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MANAGING MILITARY EQUIPMENT PROJECTS IN THE NEW ECONOMIC REALITY



ABSTRACT: The process of modernization of the Polish Armed Forces has been going on almost continuously since its inception to enable the implementation of the country's military strategy. The purpose of the article is to present issues related to the specifics of the implementation of projects for the provision of military equipment and project management methods used in the arms industry in the current economic reality. In the presented article, using the analysis and synthesis of available materials, the current economic and military situation strongly conditioned by the current actions of the Russian Federation in Ukraine is presented. The requirements for the Polish armaments industry are taken into account in this aspect. In the further part of the article, the authors will focus on presenting the specifics of the operation of armaments industry enterprises and the role they occupy in the system of ensuring the supply of equipment to the Polish Armed Forces. The specific conditions occurring in the implementation of projects in the armaments industry and the most commonly used project methodologies in the industry will also be described. The concept of project implementation efficiency is defined, and the results of research undertaken in this regard are presented. In the conclusions are included conclusions on the issues undertaken.

KEYWORDS: armaments industry, project management, project efficiency.

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INTRODUCTION

The arms industry in Poland is one of the key elements ensuring the independence and autonomy of the state on the international arena. From the very beginning, this industry has struggled with stiff competition both on the Polish defense market and internationally, which ultimately led to its consolidation aimed at increasing its competitiveness.

The basic goal of the defense industry is to provide, modernize and repair military equipment, thanks to which the Polish Armed Forces (SZ RP) will be able to gain the advantage of military operations. In order to meet the basic requirements related to the state's defense, it is necessary to provide efficient facilities in the form of efficient organizational structures of the arms industry.

The production process in the arms industry is characterised by specific requirements related to the intended use of military equipment. This implies the need for an individual approach and consideration of product and market specifics. The efficient and effective delivery of military equipment (SpW) is dictated by the current economic and military situation related to the aggression of the Russian Federation in Ukraine.

THE RECENT ECONOMIC AND MILITARY REALITY IN THE REGION

In recent years, the world has dealt with a wide range of forms of armed conflict, which differ, for example, in the scale, intensity, complexity, duration and blurring of the boundaries between the state of war and peace. The current international security environment, conditioned by the aggression of the Russian Federation against Ukraine, is increasingly complex and uncertain. This contributes to an increase in uncertainty in political, military, economic and social activities on the national, European or global scale. The current situation affects both the strategy and the main directions of transformation of the national security system.

Since its foundation, Poland has been located in a strategically important place in Europe. During this time, its geostrategic and geopolitical location has changed many times as a result of the formation of new states, the shifting of European borders and the expansion of the sphere of influence of its neighbors. Poland's accession to NATO in 1999 and the European Union in 2004 significantly changed the geopolitical position of the country, which for a long time functioned as a buffer between Germany and Russia. With Poland's accession to NATO and the EU, our eastern border became the border of both these groups, the external border

of a united Europe, cooperating with the countries of Eastern Europe that form the confederal structure of the Commonwealth of Independent States. Accession to the EU resulted in a significant shift of Poland on the geopolitical map of Europe and gave a new quality to its foreign policy. The Republic of Poland has gained new opportunities for the development of eastern policy and a new advantage in the geopolitical game with the Russian Federation¹.

Poland is situated between two different civilisations, between the cultural area of Western Christianity with its centre in Rome and Eastern Christianity (Orthodoxy). Its eastern border is the boundary between the Latin and Turanian civilisations. From a geopolitical point of view, Poland is a "transit" state, conveniently located for pan-European cooperation².

The location of Poland between Germany and Russia, apart from many benefits, is the main geopolitical dilemma of our country. Aggressive actions on Polish territory have repeatedly posed a real threat to the population living there.

At present, the most serious threat to Poland is the policy of the Russian Federation authorities, implemented through the use of military force. Russia's aggression against Georgia, the annexation of Crimea and actions in eastern Ukraine in 2014 violated the basic principles of international law and undermined the pillars of the European security system.

In recent years, the Russian Federation has intensively developed its offensive military potential and has actively developed military systems in the Kaliningrad region and in the Baltic and Black Sea areas. Repeatedly conducted large-scale military exercises, based on scenarios involving conflict with the countries of the North Atlantic Alliance, rapid redeployment of large groups of troops and even the use of nuclear weapons, have served to build up an advantage in the public awareness of Poland, Europe and the world. The Russian Federation has also repeatedly carried out hybrid activities and undertook comprehensive activities using non-military measures, including: cyber attacks or disinformation activities. The aim of all these activities was to destabilize the structures of Western states and societies and to cause divisions among allied states. The Russian Federation seeks to regain a decisive role in creating security in Europe and expand its sphere of influence in this area³.

¹ K. Łastowski, *Sytuacja geopolityczna Polski po przemianach ustrojowych i wstąpieniu do Unii Europejskiej*, Studia Europejskie 1/2011, p. 5.

² Ibidem, p. 8.

³ R. Kuźniar, *Droga do wolności. Polityka zagraniczna III Rzeczypospolitej*, Wydawnictwo Naukowe Scholar, Warszawa 2008, p. 233.

Today we also already know that all these activities were a prelude and preparation for large-scale military operation.

The Russian invasion of Ukraine, which started on 24 February 2022, has forced Poland, given its strategic location, to further strengthen its defence and deterrence capabilities. NATO increased the presence of troops on its eastern flank and raised the readiness of forces that can be rapidly redeployed when threats escalate. The measures taken have provided the Allies with a sufficient level of security for some member states to be able to provide significant support to Ukraine, significantly strengthening its ability to defend itself. While it is difficult to assess the effectiveness of Russian threats to NATO, including nuclear threats, they have likely influenced calculations on the scale and type of support currently provided to Ukraine⁴.

The role played by Russia's aggression in Ukraine, which still pretends to be a regional power, in terms of Poland's security is very important. Its aggressive policy, as well as its military actions, combined with the disinformation it conducts, force the Polish authorities to be very cautious in all its actions on the international arena.

The current situation requires a change in the approach to national defence as well as a change in Poland's individual actions. It is necessary to improve the security of the state and its citizens, to ensure its further development and to strengthen the position of the Republic of Poland in the international arena.

National security is a very important aspect of the functioning of any state with a considerable impact on ensuring the conditions for the well-being of society. Also, the very close proximity of the militarized Kaliningrad Oblast has a significant impact on the security of Poland and other countries in the region⁵. Poland's accession to the North Atlantic Alliance significantly strengthened Poland's position towards Russia and guaranteed its security. Today, the security of the Republic of Poland depends on relations with its neighbours and international cooperation with the United States, the United Kingdom or France, but above all it depends on self-sufficiency in the military area⁶.

⁴ W. Lorenz, *Wysunięta obrona - nowe podejście do polityki obrony i odstraszania NATO*, <http://polska-zbrojna.pl/home/articleshow/37133?t=Wysunieta-obrona-nowe-podejscie-do-polityki-obrony-i-odstraszania-NATO#> (access: 12.06.2022).

⁵ H. Kowalczyk, *Obwód Kaliningradzki 2016. Społeczeństwo, gospodarka, armia*, Raport OSW, Warszawa 2016, p. 18, https://www.osw.waw.pl/sites/default/files/raport_w_obwodzie_kainingradzkim_net.pdf (access: 12.06.2022).

⁶ *Strategia Bezpieczeństwa Narodowego Rzeczypospolitej Polskiej*, Warszawa 2020, p.7.

Therefore, the efficiency and independence of the Polish arms industry is so important. The arms industry in Poland is one of the key elements guaranteeing the independence and autonomy of the state in the international arena. The possibilities and capabilities of the Polish Armed Forces to acquire military equipment (SpW) depend on the efficiency and effectiveness of this sector of the market.

The development of new technologies - both civil and military - significantly increases the use of unmanned and autonomous systems, automated and robotic weapons platforms, as well as long-range precision weapons systems, including ballistic and cruise missiles. The challenge for the state is to join the technological and arms race in this area, which gives Poland the opportunity to step out of the role of only the user and join the group of countries with an efficiently functioning digital economy, providing solutions and contributing to international standards.

The cross-section and scope of the arms industry determines the capacity and readiness to produce military equipment, ranging from that directly related to weapons through modern means of communication on the battlefield or weapons of various types used by land, air, special, territorial or naval forces. No less important are the capabilities of the arms industry in terms of service, repair and modernisation. These capabilities directly result in the ability to ensure combat efficiency on today's battlefield.

Today, in the context of the aggression in Ukraine, the supply of weapons, ammunition and highly specialised military equipment is becoming the most important. Western countries, including Poland, must first and foremost provide support adequate to the needs occurring in the area of military operations. In the near future, Poland will be one of the countries most exposed to the negative long-term consequences of the war in Ukraine. These include security issues, migration implications, consequences of economic independence from Russia or the challenges of the energy transition.⁷

Already today, the strong Polish arms industry makes it possible to ensure the supply of equipment to the fighting Ukraine worth several billion zlotys. According to official information, Poland is currently the second supplier of armaments to the Ukrainian Armed Forces, and its value has exceeded USD 1.6 billion or approximately PLN 7 billion⁸.

⁷ B. Edwin, P. Buras, *Polska wobec wojny, Polska w świecie po wojnie. Zadania na nowy czas*. Fundacja im. Stefana Batorego, Warszawa 2022, p. 5.

⁸ *Polskie uzbrojenie w obronie Ukrainy*, Defence24, <https://defence24.pl/przemysl/polskie-uzbrojenie-w-obronie-ukrainy-analiza> (access:13.06.2022 r.).

Polish weapons in Ukraine can be divided into two categories. The first is modern, recently produced domestic weapons, which are either shipped directly from domestic military facilities or come from the stock of the Polish Armed Forces, which will receive newly produced examples of the same weapons in the future. Grot⁹, Piorun¹⁰ or Krab¹¹ are weapons that are already becoming a Polish export hit.

The second type is old equipment used during the Warsaw Pact era. This is heavy equipment and, if it were new, it would also be extremely expensive. In their place, Poland will buy (or get from allies) newer weapons of Western provenance.

Therefore, it is crucial to develop the capabilities of the national industrial and technological base in the area of defense, in accordance with the needs of state security including selective launching of activities for the mobilization of the economy and the needs of the Armed Forces of the Republic of Poland.

The Polish arms industry, regardless of its form of ownership, should fulfil the long-term needs of the Polish Armed Forces by utilising the results of research and development work.

In the light of the current military threats, the potential available in the arms industry becomes an indicator of the economic and political capabilities of the State.

THE ROLE OF THE POLISH ARMS INDUSTRY IN ENSURING THE SUPPLY OF SPW TO THE POLISH ARMED FORCES

In order to ensure the basic requirements related to the defence of the State, it is necessary to have an efficient background in the form of efficient organisational structures of the arms industry. In today's market, this is not a simple task, as it requires ensuring a balance in the field of diversified development of the national economy as well as maintaining free market principles consisting in obtaining the best economic indicators for implemented projects.¹²

The activity of the Polish arms industry dates back to the inter-war period. At that time, the first industrial initiatives were established, which are the foundations of many of today's companies operating within Polska Grupa Zbrojeniowa. In order to consolidate the Polish arms industry, Polska Grupa Zbrojeniowa (PGZ S.A.) was established by a government decision

⁹ "Grot" modular firearms system production by Fabryka Broni „Łucznik” - Radom sp. z o.o.

¹⁰ "Piorun" portable anti-aircraft missile system production by Mesko S.A.

¹¹ „KRAB” Self-propelled howitzer production by Huta Stalowa Wola S.A.

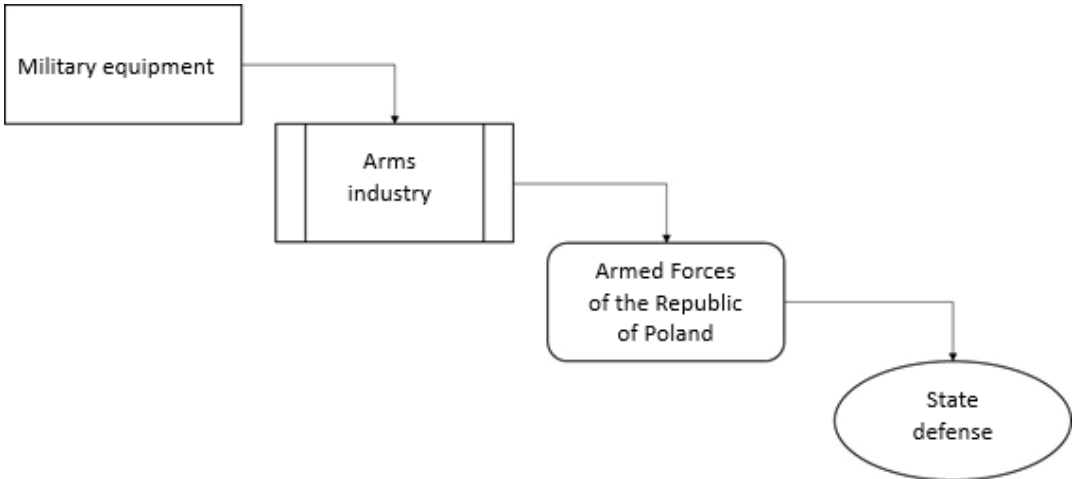
¹² A. Tomaszewski, A. Nowakowska-Krystman, P. Zamelek, (eds), *Przemysł Zbrojeniowy w systemie obronnym państwa* T.1, Wydawnictwo Akademii Sztuki Wojennej, Warszawa 2018, p. 180.

in 2013. The companies around the group form the backbone of the national defence concern, which aspires to become a competitive and flexible economic structure, performing production, research and development and commercial tasks, capable of responding quickly to the changing expectations and conditions of the defence products market.

The Group has capital-related companies as part of its operations, but in order to implement specific business projects, strategic alliances are formed.

Figure 1 shows the position of the arms industry in the chain of activities and connections aimed at ensuring the defence of the State.

Fig. 1.
The role of the arms industry in the defense of the State



Source: own study.

The arms industry tends to be highly politically dependent. It means that often the decisions taken have a pragmatic and political dimension and are less often based on economic foundations.

When characterising the arms industry, as well as trying to identify possible directions for its transformation and optimisation, one should always keep in mind the issue of its combat readiness.

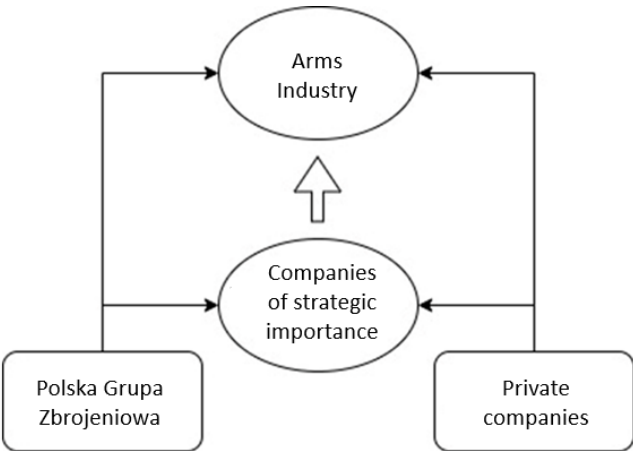
Combat readiness describes the ability of the arms industry to transfer from peacetime activities to production taking into account the needs of the risk and war time. This should also

include arms industry market players classified as being of particular importance for national defence, which are given the status of strategically important enterprises¹³.

Thus, it concerns the state of preparation of this strategic branch of industry for the production of important products used to secure the accomplishment of national military goals more broadly referred to as defence products.

Figure 2 shows the operating model of the arms industry in Poland.

Fig. 2.
The arms industry in Poland



Source: own study.

Enterprises operating in the arms industry have their own specificity, which distinguishes them from typical civil enterprises.

An important role of the arms industry is to ensure basic defence and the state's ability to produce military products in times of national security threat. This means that conditions specific to the operation of the arms industry have a significant impact on the type and method of projects implemented in the industry.

FACTORS AFFECTING PROJECT IMPLEMENTATION IN THE ARMS INDUSTRY

The aim of a project conducted in the arms industry, is to provide military equipment according to strictly defined criteria, technical-organisational and quality requirements.

¹³ Rozporządzenia Rady Ministrów z dnia 4 października 2010 roku, w sprawie wykazu przedsiębiorców o szczególnym znaczeniu gospodarczo-obronnym, Dz.U. 2010 nr 198 poz. 1313.

The recipients of the equipment are structures and organisational units of the Ministry of National Defence.

Such equipment is usually a new type that meets the standard of military equipment or is a modernization, also known as a modification of equipment already in the current state of armament. An important characteristic of such a project is that the potential failure of the project directly affects the basic interest of the state's security, which significantly increases the rank of implemented projects.

The specificity of a project in the arms industry concerns individual conditions related to securing the interests of state security. In such projects, costs and deadlines take on a different meaning than in typical projects carried out on the civilian market.

The acquisition of military equipment follows a strictly defined procedure and is a consequence of actions and decisions taken by the highest levels of state leadership related to the direction and dynamics of the development of the Armed Forces. The current sourcing system is based on a ten-year planning and development cycle which are updated every four years. This means that the very possibility of acquiring the equipment is somewhat limited and must be consistent with what was originally planned.

No less important is the fact that often, in order to meet the customer's requirements, it is necessary to carry out complex construction and technological processes aimed at developing new technology. Such projects are characterised by the necessity to provide properly qualified resources and the time needed to conduct the relevant development studies¹⁴.

The obligation of individual companies in the arms industry to fulfil contracts for the Ministry of National Defence determines that they have to implement AQAP requirements in accordance with the ISO 9001 standard and then to proceed strictly in accordance with specific rules. The quality requirements defined in this way and the method of cooperation for their implementation is quite a challenge to be taken into account in the everyday work related to the implementation of projects in the area of the arms industry.

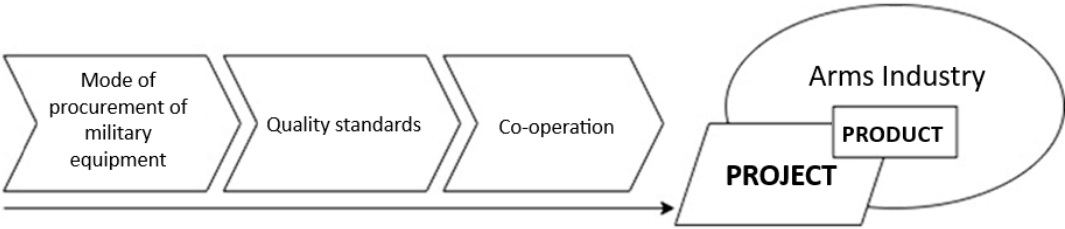
Cooperation with the Regional Military Offices, which are fully responsible for supervising the quality of defence products manufactured for the Ministry of National Defence, has great significance for the efficient implementation of projects in the arms industry.

¹⁴ A. Nowakowska-Krystman, J. Antczak (eds), *Produkty, technologie i systemy zapewnienia jakości w przedsiębiorstwach zbrojeniowych*, Wydawnictwo Akademii Sztuki Wojennej, Warszawa 2020, p. 19.

One of the key decisions affecting the ability for efficient implementation of projects related to the delivery of products for the Armed Forces is making strategic decisions related to defining the tasks and roles of individual cooperators. Thus, a very important stage in the construction of the strategy of each defense company is the development of collaborative cooperation with companies within the capital group, as well as with collaborative partners on the external market.

Figure 3 shows the chain of related factors affecting project implementation in the arms industry.

Fig. 3.
Factors affecting project implementation in the arms industry



Source: own study.

In the case of the providing military equipment for the Armed Forces, a typical design approach really means the need to jointly handle interrelated manufacture processes such as construction, technology, production, co-operation, quality control of the final product and sales. Consistent treatment of these processes in terms of design, ensures the integrity of activities and consequently contributes to the organisation's effectiveness and efficiency in achieving its objectives.

During the research conducted on analysing the specific conditions occurring in the arms industry, it was proven that the key factors influencing the implementation of projects include how military equipment is acquired, the methods of ensuring the quality of the supplied products and the reliability of the partners responsible for cooperation.

These elements, due to their significant importance in the process of supplying products to the Polish Armed Forces, must be taken into account when planning and implementing project activities. The undertaken activities must be aimed at achieving high efficiency in project implementation and maintaining consistency with formal conditions. The means and methods

used for this must take into account both the companies' own potential and the efficiency of the cooperation processes.

TYPES OF DESIGN METHODOLOGIES

Project management, despite being a relatively young field of management, has already managed to develop many methods to standardise project work. Often the authors of project methodologies are international and local organisations, research units, consulting companies or individual specialists with extensive experience in project management.

Unlike other scientific disciplines, there is no single proven recipe for success in project management. Over the years, various tools have been developed in the form of methodologies aimed at increasing the chances of success. However, due to the changeable nature of projects, they never provide a clear path to achieve the goal set during implementation. The individual characteristics of each running project determine which tools and techniques should be used, while which approach should be adopted in the implementation of a specific project depends on its scope and is decided by its project manager. Project management is part of a broader field of management dealing with the application of available knowledge, skills, methods and tools in order to implement a project aimed at meeting the needs and expectations of the contracting authority.¹⁵

Project management is a field focused on creating new things and introducing continuous change. Projects are, by definition, new and not typical activities and their management must focus on defining objectives and gathering the necessary human or material resources and managing them in a rational, efficient and effective way.

Another issue is regular business activity, also known as process management or operations management. Operations management is a subject that goes beyond the scope of standard project management. It is an area of management related to the current production of goods or the actual delivery of services. It assumes, among other things, making sure that operational activities in the organisation are carried out efficiently using the optimal configuration of the needed resources to meet the customer's requirements.

Operations management is related to the process management that involves transforming materials, energy and labour into results in the form of products or services¹⁶.

¹⁵ K. Janasz, J. Wiśniewska (eds), *Zarządzanie projektami w organizacji*, Difin, Warszawa 2014, p. 10.

¹⁶ *Ibidem*, p. 13.

A project in the arms industry can be defined as a temporary organisation established to provide technology, military equipment or services to the Armed Forces according to approved requirements and an accepted business justification (requirements)¹⁷.

There are many heterogeneous methodologies in the field of project management. Such a phenomenon is considered as proof of the maturity and independence of the project management field. In order to improve project implementation, organisations use different methods, tools, techniques but also strive for standardisation in this field.¹⁸

Project management methodologies are a kind of guide to the types of documentation and authorisations needed for the various stages of a project. The methodologies help novice project managers, provide ready-to-use solutions to complete planned work and help organizations to standardize procedures and applied terminology¹⁹.

The most important groups of project methodologies include traditional and agile approaches to project management.

In the case of projects with clearly defined and predictable results, it is possible to use traditional project management (TPM -Traditional Project Management) methods. Traditional project management assumes that the client has a clearly formulated need, a deadline date and an amount they are prepared to spend on the project. This works particularly well in situations where the objectives, together with the technique for achieving them, are clearly and transparently formulated and the scope is unlikely to change during the project duration. TPM is applied to most projects that have well-defined objectives and ways to achieve them. Such methods ensure the fastest possible achievement of project results by planning the complete implementation of the project²⁰.

Figure 4 shows the different phases and characteristic stages in the implementation of projects involving traditional design methodologies.

¹⁷ A. Nowakowska-Krystman, J. Antczak, (eds), *Produkty, technologie i ...op.cit.*, Wydawnictwo Akademii Sztuki Wojennej, Warszawa 2020, p. 18.

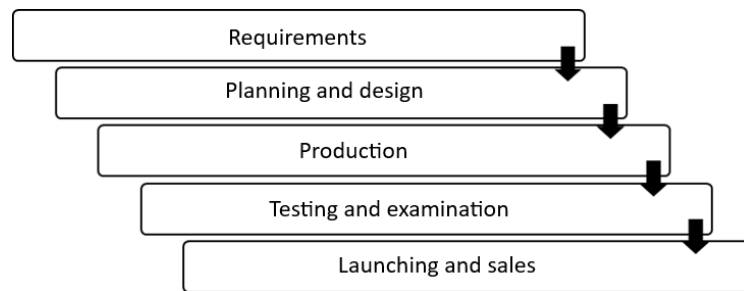
¹⁸ K. Janasz, J. Wiśniewska (eds), *Zarządzanie projektami w organizacji*, Difin, Warszawa 2014, p. 155.

¹⁹ N. Mingus, *Zarządzanie Projektami*, Wydawnictwo Helion, Gliwice 2009, p. 26.

²⁰ R.K. Wysocki, R. McGary, *Efektywne zarządzanie projektami*, Helion, Gliwice 2005, p. 27.

Fig. 4.

Traditional design approach in the arms industry



Source: compiled on the basis of PMBOK® Guide – Seventh Edition, Project Management Institute 2021.

Such model is also called the Waterfall Model, or the sequential model, and it is the oldest and most widely used model of project implementation. The name cascade is used because the implementation of the project involves the execution of successive phases, and each phase passes into the next. As a rule, it is not possible to proceed to the next phase without completing the previous one. Such activity usually includes stages, that define the individual phases of the project.

APM methods, also known as evolutionary, agile, incremental or iterative models, are used primarily in large corporate research and development projects in particular in the IT industry.

Such projects are generally associated with a high risk of failure, the need for frequent change and an area of activity with a wide scope of work for the client. These types of projects tend to have quite undefined goals and hard to define ways of implementation. These methods ensure quick achievement of the results (especially partial results) of the project by searching for the optimal way of performing tasks during the project. They ensure the achievement of goals and results through a step-by-step iteration of the activities implemented in relation to the goal and the client's expectations, as well as by constantly looking for a way to achieve them.

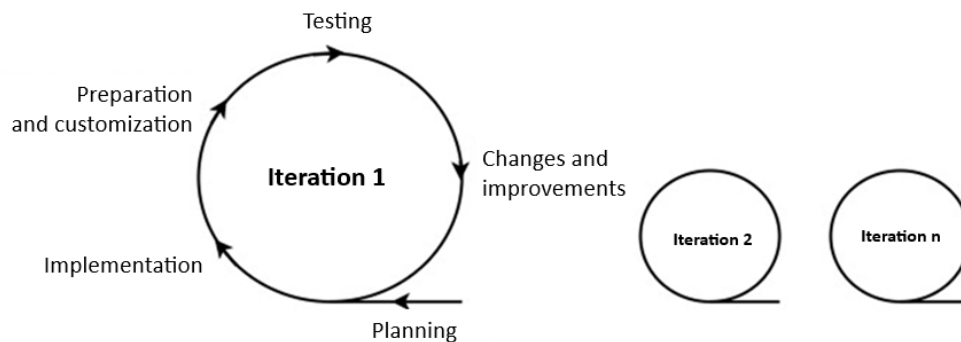
Agile project management has emerged in response to the need to implement projects under conditions of increased uncertainty. The methodologies and assumptions were developed and implemented as solutions for more effective software design, although they are now also applied to other types of projects. The basic principles of the approach are efficiency, adaptability and co-operation. Some authors also emphasise the importance of simplification, which brings the methodology closer to the principles of 'lean' thinking, based on flexibility

and simplicity. As a result, the project focuses on the elements of usefulness of the end result and setting priorities of project implementation²¹.

Figure 5 shows the management model used in agile project management methodologies.

Fig. 5.

Agile design approach



Source: compiled on the basis of AgilePM[®] Agile Project Management Handbook v2, Dynamic Systems Development Method Limited 2014.

In the agile approach, a project is divided into small, manageable units and activities. After each unit (iteration) is completed, as a result there should be a working solution. Dividing a project into small units of activity helps to prioritise results and methods of achieving them. Such division also allows for more efficient implementation of changes, adding or redefining the goal of the work.

The main difference between this model and the cascade model is the inclusion of changes and corrections introduced at the project implementation stage as necessary elements of the entire model. In the cascade model, changes are usually treated as undesirable and as hampering the achievement of the original goal. By contrast, in the iterative model, changes are its inherent component, the heart of the entire system. Iterations are treated as crucial to the work progress at the execution stage, while the progress itself, within each iteration, is carried out sequentially²².

In order to ensure an efficient environment that allows for the efficient delivery of products for the Polish Armed Forces, it is necessary to properly select project methodologies: traditional or agile. Such a selection should be carried out adequately to the scope of the implemented

²¹ R.K. Wysocki, R. McGary, *Efektywne zarządzanie projektami*, Helion, Gliwice 2005, p. 328.

²² M. Trocki (eds), *Metodyki i ...*, Polskie Wydawnictwo Ekonomiczne, Warszawa 2017, p. 89.

project. The selection of specific operating models from the available methodologies (traditional or agile) will determine, among others, how the team will carry out particular tasks.

Traditional methodologies are suitable for those projects in which we know from the beginning the scope and objective of the activities. Agile methodologies can be successfully used in projects where the dynamics and variability of goals will be present in organised projects. A methodical approach and knowledge in the area of project management can significantly facilitate project implementation in organisations operating in the arms industry.

EFFICIENCY OF PROJECT IMPLEMENTATION

In order to be able to fully and unequivocally refer to the features proving the success of the project, the concept of efficiency should be defined in terms of management assessment criteria. Adoption of an unambiguous approach to the assessment of the efficiency of implemented projects allows for the development of a unified and coherent system of project assessment.

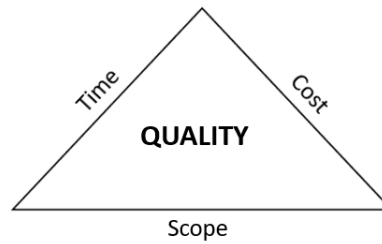
The key issue related to the implementation of projects is the efficiency with which projects are completed. It is an indicator that allows to determine whether a project delivers the required products according to the specified requirements, at specified costs, within the defined deadline and within the agreed scope. As projects are temporary their success should be measured in terms of completing the project within agreed, by project managers and senior management, quality, resource and risk constraints.

The issues related to project efficiency are described by the so-called project triangle defined by H. Kerzner. The concept implies that the main parameters of a project can be presented as sides of a triangle described as: time, cost, scope.

Figure 6 shows the project triangle, which represents the characteristic correlations that affect the efficiency of project implementation.

Fig. 6.

Project triangle - main parameters



Source: compiled on the basis of Kerzner H. *Project Management. A System Approach to Planning, Scheduling and Controlling*, Wiley John Wiley & Sons Inc. 2009, p. 715.

The availability of the organisation's resources assigned to the project is defined as the area of the triangle. Each change of one of the project parameters directly affects the change of the others.

When analysing the functions of the project triangle, it can be noticed that for companies the specification of time, scope or cost can be interchangeable depending on the market situation. When it is necessary to launch a product faster, the product function (scope) may be restricted.

In order to define the concept of efficiency in project management even more precisely, in accordance with the assumptions quoted above, it is necessary to establish an unambiguous measure. Defining such a measure will allow to measure the efficiency of implemented projects in a quantifiable way.

A proposal for defining such a measure is presented below.

Equation 1.

Project efficiency measure

$$P_e = \frac{T_1}{T_2} + \frac{C_1}{C_2} + \frac{S_1}{S_2} \rightarrow 1 \quad (1)$$

where:

P_e – project efficiency,

T_1 – time of project implementation,

T_2 – actual duration of the project,

C_1 – cost of the project,

C_2 – actual cost of the project,

S_1 – scope of the project,

S₂ – actual scope of project implementation.

Source: own study.

Reducing costs can reduce the scope of work while maintaining the time available for the project. The project environment changes dynamically influencing the project parameters. The organisation's response should be flexible and strongly determined by the market. The main tasks for the project manager include constant balancing of the project triangle and keeping the basic parameters of the project within the established framework²³.

Project quality is defined individually depending on the type of project or the adopted corporate strategy and is a consequence of the impact of above-described parameters. The starting point for defining a project's success and thus its efficiency are the baseline plans prepared in the first phase of project preparation and approved by appropriately authorised stakeholders²⁴.

The baseline plans are archived and remain unchanged until the project is completed. Therefore, it is possible to compare them with the actual results that the project has achieved. Such a comparison can be made during the project closure phase and the lessons learned should be added to the experience registers, allowing long-term lessons to be drawn for future projects.

By identifying the main parameters of the project implementation, it is possible to clearly define the components constituting the basis for determining the key elements of the project efficiency measure, i.e. 'Time', 'Cost', 'Scope'. Such components will hereafter be referred to as project performance parameters.

CONCLUSIONS OF STUDIES CONDUCTED ON THE EFFICIENCY OF PROJECT IMPLEMENTATION

In the course of research on the presented issues, empirical research methods were used with the application of techniques and tools in the form of a survey (questionnaire) and an expert interview. These methods and techniques were used to investigate the type of used design methodologies and their impact on the efficiency of project implementation in the arms industry.

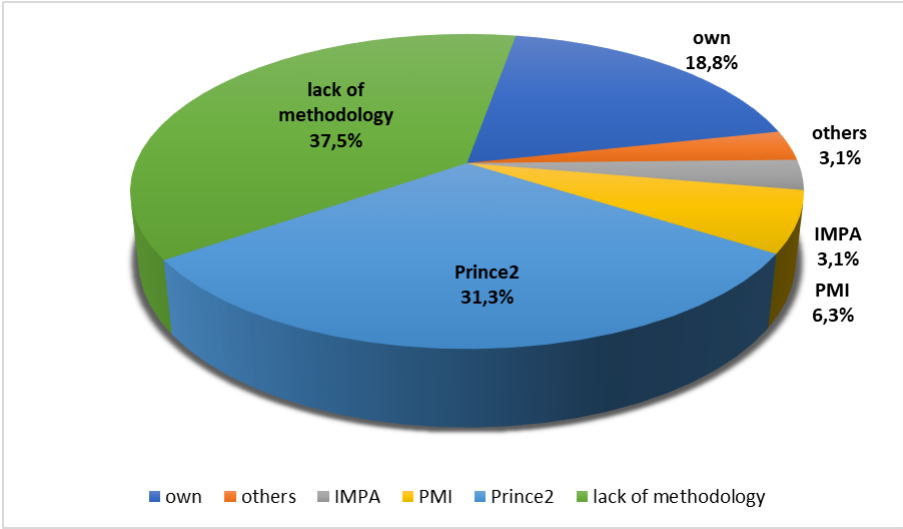
²³ A. Nowakowska-Krystman, J. Antczak (eds), *Produkty, technologie i ...op.cit.*, Wydawnictwo Akademii Sztuki Wojennej, Warszawa 2020, p. 31.

²⁴ PMBOK® Guide ..., Project Management Institute 2021, p. 34.

Conducted empirical research consisted of collecting data in a homogeneous environment within a specific research group, i.e. managerial staff and employees of arms industry companies who work in project implementation.

The obtained results confirm that project management and thus also the degree of use of project methodologies in individual companies is very diverse and heterogeneous. A significant part, 37.5%, of the companies do not use project management, while the remaining companies use various management methodologies (Figure 7).

Fig. 7.
Application of project management methodologies.



Source: own study.

As far as project management is concerned, it is evident that there is no focus on these types of management methods in arms industry companies. Correspondingly, 78.1% of companies do not use project management and 90.6% of them do not build project portfolios. It should also be emphasised that the use of agile management methodologies is not widespread, i.e. 53.1 % do not use this type of methodology.

The obtained results of the research lead to the conclusion that there is currently no standard for project management among companies in the arms industry.

It can be assumed that the above results are influenced by the different level of development of individual companies and their organisation, as well as by conditions related to the dynamics of their development.

The obtained results regarding the behaviour of individual project efficiency parameters depending on the use of project management methodologies allow to conclude that there are significant differences in project efficiency depending on whether individual organisations use project management methodologies or not.

At the same time, it should be noted that the use of project methodologies, as proven by the conducted research, has a positive effect on increasing the efficiency of implemented projects among companies in the arms industry.

SUMMARY

In accordance with a study of the available literature, it has been verified that the arms industry is characterised by specific conditions that affect project implementation. The most important factors influencing the implementation of projects include: the mode of procurement of military equipment, methods of ensuring the quality of the delivered products and the stability of collaboration with partners implementing cooperation processes. These areas, due to their significant importance in the process of delivering products to the Armed Forces, must be particularly considered when planning and implementing project activities.

Thanks to the analysis of the collected literature, two main types of project management methodologies were identified. The first group are methodologies based on a traditional model, the so-called cascade model, characterised by an approach based on detailed planning of all stages of the project. A separate group of methodologies are agile methodologies particularly useful in the implementation of complex projects with difficult-to-define objectives in the initial phase of the project life cycle.

By proposing to introduce an unambiguous definition of the efficiency of an implemented project, it is possible to introduce a standardised measure for it. Basing the efficiency of a project on the basic elements of time, scope and cost allows for an unambiguous evaluation of the effects related to the production of products under the project.

The final conclusions include the statement that it is necessary for companies in the arms industry to continually improve their product delivery strategies while taking into account in their operational activities the specifics of acquiring SpW, the impact of cooperation and quality requirements in implemented projects.

Summarising the conducted research, it should be noted that in order to ensure an efficient environment allowing for the efficient delivery of products for the Polish Armed Forces, it is necessary to apply and appropriately select project methodologies: traditional or agile. Such a selection should be carried out adequately to the scope of the implemented project.

The use of project methodologies allows for the standardisation of performed tasks as part of the implemented projects. The use of uniform theoretical foundations and conceptual definitions allows to provide the basis for efficient communication within the project team.

In the course of the conducted research it was shown that the application of methodologies affects the efficiency of implemented projects in the arms industry, i.e. it allows to minimise the difficulties encountered in the course of the project. The results of the conducted research indicate that the application of appropriately selected project management methodologies is an important factor influencing the possibility of achieving high efficiency in the realisation of projects in the arms industry.

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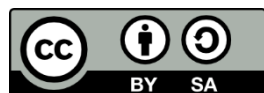
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