capabilities at EU level and identify potential areas of cooperation between Member States to optimize costs in the defense sector. Handa and Nagy (2019) recognized the importance of CARD as it focuses on

reviewing EU Member States' defense plans in three key areas for the EU: trends in defense spending, implementing Capability Development Priorities, and reviewing multinational cooperation. The *2020 CARD* report analyzes Member States' defense activities with a particular focus on capability development, research and development efforts, defense industry support and other operational aspects. One of the most important recommendations contained in the report includes increasing the share of research and development expenditures in the defense budgets of EU Member States in order to develop state-of-the-art defense capabilities through joint cooperation at national and EU level, thus supporting European technological development and resilience (European Defence Agency, 2020). In this context, it is unavoidable to mention the Permanent Structured Cooperation (PESCO), the area of security and defence policy established in 2017, which offers a legal framework to jointly plan, develop and invest in shared capability projects, and enhance the operational readiness and contribution of armed forces.

According to the European Commission (2021b), the European Defence Fund (EDF) is the Commission's initiative to support collaborative defence research and development, and to foster an innovative and competitive defence industrial base. Complementing and amplifying Member States' efforts, the EDF promotes cooperation among companies and research actors of all sizes and geographic origin in the Union, in research and development of state-of-the-art and interoperable defence technology and equipment. The EDF supports competitive and collaborative projects throughout the entire cycle of research and development for a bigger impact on the European defence capability and industrial landscape. It strongly encourages participation of small and medium-sized enterprises in collaborative projects and fosters breakthrough innovative solutions. The EDF[1] was preceded by two test programmes - the Preparatory Action on Defence Research (PADR) and the European Industrial Development Programme (EDIDP). A budget of close to €8 billion for 2021 - 2027 is dedicated to the European Defence Fund (€2.7 billion to fund collaborative defence research and €5.3 billion to fund collaborative capability development projects complementing national contributions). Although EDF represents 0.74% of the amount within the EU's multiannual financial framework and faces a large number of criticisms of the political and economic spectrum, EDF represents a serious opportunity to improve Europe's defense capabilities (Zande, 2021). With this, the EU shows for the first time that it is able to operationalize its supranational character into a platform for the realization of joint projects in the field of defense, which are envisaged within the multiannual financial framework of the EU.

Insufficient defense spending is a constant subject of discussion among NATO member states. In this context, Lupinot (2018) sees the EDF as an essential tool for a fairer burden-sharing between allies. It considers that the fund encourages the intensification and support of the development of modern capabilities of the armed forces of the EU member states and provides an opportunity for member states to involve small and medium-sized enterprises in the implementation of complex research and development projects. He points out that such interstate cooperation also significantly contributes to achieving economies of scale. The intention of the European Commission in the coming period is to create synergies in the segment of research and development between the defense and civilian sectors. To this end, in February 2021, the Action Plan (2021a) on synergies between civilian, defense and space industries was adopted, which aims to maximize the benefits of military research, not only for defense purposes, but also to raise the competitiveness of industry within the EU and achieve social effects on EU citizens who will have access to state-of-the-art technologies. In order to achieve this, the goal is to connect and harmonize existing EU programs such as Horizon

[1] Preparatory action on defense research, as a kind of preparation for the European Defence Fund, is a continuation of the European Commission's policy from 2015, which signed an agreement with the European Defence agency on a pilot project focused on defense research (Preparatory Action on CSDP - related research).

Europe, the European Defense Fund, the EU Space Program, the European Innovation Council, InvestEU, etc.

2.1. Preparatory Action On Defence Research (PADR) 2017 - 2019

Preparatory action on defense research (PADR) for the period from 2017 to 2019 was approved in the amount of 90 million euros. Of that amount, 25 million was allocated for 2017, 40 million for 2018, and 25 million for 2019. Completion of all contracted projects is planned by mid-2023. A total of 18 projects of strategic importance for the EU have been established in three years (table 1). Given the recentness of 2019 and the number of projects realized in that year, we decided to show the specific goals of those projects.

Table 1: Realized PADR projects in 2017 - 2019 period (Masson, 2021)

PADR 2017	ACAMS II	Adaptive Camouflage for the Soldier II
	GOSSRA	Generic Open Soldier System Reference Architecture
	OCEAN2020	Technological demonstrator for enhanced situational awareness in a naval environment. Open Cooperation for European mAritime awareNess
	PYTHIA	Predictive methodologY for TecHnology Intelligence Analysis
	VESTLIFE	Ultralight Modular Bullet Proof Integral Solution for Dismounted Soldier Protection
PADR 2018	EXCEED	trustEd and fleXible system-onChip for EuropEan Defense applications
	SOLOMON	Strategy-Oriented anaLysis Of the Market fOrces in EU defeNce
	TALOS	Tactical Advanced Laser Optical System
PADR 2019	AIDED	Artificial Intelligence for the detection of explosives devices
	ARTUS	Autonomous Rough-terrain Transport UGV Swarm
	CROWN	European active electronically scanned array with Combined Radar, cOmmunications, and electronic Warfare fuNctions for military applications
	INTERACT	INTERoperability Standards for Unmanned Armed ForCes SysTems
	METAMASK	Metasurfaces for time-domain adaptive masking
	OPTIMISE	Innovative Positioning system for defence in GNSS-denied areas
	PILUM	Projectiles for Increased Long-range effects Using Electro-Magnetic railgun
	PRIVILEGE	PRIVacy and homomorphIc encryption for artificiaL intelligence
	QUANTAQUEST	Quantum Secure Communication and Navigation for European Defence
	SPINAR	Spin-based hardware artificial neural network for embedded RF processing

In 2019, the focus of PADR was focused on three areas. Primarily, it is the achievement of dominance in the **Electromagnetic Spectrum** through research and development of combined radar, communication and electronic combat functions, which are based on the European Active Electronically Scanned Arrays (AESA) for military applications. The aim of the research is to build a multifunctional radio frequency system based on AESA technology for a wide range of applications. Second, the commission highlighted **Future Disruptive Defense Technologies** as a segment that can make an important contribution to strengthening the EU. For this purpose, the Commission approved the financing of five projects in the category of „Emerging game changers"- ARTUS, AIDED, OPTIMISE, PILUM and QUANTAQUEST, and three projects in the category „Challenging the future" - METAMASK, SPINAR and PRIVILEGE. The ARTUS project (Autonomous Rough-terrain Transport UGV Swarm) refers to the development of unmanned ground vehicles for tracking troops in the field up to the size of the platoon and providing logistical support to them in the field by transporting equipment, ammunition, food, water or wounded soldiers. The AIDED (Artificial Intelligence for the detection of explosive devices) project focused on the use of

artificial intelligence to detect explosive devices, which proved necessary due to the large number of soldiers killed by improvised electronic devices in areas of operations such as Afghanistan, Iraq or Syria. The OPTIMISE project (innOvative PosiTIoning systeM for defense In gnSs-denied arEas) aims to improve the positioning, navigation and timing capabilities in areas without access to global navigation satellite systems. This aims to integrate several different positioning, navigation and time technologies into one to make it easier to perform GPS-dependent military tasks. Project PILUM (Projectiles for Increased Long-range Effects Using Electro-Magnetic railgun) focuses on the development of "electromagnetic rail rifle", i.e., a linear motor device for launching missiles at extremely long distances (over 200 km) using electromagnetic acceleration instead of chemical fuels. The QUANTAQUEST (Quantum Secure Communication and Navigation for European Defense) project, aims to develop the field of quantum sensing for navigation and timekeeping without relying on the global navigation satellite system and quantum communication to achieve safety and security in key areas and combat functions in the field of defense. The METAMASK (Metasurfaces for time-domain adaptive masking) focused on the development of metamaterials for electromagnetic camouflage of military equipment. The aim of the research is to develop a technology that is able to achieve radar camouflage and/or illusion based on a new type of adaptable, time-modulated, active meta-surface. There is also the SPINAR project (Spin-based hardware artificial neural network for embedded RF processing) which aims to combine radio intelligence and nanotechnology to process radio frequency signals to identify signal transmitters with very low power consumption and very high efficiency. The PRIVILEGE (Privacy and homomorphic encryption for artificial intelligence) focuses on developing of artificial intelligence technology to more effectively encrypt confidential military data. The synergy of different technologies (Homomorphic Encryption, Verifiable computing, Private Aggregation of Teacher Ensembles) aims to achieve more efficient use of military and defense data. The third area identified under this strategic concept relates to the establishment of **Interoperability standards for military unmanned systems**. The INTERACT project (INTERoperability Standards for Unmanned Armed ForCes SysTems) is being implemented with this goal in mind. The joint participation of 19 entities from 11 countries seeks to integrate technical knowledge and operational experience in this area in order to define future cross-sectoral standards for unmanned systems. The ultimate goal is to facilitate the use of unmanned systems through a wide range of operations and missions, all with the aim of building the EU's defense capabilities, both individually and collectively. French, Italian, followed by German, Spanish and Dutch entities (companies, centers, academic institutions, etc.) are mostly involved in PADR.

2.2. European Defence Fund 2021 - 2027

The European Defence Fund 2021 - 2027 with a budget of €8 billion[2] (annual budget of €1.2 billion for 2021), is addressing 15 categories in 2021 calls (sorted by belonging budget): Air combat; Ground combat; Energy resilience and environmental transition; Naval combat; Air and missile defence; Information Superiority; Defence medical response, Chemical Biological Radiological Nuclear (CBRN), biotech and human factors; Open calls for innovative defence technologies; Disruptive technologies; Digital transformation; Space; Force protection and mobility; Materials and components; Advanced passive and active sensors; Cyber. Specific

[2] Although the formation of the EDF in the amount of 13 billion euros is initially planned in 2018, due to the situation with the SARS-CoV-2, the EC has decided to reduce the fund's budget by 39%, relocated for health and social measures.

categories and related topics are shown in the table below (ranked per belonging indicative budget).

Table 2. Categories and topics from the EDF calls for proposals for 2021 ranked per belonging indicative budget. (Adapted to the European Commission, 2021c: European Defence Fund calls 2021)

Calls categories	Topics addressed by the calls
Air combat 190 million EUR	a) Next generation rotorcraft technologies (Research) b) Enhanced pilot environment for air combat (Development) c) European interoperability standard for collaborative air combat (Development)
Ground combat 160 million EUR	a) Improved warheads (Research) b) Future modular ground vehicles and enabling technologies, including green technologies (Development) c) Unmanned ground vehicle technologies (Development) d) Beyond line of sight collaborative close combat architecture (Development)
Energy resilience and environmental transition 133 million EUR	a) Energy independent and efficient systems for military camps (Development) b) Next generation electrical energy storage for military forward operation bases (Development) c) Alternative propulsion and energy systems for next generation air combat systems (Development)
Naval combat 103.5 million EUR	a) Digital ship and ship digital architecture (Research) b) Ship Structural Health Monitoring (Research) c) Multirole and modular offshore patrol vessel (Development)
Air and missile defence 100 million EUR	Endo-atmospheric interceptor – concept phase (Development)
Information Superiority 70 million EUR	a) High-altitude platform systems (Development) b) Robust defence multi-dimensional communications (Development)
Defence medical response, Chemical Biological Radiological Nuclear (CBRN), biotech and human factors 68.5 million EUR	a) Detection, identification and monitoring (DIM) of CBRN threats (Research) b) Defence medical countermeasures (Development)
Open calls for innovative defence technologies 63.5 million EUR	a) Open call addressing disruptive technologies for defence (Research) b) Open call focused on SMEs for research on innovative and future-oriented defence solutions (Research) c) Open call dedicated to SMEs for development of innovative and future-oriented defence solutions (Development)
Disruptive technologies	a) Quantum technologies for defence (Research)

60 million EUR	b) Non-line-of-sight optical sensors applications (Research) c) Over-the-horizon radars applications (Research) d) New materials and technologies for additive manufactured defence applications (Research)
Digital transformation 58.5 million EUR	a) Frugal learning for rapid adaptation of AI systems (Research) b) Military multi-domain operations cloud (Development)
Space 50 million EUR	a) Space and ground-based navigation warfare (NAVWAR) surveillance (Development) b) European protected waveform and accompanying technologies for resilient satellite communications against jamming (Development)
Force protection and mobility 50 million EUR	a) Development of full-size demonstrators for soldier systems (Development) b) Development of a digital system for the secure and quick exchange of information related to military mobility (Development)
Materials and components 40 million EUR	a) Materials and structures for enhanced protection in hostile environments (Research) b) Advanced radiofrequency components (Research)
Advanced passive and active sensors 38 million EUR	a) Infrared detectors (Research) b) Advanced radar technologies (Research)
Cyber 33.5 million EUR	a) Improving cyber defence and incident management with artificial intelligence (Research) b) Improved efficiency of cyber trainings and exercises (Development)

3 Conclusion

Numerous empirical examples testify the importance of project funding and cooperation in research and development in a specific area of security and defense. In this context, the benefits of the projects implemented under the auspices of the Preparatory Action on Defense Research (PADR) may be recognized in the strengthening of international cooperation, strengthening cooperation between public and private companies and other institutions involved. The exchange of experiences between states, institutions and companies ultimately leads to improved efficiency (Ianakiev, 2019). The European Defence Fund also contributes to the sharing of costs between countries, with easier overcoming of national budgetary constraints, and by encouraging cooperation, it also significantly contributes to reducing fragmentation and leads to higher production volumes. Apart from the financial sense, the benefits can be seen in capacity building in the field of national security, but also in the context of influencing domestic policy. Further, by participating in such projects countries demonstrate compatibility with the EU's internal policy strategy. In addition to the development of domestic *know-how*, in the broader sense of EU foreign policy, they

strengthen the EU's capacity in the field of security and defense, which can affect the *hard power* of the European Union as a globally important actor.

One of the major challenges is the insufficient geographical dispersion of the partners involved. Most of the projects included the most developed EU member states, which leads to the issue of equality and participatory competitiveness of other countries. Issues of the need to achieve a more even representation of smaller countries are problematized by Brichet et al. (2021) who concluded that smaller states, due to the structure and narrow specialization of their industry, cannot match more developed countries. It should not be overlooked the issue of highly different national policies of EU countries, as well as the lack of expertise in the field of project management which can be an additional aggravating circumstance in certain countries. The problem of interoperability between Member States' weapons systems, which in most cases are still quite different, may be also reduced by mentioned efforts. Further research should examine the benefits but also typical obstacles for joining and implementing such an international collaborative projects for research and development in the field of security and defence.

References

Braddon, D. (1999). Commercial Applications of Military R&D: US and EU Programs Compared. University of the West of England. (Unpublished).

Brichet, S., Chouarbi, H., Dénoue, M., Frossard, V., Laurent, A., Libert, N., Magnuszewski A., Maillard, P. and Rolin, J. (2021). „The Governance of the European Defence Fund." Fondation Robert Schuman, *European issues*, 592.

Congressional Research Service (2018). *Government Expenditures on Defense related R&D by the US and other OECD Countries*. Washington DC. https://fas.org/sgp/crs/natsec/R45441.pdf (visited on July 10th 2021).

Esty, B.C. (2004a). *Modern project finance: a casebook*. Wiley, New York, NY (Wiley internat. ed.).

Esty, B.C. (2004b). „Why study large projects? An introduction to research on project finance." *European Financial Management* 10, 213-224.

Esty, B., Chavich, C. and Sesia, A. (2014). An overview of project finance and infrastructure finance-2014 Update. In: Working paper. Harvard Business School, Boston.

European Commission (2021a). Action Plan on synergies between civil, defence and space industries. https://www.eesc.europa.eu/en/our-work/opinions-information-reports/opinions/action-plan-synergies-between-civil-defence-and-space-industries (Visited July 11 2021).

European Commission (2021b). The European Defence Fund (EDF). https://ec.europa.eu/defence-industry-space/eu-defence-industry/european-defence-fund-edf_en (Visited on July 15th 2021).

European Commission (2021c). European Defence Fund calls 2021.

European Defence Agency (2018). Capability Development Plan, Fact sheet. https://eda.europa.eu/docs/default-source/eda-factsheets/2018-06-28-factsheet_cdpb020b03fa4d264cfa776ff000087ef0f (Visited on July 15th 2021).

European Defence Agency (2020). 2020 CARD Report - Executive Summary. https://eda.europa.eu/docs/default-source/reports/card-2020-executive-summary-report.pdf (Visited on July 15th 2021).

Flyvbjerg, B., Garbuio, M. and Lovallo, D. (2009). „Delusion and deception in large infrastructure projects: two models for explaining and preventing executive disaster." *California Management Review* 51, 170-193.

Handa, J. and Nagy, Z. (2019). Towards an European defence union? A new phase in the European union's defence cooperation and the Hungarian public opinion. Challenges in public, non-profit and social marketing. 18 th International congress on public and non-profit marketing, University of Győr, Hungary, 81-91.

Ianakiev, G. (2019). The European Defence fund, A Game Changer for European Defence Industrial Collaboration. Policy paper 48, Armament Industry European Research Group.

Kensinger, J.W. and Martin, J.D. (1988). „Project finance: raising money the old-fashioned way.“ *Journal of Applied Corporate Finance* 1, 69-81.

Lupinot, Q. (2018). *Why the European Defence Fund Is Good News for U.S. Security Interests*. Center for Strategic and International Studies.

Masson, H. (2021). *Precursor Programmes of the European Defence Fund*. Fondation pour la recherche stratégique.

Middleton, A., Bowns, S., Hartley, K. and Reid, J. (2006). „The Effect Of Defence R&D On Military Equipment Quality. Defence and Peace Economics.“ *Taylor & Francis Journals*, 17 (2), 117-139.

Molenaar, A. (2021). Unlocking European Defence. In Search of the Long Overdue Paradigm Shift. Istituto Affari Internazionali. https://www.iai.it/en/pubblicazioni/unlocking-european-defence. (Visited on July 15th 2021).

Project Finance International (2016). League tables. http://www.pfie.com/Journals/2016/01/26/c/b/y/PFI-Financial-League-Tables-2015.pdf (Visited on July 15th 2021).

Sawant, R.J. (2010). „The economics of large-scale infrastructure FDI: the case of project finance.*“ Journal of International Business Studies,* 41, 1036-1055.

Senor, D. and Singer, S. (2009). *Start-up Nation: The Story of Israel's Economic Miracle*. Council on Foreign Relations.

Zande, D. (2021). European Defence Fund - The real test is yet to come. Clingendael, Netherlands Institute for International Relations.