Institute of Management
Faculty of Security, Logistics and Management
Military University of Technology in Warsaw

Instytut Zarządzania
Wydział Bezpieczeństwa, Logistyki i Zarządzania
Wojskowa Akademia Techniczna w Warszawie

ISSN 1896-9380 | eISSN 2719-860X

Modern Management Systems
Volume 21 (2026)
No. 2 (April-June)
pp. 69-80

Nowoczesne Systemy Zarządzania
Zeszyt 21 (2026)
nr 2 (kwiecień-czerwiec)
s. 69-80

Dilemmas and risks in the implementation of military equipment

Dylematy i ryzyko przy wdrażaniu sprzętu wojskowego

Przemysław Simiński[A-D]
State University of Applied Sciences, Suwałki, Poland
p.siminski@puz.suwalki.pl; ORCID: 0000-0002-2323-3152

Beata Domańska-Szaruga[C, E-F]
Military University of Technology, Warsaw, Poland
beata.domanska-szaruga@wat.edu.pl; ORCID: 0000-0001-7290-4197

DOI: 10.37055/nsz/225703

A – Research concept/Koncepcja badania
B – Data collection/Gromadzenie danych
C – Data analysis/Analiza danych
D – Writing the article/Napisanie artykułu
E – Critical revision/Krytyczne zrecenzowanie
F – Final approval/Zatwierdzenie artykułu

Submission/Nadesłano: 14.04.2026
First review/Pierwsza recenzja: 18.04.2026
Second review/Druga recenzja: 20.04.2026
Acceptance/Zaakceptowano: 21.04.2026
Online publication/Opublikowano online: 30.06.2026
Publication/Opublikowano: 30.06.2026

Abstract:
Research objectives and hypothesis/research questions
The research hypothesis was formulated as follows: effective risk management requires an integrated approach that takes into account the specifics of the defence industry, NATO normative regulations (AQAP), and building trust-based relationships between process participants.
Research methods
Qualitative methods were applied, including analysis of normative documents, case analysis, and literature studies.
Main results
The results indicate that the main dilemmas include: selecting the appropriate level of quality requirements (AQAP 2110 vs. AQAP 2131), the disproportion between design time and the dynamics of changing operational needs, and insufficient competencies of personnel involved in the implementation process. The conclusions confirm the research hypothesis, pointing to the necessity of implementing a systemic approach to risk management covering the entire life cycle of a military vehicle. The research conducted enabled a positive verification of the research hypothesis. Effective risk management in the

ME implementation process indeed requires an integrated approach that takes into account the specifics of the defence industry, NATO normative regulations, and the development of trust-based relationships.
Implications for theory and practice
In response to the research questions, the following conclusions were formulated. First, each of the implementation process parties – the user, the manufacturer, and the research institute – bears differentiated types of risk, with the greatest safety-loss risk falling on the direct user. Second, the main dilemma concerns balancing oversight costs against the level of acceptable risk – applying AQAP 2131 instead of AQAP 2110 reduces current costs but generates potentially far higher costs and hazards in the operational phase. Third, risk minimisation requires a combination of formal, technical, and relational instruments, encompassing trust-building, appropriate contracts, evaluation and testing (OiB), terminology standardisation, and an adequate research process.

Keywords:
risk, military equipment implementation, risk management, AQAP, military vehicles

Abstrakt:
Cel badań i hipotezy/pytania badawcze
Sformułowano następującą hipotezę badawczą: efektywne zarządzanie ryzykiem wymaga zintegrowanego podejścia uwzględniającego specyfikę branży obronnej, regulacje normatywne NATO (AQAP) oraz budowanie relacji opartych na zaufaniu między uczestnikami procesu.
Metody badawcze
W badaniach zastosowano metody jakościowe, obejmujące analizę dokumentów normatywnych, analizę przypadków oraz studia literaturowe.
Główne wyniki
Wyniki wskazują, że głównymi dylematami są: wybór odpowiedniego poziomu wymagań jakościowych (AQAP 2110 vs. AQAP 2131), dysproporcja między czasem projektowania a dynamiką zmian potrzeb operacyjnych oraz niedostateczne kompetencje kadr uczestniczących we wdrażaniu. Wnioski potwierdzają hipotezę badawczą, wskazując na konieczność wdrożenia systemowego podejścia do zarządzania ryzykiem, obejmującego cały cykl życia pojazdu wojskowego. Przeprowadzone badania pozwoliły na pozytywną weryfikację hipotezy badawczej. Efektywne zarządzanie ryzykiem w procesie wdrażania SpW rzeczywiście wymaga zintegrowanego podejścia, uwzględniającego specyfikę branży obronnej, regulacje normatywne NATO oraz budowanie relacji opartych na zaufaniu.
Implikacje dla teorii i praktyki
W odpowiedzi na pytania badawcze sformułowano następujące wnioski. Po pierwsze, każda ze stron procesu wdrażania – użytkownik, producent i instytut badawczy – ponosi zróżnicowane rodzaje ryzyka, przy czym największe ryzyko utraty bezpieczeństwa ponosi bezpośredni użytkownik. Po drugie, główny dylemat dotyczy równoważenia kosztów nadzorowania z poziomem akceptowalnego ryzyka – stosowanie AQAP 2131 zamiast AQAP 2110 obniża koszty bieżące, ale generuje potencjalnie znacznie wyższe koszty i zagrożenia w fazie eksploatacji. Po trzecie, minimalizacja ryzyka wymaga połączenia instrumentów formalnych, technicznych i relacyjnych, obejmujących budowanie zaufania, właściwe umowy, OiB, standaryzację terminologii oraz odpowiedni proces badawczy.

Słowa kluczowe:
ryzyko, wdrażanie sprzętu wojskowego, zarządzanie ryzykiem, AQAP, pojazdy wojskowe

Introduction

The implementation of military equipment (ME) into the Armed Forces of the Republic of Poland is a multi-faceted process determined by technological, organisational, financial, and legal factors. The contemporary security environment, dynamically shaped by armed conflicts – including the Russo-Ukrainian war – compels NATO member states to accelerate the technical modernisation of their armed forces (Simiński, 2024a). In this context, military vehicles play a fundamental role, providing mobility, crew protection, and the execution of operational tasks.

The ME implementation process carries risk at every stage – from the formulation of tactical and technical requirements, through design and production, to operation and disposal. The dilemmas accompanying this process concern, inter alia, the selection of the optimal level of quality requirements, balancing costs against technical parameters, and ensuring coherence among the many institutions involved in the acquisition process (Domańska-Szaruga, Simiński, 2017).

The aim of the article is to identify and analyse the key dilemmas and types of risk arising in the ME implementation process, with particular focus on military vehicles. The research hypothesis was formulated as follows: effective risk management in the ME implementation process requires an integrated approach encompassing institutional cooperation, application of NATO normative regulations, and the development of trust-based relationships.

Based on this objective, the following research questions were formulated: (1) What types of risk do the individual parties to the ME implementation process bear? (2) What dilemmas accompany the selection of quality requirement levels in the context of AQAP regulations? (3) How can risk be minimised in the process of implementing military vehicles?

1. Literature review

The issue of risk in military equipment implementation processes is the subject of interest for researchers in the fields of security studies, military logistics, and quality management. The ISO 31000:2018 standard defines risk as the effect of uncertainty on objectives, which in the military context refers to potential deviations from stipulated tactical and technical parameters, delivery schedules, and budgets (ISO, 2018).

Pokora and Gręzicki (2016) emphasise the key role of configuration management in ensuring the safety of military equipment, pointing to the need to maintain the repeatability of combat attributes across individual equipment units. Misztal (2016) analyses the determinants of quality management system implementation in the automotive industry, which has direct implications for the military vehicle sector, particularly with regard to ISO 9001 standards and their adaptation to defence requirements.

Domańska-Szaruga and Simiński (2017) examined the relationship between trust and business risk in the operations of research institutes, demonstrating that the level of trust between implementation process participants has a direct bearing on the level of risk incurred. Simiński (2017) classified the risks occurring in the ME implementation process in the area of vehicles, identifying the risks of the user, the manufacturer, and the research institute. In subsequent work, Simiński

(2024b) extended the analysis to cover challenges associated with the integration of information and electronic systems in military vehicles.

In the foreign literature, the issue of risk in military equipment acquisition is analysed in the context of the life cycle of weapons systems. NATO standards, including STANAG 4728, define the principles of life cycle cost analysis, while AQAP publications form the foundation of the quality assurance system in defence procurement (AQAP 2110, 2016; AQAP 2131, 2017).

The United States Department of Defense published an updated version of the Risk, Issue, and Opportunity (RIO) Guide in 2023, which constitutes a comprehensive risk management framework for weapons acquisition programmes. The guide defines risk as a potential future event or condition that could negatively affect the achievement of programme objectives in terms of cost, schedule, and performance parameters (DoD, 2023). This approach is consistent with European normative frameworks, though it places greater emphasis on quantifying risk through probability-consequence matrices.

Lucas, Ekström, Fusaro et al. (2024), in a RAND Corporation report devoted to the resilience of defence supply chains, identified key gaps in disruption risk management in the defence sector. The authors emphasise that military supply chains differ fundamentally from commercial ones owing to the unique structure of the monopsonic market, long development cycles and specific security requirements. Loredo, Eckhause, Abler et al. (2024), also from RAND Corporation, developed a supply chain risk management framework covering the entire acquisition cycle, which directly corresponds to the subject matter of this article in the area of supplier quality oversight.

Loska, Genchev, Rich et al. (2025) conducted a systematic literature review on military supply chain logistics, identifying the growing importance of dynamic capabilities in adapting to changing operational conditions. Their analysis confirms that defence sector supply chains are characterised by high entry barriers, deep interdependence, and a specific trust-based relationship dynamic, which is consistent with the findings of Domańska-Szaruga and Simiński (2017). Ekström, Hilletofth, and Skoglund (2025), in turn, examined performance constraints in defence industry supply chains using Sweden as a case study, pointing to the need to design supply chains capable of functioning under both peacetime and wartime conditions. Their findings are particularly pertinent in the context of lessons drawn from the Russo-Ukrainian war.

Mardo (2022) analysed the principles of life cycle costing of armed forces assets, drawing on the NATO RTO-TR-SAS-069 methodology. He demonstrated that operating and maintenance costs can exceed acquisition costs many times over, which justifies investing in higher quality oversight standards at the production stage even if this generates higher current costs. This observation directly supports the argument for applying AQAP 2110 rather than AQAP 2131 in the case of complex technical systems.

The research gap concerns the insufficient analysis of decision-making dilemmas associated with the selection of quality requirement levels and their impact on the safe operation of military vehicles. While foreign research concentrates on logistical aspects and supply chains, analyses combining the normative perspective (AQAP) with the institutional perspective – accounting for the roles of the three parties to the implementation process within the Polish defence system – are lacking.

2. Research methodology

A qualitative research approach was applied, encompassing three methods. The first is analysis of normative documents, involving a review of the AQAP 2110, AQAP 2131, and AQAP 2070 standardisation publications with respect to their impact on the level of risk in the ME implementation process. The second method is literature studies, comprising a systematic review of domestic and foreign literature in the fields of risk management, military logistics, and quality assurance. The third method is case analysis, involving the examination of military vehicle implementation processes in the Polish Armed Forces based on the experience of the Military Institute of Armoured and Automotive Technology (WITPiS).

The research perspective is grounded in risk management theory based on ISO 31000:2018 and the concept of the life cycle of technical systems. The research instruments used were risk analysis questionnaires and hazard identification matrices. A limitation of the study is its qualitative nature, which does not permit the statistical generalisation of results.

3. Planning a risk management system for military equipment implementation process

Activity in the area of military vehicle implementation is inherently fraught with risk. Effective risk management in this area enables an improvement in safety levels, more effective service delivery, better resource utilisation, and more efficient introduction of organisational and financial innovations. In general terms, the procedural framework enabling risk management system planning – which encompasses defining the organisational context, planning the framework structure, preparing documentation, identifying and analysing risk, defining early warning indicators, and preparing risk responses – also applies to the implementation of military vehicles (Domańska-Szaruga, Simiński, 2017).

When the subject of consideration is military vehicles, their safety structure – unlike that of commercial vehicles – must be viewed in considerably broader terms. Given the wide spectrum of issues that must be accommodated within the safety structure of a military vehicle, there is almost always a redundancy present: elemental, strength-related, parametric and, less commonly, functional, structural, and informational redundancy. These redundancies are associated with the introduction of various systems aimed at improving safety (Simiński, 2017).

A significant problem is the disproportion between the long design and service life of a military vehicle and the short time available for introducing design changes arising from the nature of contemporary conflicts. While adding systems intended to reduce risk, it is possible to overlook an important hazard associated with a loss of safety in other respects, or with the reduction of required vehicle parameters. Risk constitutes a measure of safety – the greater the tolerance for risk, the lower the level of safety (Simiński, 2024b).

4. Identification and analysis of risk among implementation process participants

In the area of military vehicle implementation, there is an interdependence among the institutions participating in the process. The degree of involvement of these institutions affects the level of risk, as does the depth of their mutual cooperation and business relationships. Three key parties can be distinguished in the implementation process (see Table 1): the user – the military side, encompassing the equipment custodian, the prospective vehicle operator, and the contracting authority; the manufacturer – an industrial entity or consortium undertaking production; and the research institute – an independent institution responsible for verifying the manufacturer's declarations (Simiński, 2017).

Table 1. Types of risk borne by each party to the military equipment implementation process

Process party	Type of risk	Illustrative factors
User (Polish Armed Forces)	Financial, technical, reputational, safety	Delivery schedule, warranty, failure to meet specifications, missing functionalities, loss of operational capabilities
Manufacturer	Financial, technical, reputational	Price, exchange rate, contractual penalties, design errors, material defects, loss of liquidity
Research institute	Financial, technical, equipment-related, reputational	Contractor liquidity, equipment damage, infrastructure, complexity of the test object

Source: own elaboration based on: Simiński, 2017

The user of the ME planned for implementation bears financial, technical, and reputational risk, as well as – most critically – the risk of a loss of safety. The financial risk is associated with the delivery schedule, warranty, production durability, and enterprise stability. The technical risk encompasses failure to meet specifications and the absence of desired functionalities. It should be emphasised that the greatest risk of a loss of safety in the event that implementation fails to materialise is borne by the direct user. The loss of the planned level of safety nullifies all prior activities and expenditure (Simiński, 2017).

The manufacturer bears financial risk arising from the product price, exchange rate, delivery schedule, and declared warranty. When the ME being implemented exhibits high failure rates during the initial phase of operation, additional financial burdens fall on the supplier. There is also technical risk, manifesting through failure to achieve the required parameters, design errors, and identified material defects.

The research institute, acting as an independent third party, bears financial risk derived from the stability of the contracting party, its own financial liquidity, and potential penalties. Technical risk increases in the case of objects with a complex design that requires the development of non-standard research methods or the use of unique equipment. Additionally, the institute bears equipment-related risk associated with the possibility of failure of specialised research apparatus (Simiński, 2024a).

5. Dilemmas associated with the selection of AQAP quality requirement levels

One of the fundamental dilemmas in the ME implementation process is the selection of the appropriate level of quality requirements as defined by AQAP standardisation publications. AQAP 2110 pertains to quality assurance requirements for design, development, and production, whereas AQAP 2131 concerns final inspection and testing only. The choice between these documents has a direct bearing on the level of risk (Pokora, Gręzicki, 2016).

Table 2. Consequences of selecting the AQAP quality requirement level

Criterion	AQAP 2110	AQAP 2131
Scope of oversight	Design, production, acceptance	Final inspection only
Possibility of stage-by-stage oversight	Yes	No
Risk of undetected defects	Low	High
Oversight cost	Higher	Lower
Risk of defect cascades	Minimal	Considerable

Source: own elaboration based on: AQAP 2110, 2016; AQAP 2131, 2017

The analysis (see Table 2) demonstrates that applying only AQAP 2131 instead of AQAP 2110 generates a range of hazards. The probability of vehicle defectiveness increases, as stage-by-stage acceptance inspections for critical production and technological processes are no longer possible. Failure to detect a defect in a single component can trigger defect cascades affecting entire vehicle systems. Furthermore, the risk of using incorrect raw materials, components, and parts that do not conform to the contracting authority's requirements increases. The dilemma lies in balancing oversight costs against the level of acceptable risk.

6. The dilemma of personnel competencies and absorptive capacity of the implementing environment

An optimal ME acquisition process should be oriented towards the challenges associated with technology absorption. The introduction of new weaponry is accompanied by an enormous volume of information and knowledge. The future effectiveness of vehicles and the reduction of self-elimination risk depend on the absorptive capacity of the implementing environment. This absorptive capacity is a function of the education of the personnel involved in implementation, their adequate numbers, and the organisational system in place (Simiński, 2024b).

The dilemma also concerns the level of education, which must be correlated with the training programmes of military educational centres, particularly academic ones. Inadequate preparation of technical personnel can lead to misinterpretation of documentation, inefficient operation, and, in extreme cases, damage to or self-elimination of equipment. This problem is particularly evident in the context of the growing complexity of information and electronic systems integrated in modern military vehicles.

7. Risk mitigation instruments

Minimising the level of risk in the ME implementation process requires the application of an integrated set of tools and measures. Building mutual relationships grounded in business trust constitutes the foundation of effective cooperation among process participants. Well-constructed contracts incorporating quality clauses and protective mechanisms reduce contractual risk (Domańska-Szaruga, Simiński, 2017).

A pivotal role is played by Evaluation and Testing (OiB) as an instrument for verifying ME compliance with user requirements. Uniform terminology among process parties eliminates the risk of misunderstandings and misinterpretations. An appropriate research process – based on preliminary analyses (FMEA, FTA), numerical simulations, and functional verification using HIL test platforms – enables the systematic identification of potential failure points already at the design stage (Simiński, 2024a).

The implementation of integrated risk management systems – encompassing procedural standardisation, digital analytical tools, and institutional cooperation – is a necessary condition for conducting research effectively and ensuring the reliability of tested systems. Effective monitoring of technical and operational condition through advanced telemetric systems, such as the Vehicle Reliability Analysis System (SANP), analyses data and generates reports for the user and the command.

8. Discussion

The analysis conducted confirms that the ME implementation process in the area of military vehicles is burdened with multi-dimensional risk, the sources of which are closely linked to the interactions among the three key parties to the process. The results obtained are consistent with the earlier findings of Pokora and Gręzicki (2016), who underscored the necessity of configuration management as a risk minimisation element, and with the conclusions of Misztal (2016) regarding the determinants of quality system implementation.

The novel contribution of this article is the systematisation of decision-making dilemmas associated with the selection of AQAP requirement levels. Previous research focused on the general principles governing the application of these publications, whereas the present work reveals the concrete consequences of the choice between AQAP 2110 and AQAP 2131 for the safety of vehicle operation. It was demonstrated that the apparent savings arising from the application of a lower oversight level may generate considerably higher costs in the operational phase.

The observation of Simiński (2024b) regarding the growing importance of personnel competencies in the context of the complexity of modern systems was also confirmed. The Russo-Ukrainian war demonstrates that military vehicles are among the indispensable types of weaponry, and their effective use requires not only a reliable design but also appropriately trained personnel. The problem of absorptive capacity of the implementing environment becomes particularly significant in conditions of large-scale acquisition of new vehicle types.

9. Conclusions

The research conducted enabled a positive verification of the research hypothesis. Effective risk management in the ME implementation process indeed requires an integrated approach that takes into account the specifics of the defence industry, NATO normative regulations, and the development of trust-based relationships.

In response to the research questions, the following conclusions were formulated. First, each of the implementation process parties – the user, the manufacturer, and the research institute – bears differentiated types of risk, with the greatest safety-loss risk falling on the direct user. Second, the main dilemma concerns balancing oversight costs against the level of acceptable risk – applying AQAP 2131 instead of AQAP 2110 reduces current costs but generates potentially far higher costs and hazards in the operational phase. Third, risk minimisation requires a combination of formal, technical, and relational instruments, encompassing trust-building, appropriate contracts, evaluation and testing (OiB), terminology standardisation, and an adequate research process.

Further research should focus on the development of quantitative risk estimation models for specific types of military vehicles and on the empirical verification of the effectiveness of individual risk minimisation instruments in the context of ongoing modernisation programmes of the Polish Armed Forces.

REFERENCES

[1] AQAP 2070, 2019. *The NATO Mutual Government Quality Assurance (GQA) Process*, Edition B, Version 4, Brussels: NSO.

[2] AQAP 2110, 2016. *NATO Quality Assurance Requirements for Design, Development and Production*, Edition D, Version 1, Brussels: NSO.

[3] AQAP 2131, 2017. *NATO Quality Assurance Requirements for Final Inspection and Test*, Edition C, Version 1, Brussels: NSO.

[4] DoD, 2023. *Risk, Issue, and Opportunity (RIO) Guide for Defense Acquisition Programs*, Version 2.2, Washington, DC: Department of Defense, Office of the Under Secretary of Defense for Research and Engineering.

[5] Domańska-Szaruga, B.A., Simiński, P.K., 2017. Trust and business risk in a research institute's operations, *Zeszyty Naukowe UPH w Siedlcach. Seria: Administracja i Zarządzanie*, No. 42, pp. 113-126.

[6] Ekström, T., Hilletofth, P., Skoglund, P., 2025. Performance constraints in defence industry supply chains: evidence from case studies, *Defence and Peace Economics*, No. 36(2), pp. 1-22.

[7] ISO, 2018. *ISO 31000:2018. Risk Management – Guidelines*, Geneva: International Organization for Standardization.

[8] Loredo, E.N., Eckhause, J.M., Abler, A.M., Colbert-Kelly, S., Najera, A., Stanley, K.D., Szafran, A., Whitehead, N.P., 2024. *Frameworks for a Common Operating Procedure for Supply Chain Risk Management Over the Acquisition Life Cycle*, Santa Monica, CA: RAND Corporation, RR-A2002-1.

[9] Loska, D., Genchev, S., Rich, N., Wilding, R., 2025. Military Supply Chain Logistics and Dynamic Capabilities: A Literature Review and Synthesis, *Transportation Journal*, No. 64(1), pp. 1-34.

[10] Lucas, R., Ekström, T., Fusaro, P., Hastings Roer, E., Retter, L., 2024. *Toward Defense Supply Chain Disruption Management: A Research Agenda for Defense Supply Chain Resilience*, Santa Monica, CA: RAND Corporation, RR-A2504-1.

[11] Mardo, M., 2022. The Principles of Life Cycle Costing of the Assets of the Defence Forces, *Sõjateadlane (Estonian Journal of Military Studies)*, No. 19, pp. 52-77.

[12] Misztal, A., 2016. Determinants of Quality Management System Implementation in the Automotive Industry, *Gospodarka Materiałowa i Logistyka*, No. 10, pp. 23-35.

[13] Pokora, W., Gręzicki, M., 2016. The Role of Configuration Management in Ensuring the Safety of Military Equipment, *Gospodarka Materiałowa i Logistyka*, No. 10, pp. 45-58.

[14] Simiński, P., 2015. *Military Wheeled Vehicles*, Sulejówek/Warszawa: BEL Studio.

[15] Simiński, P., 2017. *Risk of Military Equipment Implementation in the Area of Vehicles*, [in:] Szudrowicz, M., Ciekot, Z., Simiński, P. (Eds.), *Development, Exploitation, Storage and Ballistic Protection of Transport Means – New Trends*, Warszawa: BEL Studio.

[16] Simiński, P., 2020. *Research on the Influence of the Design of Key Systems on the Ride Comfort of Military Wheeled Vehicles*, Zielonka: WITU Publishing House.

[17] Simiński, P., 2024a. *The Military Institute of Armoured and Automotive Technology in the Support System of MoD Institutions – a Proposed Operating Model*, [in:] Ciekot, Z. (Ed.), *Challenges of Technical Support for Newly Introduced Equipment in the Armed Forces in the Context of 25 Years of NATO Membership*, Radom: Instytut Naukowo-Wydawniczy Spatium, pp. 29-39.

[18] Simiński, P., 2024b. *Challenges for Information and Electronic Systems of Military Vehicles*, Siedlce: Uniwersytet w Siedlcach.

[19] STANAG 4728. *Life Cycle Cost Analysis(System Life Cycle Management)*, Brussels: NATO Standardization Office.