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ISR DRONES AS DUAL-USE TECHNOLOGY. ECONOMICS OF COST-BENEFIT UNDER THE INFLUENCE OF INDUSTRY 4.0

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Abstract: *Modern battlefield is undergoing radical transformations, ISR drones becoming an essential capability for operational superiority. In parallel, migration to Industry 4.0 comes with much more capable civilian technological systems with significant spillover potential in the military industry. The article comparatively analyzes dual-use drones, with three specific development and use scenarios for ISR drones: dedicated military development, industrial and civil-military conversion.*
Using a cost-benefit analysis (CBA) correlated to the maturity of Industry 4.0, specific to each sector and to the impact of technological culture on the spillover effect, the study examines the total cost of ownership (TCO), operational performance in contested environments and the impact of losses in conflict, for the three constructive variants, that can be consider also to adaptive robotics solutions.
Keywords: *Industry 4.0, drones, dual-use, spillover, CBA, technological culture, military ISR.*

1. INTRODUCTION

In contemporary warfare, drones are proving to be the most visible and disruptive technologies, led by the ISR drones - Intelligence, Surveillance, and Reconnaissance, that radically change the way of leading missions. Recent conflicts clearly show that drones no longer play only operational roles in multiplying force, but act as a determining factor in strategic [1] and tactical decisions.

In this context, budget pressure and accelerated production timelines push defense industries toward non-dedicated solutions and therefore the civil industrial sectors, heavily influenced by the new industrial revolutions, can offer viable solutions adaptable for use on the battlefield [2].

Despite extensive Industry 4.0 and UAVs dedicated literature [3], few studies assess the cost-benefit of dual-use drone conversion under varying technological maturity and the inter-sectorial influence conditions (spillover), raises questions like: When and why the military should exploit civil or industrial predictive maintenance and accelerated development, enabled by digital twins. technologies?The article addresses this gap through a cost-benefit analysis (CBA) that correlates I4.0, technological spillover, and the economic efficiency of ISR drones in a military context.

2. CONCEPTUAL FRAMEWORK

2.1 ISR Drones as Cyber-physical System

ISR drones are tangible examples of cyber-physical systems specific to the I4.0. The integration of advanced manufacturing and post-acquisition technologies reflects high maturity, where value derives not only from production capabilities, but also from the data integration, real-time analysis and decision-making capabilities.

In the military perspective, the value of drones is not given solely by the platform itself, but by the ecosystem they support [4], directly correlated to technological maturity level- TRL.

2.2 Industry 4.0 on military production

Industry 4.0 reshapes design and cost structures through digitalized manufacturing,

This approach is particularly emphasized by the modular nature of drone platforms. In the

military sector, additional to all benefits brought by I4.0 [5], additional requirements are also demanded, for resilience, security, and interoperability. This explains why, although civil or industrial solutions may appear attractive in terms of cost, production or delivery speed, but raise also issues about applications in the considered operational environments.

From this point of view, the maturity of I4.0 and technological culture are determinant factors in assessing the feasibility of the spillover between the sectors.

2.3 Technological spillover in the dual use

Technological, spillover refers to faster cross-sector transfer of knowledge and technologies, including UAVs's case, civil and industrial innovations becoming more attractive to the military. However, this transfer does not happen automatically and not without costs.

The conversion to dual-use technologies requires certain modifications for adapting to the military sector's higher requirements. Whether structural adaptations, hardening, or cybersecurity impose, these adaptations not only have a functional, but also a strategic stake. Failure to manage correctly the conversion goes beyond the economic goals and reaches the security issues, given the scale of the conflicts in which drones are used.

2.4 Technological culture

Technological culture (TC) defines an organization habit to use a certain technology or the ability to adopt new technologies and adapt competencies, in the studied case, the military TC in adoption of civil-industrial solutions for operational use. The TC acts as a mediator between I4.0 as a modus operandi, spillover as a phenomenon, and the required economic and operational performance. The different forms of TC explain why different organizations may have the same technologies or production methods but they still have completely different results, with different performances and different final efficiencies. Therefore, recognizing TC as a very important factor, the CBA proves to be an adequate instrument.

3. VALIDATIOS SCENARIOS

3.1 General methodological approach

In this article, is presented the adoption of the three pillars approach:

- CBA, based on economic rationality.
- OA, Operational Analysis field performance.
- TC, maturity analysis (with I4.0 maturity).

Together, these dimensions quantify the spillover between sectors and support rational comparison of alternative development paths, integrating costs and operational performance with sectoral absorption capacity.

3.2 Reasoning behind cost-benefit analysis

The CBA is considered for the methodology capability to offer an objective and transparent comparison for the drones' constructive alternatives, based on valid common criteria to all three adopted pillars and considered sectors. Thus, cost, performance and risk can be evaluated across the full life cycle, taking into account efficiency and sector-specific I4.0 maturity, rather than just the nominal price.

3.3 Methodological limitations

As working assumptions, the analysis assumes a medium-to-high intensity conflict environment, similar to the Russia-Ukraine one, characterized by intensive electronic warfare (EW) and frequent ISR platform losses.

The most important limitation is related to the nature of the data. Thus, the study focused on medium-class ISR drones and not considered other types of platforms.

3.4 Evaluation criteria and scenarios

To ensure a consistent analysis, the criteria are grouped into three categories (Table 1):

- ***Economic*** - indicators for financial evaluation over the entire drone's life cycle;
- ***Operational*** - indicators for understanding the economic impact that the drone's loss or decrease in performance may have;

- ***Cultural-technical*** **-** indicator, showing differences in performance, deriving from users or design variants.

The analysis is structured around three scenarios for military sector ISR (Table 2).

S1 - Dedicated military development

Purpose-built drones are designed for specific environments, ensuring full combat capability and doctrinal integration, but with development, production and supply-chains high cost.

S2 – Industrial Drone conversion

Industrial platforms offer robustness and partial mission compatibility but require adaptation and a trade-off between performance and costs.

S3 - Civilian Drone conversion

Civil drones provide low unit costs and modularity, but require extensive adaptations, come at higher loss rates and are viable mainly where loss tolerance offsets operational risks.

Table 1

Evaluation criteria

Evaluation Criteria	**Financial**	Capital cost (CAPEX)
		Operational cost (OPEX)
		Loss cost (LC)
		Total cost of platform ready for contested environments (TCR)
		Total cost of ownership (TCO)
	Operational	Initial Capabilities / Price in Co. Envir. ISR sensors
		EW Resilience
		Hardening (Mechanical + Electrical)
		C2 (external + internal)
		Other
		Integration + Testing
		Performance in combat environments
	Technological culture and I4.0 maturity	Technological absorption capacity
		Technological integration capacity
		Capacity to exploit technologies
		Risk tolerance
		Level of interdisciplinary integration
		Technical decision-making speed.

Table 2

Drone conversion scenarios

	Scenario	**S1**	**S2**	**S3**
Financial (Cost)	Initial cost	High	Medium	Low
	Development	-	Medium	Low
	Production	Slow	Rapid	Easy, very fast
	Conversion	-	Light, efficient	Significant adjustments
	Operation	High	Medium	Reduced
Operational	Initial capabilities in contested environments	10/10	4/10	1/10
	Capabilities after conversion	-	6/10	3/10
	Modularity	-	Medium	High
	Integration into military doctrine	Complete	Good	Sufficient
	Control over architecture	-	Medium	Medium
	Operational risks	Minor	Medium	High
	Losses	Minor	Medium	High
Cultural-technological	Dedicated development	Military	Industrial	Civil
	Custom design	Military	Industrial	Civil
	Supply	Closed - Military	Commercial - industrial	Commercial - civil

4. COST-BENEFIT ANALYSIS OF THE CONSIDERED USE SCENARIOS APPLIED TO ISR DRONES

This section contains the comparison between the three scenarios defined as follows:

- Dedicated military development (S1)
- Industrial-military conversion (S2)
- Civil-military conversion (S3)

The total cost of ownership (TCO) will be considered according to operational benefits and the impact of losses in conflict conditions.

All three scenarios are evaluated under intensity conflict conditions similar to the Russia-Ukraine one, using identical tactical ISR mission requirements, exemplified in Table 3. The scenarios S2 and S3 require conversion costs to approach S1 level comparability, in order to be quantified/compared in a relevant manner and explained pertinently**.**

Table 3

Analyzed hypothesis

Operational assumptions		
Mission type	Tactical ISR	Reconnaissance, Surveillance, Fire correction.
Environment	Contested	Moderate-high EW
Horizon Analysis	36 Months	
Use	20 missions/month/drone	1h/mission
Fleet analyzed	1 Drone	Per-unit analysis
S1	*Skydio X10D*	*Dedicated military*
S2	*DJI M350 RTK (converted)*	*Industrial*
S3	*DJI Mavic 3E (converted)*	*Civil*
Loss	*S1=10%, S2=25%, S3=40%*	%/year

4.1 Technical and operational analysis

The economic approach is grounded in identifying the technical and operational requirements that these kinds of platforms must meet. In terms of operational capability, the CBA analysis of each scenario is based on elements such as: ISR sensor quality, electronic warfare (EW) resilience, system reliability and combat survivability, ease of maintenance, and production scalability. These benefits are expressed in a comparable mode for the three platforms intended to have similar capabilities. Nevertheless, they implicitly have different levels of technological complexity.

4.1.1 Technical–operational criteria

Within military employment, the main differentiator versus civilian/industrial drones is not limited to the airframe, but to operational robustness under deliberate interference and deception. The electromagnetic spectrum becomes both a mission enabler and an adversarial domain; therefore, a realistic assessment of converting civilian/industrial platform to military ISR must explicitly evaluate:

- the ***resilience of*** **C2** and data links,
- ***tolerance: to jamming, interference, and spoofing,***
- ***protection against interception and geolocation*** (LPI/LPD), and the ability to maintain minimum mission performance in GNSS-degraded or GNSS-denied conditions.

These factors are operationalized into five criteria with measurable indicators mapped to conversion cost categories (C2, EW resilience, ISR payload, hardening and integration/testing). Security-by-design principles for the control and telemetry plane should follow OT/ICS guidance [6] [7].

Criteria 1 - C2 and data-link robustness (range, integrity, continuity)

- Link budget and effective range under nominal conditions, including antenna configuration and platform altitude constraints.
- Integrity and authenticity: cryptographic authentication control channel and telemetry; resistance to session hijacking [6] [7].
- Continuity mechanisms: adaptive bitrate, forward error correction, retransmission strategy, and graceful degradation (reduced video, priority telemetry).
- Redundancy options: secondary link (e.g., sub-GHz + 2.4/5 GHz, LTE/5G where permitted), frequency agility/hopping, or spatial diversity (MIMO/dual antennas).
- Operational indicators for the model: probability of maintaining C2 above a minimum threshold during the mission (P_C2), and mean time to link loss (MTLL).

Criteria 2 - Electromagnetic spectrum resilience [8]. (EW tolerance, LPI/LPD)

- Antijamming tolerance: ability to operate at reduced SNR, interference detection, and automatic channel reselection.
- Signature management (LPI/LPD): transmit-power control, duty-cycle reduction, directional antennas, minimized continuous beacons.
- Interception and geolocation exposure: susceptibility to RF detection/triangulation; mitigations via BT and edge processing.
- EW-driven failure modes: “return-to-home” traps, link-loss behaviors

exploitable by the adversary; safe-state logic for contested settings.

• Operational indicators: effective exposure time (T_exp) and a spectrum-resilience score (S_EW) used to adjust annual loss rate (ALR) by threat level.

Criteria 3 - **Navigation and operation** in GNSS-degraded / GNSS-denied environments

• Baseline: quality of inertial sensors and attitude estimation; drift behavior during GNSS outages.

• Anti-spoofing and plausibility checks: detection of inconsistent GNSS measurements (velocity/acceleration bounds) [9].

• Alternative aids: visual odometry/terrain referencing, magnetometer use with robustness checks, barometric altitude stability, and geofencing robustness.

• Degraded-mode mission profile: ability to continue ISR in loiter patterns or execute safe recovery without GNSS.

• Operational indicators: probability of completing a reduced mission set without GNSS (P_GNSS-), and recovery success rate.

Criteria 4 - **ISR payload value** (sensor performance, fusion, and edge processing)

• Sensor capability: EO/IR resolution, stabilization quality, low-light performance, and frame rate under constrained bandwidth.

• Integration quality: calibration, time synchronization, geo-referencing, and sensor-to-C2 interoperability.

• Onboard/edge processing: target detection/tracking, compression and region of interest streaming to reduce uplink dependency.

• Optional RF sensing: passive RF detection (where feasible) or low-power radar concepts; emphasis on minimizing emissions and data-link load.

• Operational indicators: probability of actionable ISR output per sortie (P_ISR) and average time-to-information (TTI).

Criteria 5 - **Reliability, maintainability, and logistics** under field constraints

• System reliability: component derating, thermal margins, and vibration tolerance; expected failure rate in field conditions.

• Maintainability: modularity, mean time to repair (MTTR), availability of spares, and simplicity of pre-flight checks.

• Battery/energy subsystem robustness: swap time, state-of-health awareness, safe charging, and cold/heat performance limits.

• Software/update discipline: configuration control, fallback versions, and audit logs for post-mission accountability.

• Operational indicators: effective sortie rate (SR_eff) and availability (A), which influence cost per successful mission.

Mapping to the CBA model: for each criterion we assign a normalized score (e.g., 1–10) and link it to (a) conversion CAPEX/OPEX items (C2 upgrade, EW hardening, ISR payload, testing), and (b) operational effectiveness parameters (P_C2, P_GNSS-, P_ISR, SR_eff) that directly affect the expected number of successful missions and the platform loss rate.

In specific environments, low spectrum resilience inflates the effective cost per mission, modeled through operational penalties or threat-adjusted ALR (annual loss rate).This structure enables consistent, auditable comparison between scenarios while keeping the analysis grounded in observable technical characteristics.

4.1.2 Pre/post conversion operational performance.

Pre/post capabilities are as in Table 4.

4.2 Economic analysis: TCO, losses, and financial efficiency.

In the section, the previously proposed design options are analyzed comparatively.

The analysis is made from the perspective of total cost of ownership (TCO) over the life cycle.

Table 4

Comparison between the three scenarios of drone designs

Performance indicator \ Platform	Platform Type		Native Capabilities / Initial Price	ISR sensors	EW Resilience	Hardening (Mech. + Elect.)	C2 (external + internal)	Other	Integration + Testing	TCR / OC_{index}
Skydio X10D	Dedicated	V1	***10/10 (Reference Value)***						***Already Dedicated***	***10/10***
		V2								***125000***
DJI M350 RTK	Industrial-converted	V1	4/10	6/10	6/10	6/10	6/10	-	6/10	**6/10 Final**
		V2**	15000 [14]	5500 [15]	8000	5500	7500	1000	2500	**45000**
		V3		Zenmuse H30	* Mil. Gr.	* Mil. Gr.	* Mil. Gr.	* Mil. Gr.	* Mil. Gr.	
		V4		Conversion components for ISR in Cont. Envir.						
DJI Mavic 3E	Civil-converted	V1	1/10	3/10	Not Supp.	Not Supp.	Not Supp.	2/10	3/10	**3/10 Final**
		V2**	5500 [11]	650 [12]	-	-	-	100[13]	250	**6500**
		V3		DJI Mavic 3E RTK Module	-	-	-	E-port Dev Kit	-	
		V4		Basic Geo-sensors						

V1 - [x/10] - Performance/Impact after conversion (Operational Capabilities Index); S1=10/10=1 (Reference value), S2 and S3 indices for value and performance after conversion.

V2 - [€] - Conversion component Price (including conversion price) – Total sum + drone costs = CAPEX

V3 - Component Name

V4 - Operational Capability after conversion (also represents the index relative to the S1 reference)

* Mil.Gr - Due to classified military nature of this information, either the model or the price the value is estimative.

** The initial costs represent an average of prices on the market for drones and their components. [11][12][13][14][15]

TCR - [€] - Total cost of platform ready for contested environments

Table 5

Proposed calculation formulas for indicators

CAPEX - Acquisition and conversion cost:
$CAPEX = C_{ISR\ Sensors}+C_{EW\ Resilience}+C_{Hardening}+C_{C2}+C_{Other}+C_{Integration}$
OPEX - Annual operating cost:
$OPEX = C_{Operating}+C_{Personnel}+C_{Logistics}+C_{Software}$
Loss cost:
LC = CAPEX x ALR (Annual loss rate)
TCO - Total Cost of Ownership – calculated on an interval of 3 years:
TCO = CAPEX+3(OPEX+LC)
TCO_{index}: S1=1 reference Index; $S2=TCO_{S2}/TCO_{S1}$; $S3= TCO_{S3}/TCO_{S1}$
Operational Index
Expressed as value compared to reference S1=1
Cost-benefit Index:
$CBA_{Index} = S(x)_{TCOindex} / OC_{index}S(x)$
CBA Value (€ Spent vs € Earned):
$CBA_{value} = TCO/CBA_{index}$

Table 6

OPEX Calculation

Usage Scenario			
Missions/Month	20		
Hours/Mission	1		
Horizon analysis (months)	36		
Total usage time (hours)	720		
	S1 (€)	(€)	T.Val. (€)
C-Op (€/hour)*	Military-grade batteries.	75	54000
C-Personnel (€/hour)*	Training and operation for: UAV Operator + ISR Analyst.	60	43200
C-Logistics (approx. 1 year use)*	Spare parts, periodic maintenance, transportation.	8000	24000
C-Software (1 year subscr.)*	C2, AI on board, necessary software updates	5000	15000
OPEX S1 (€)*	***Hourly cost:***	***189***	***136200***
	S2 (€)	(€)	T.Val. (€)
C-Op (€/hour)*	Industrial batteries for heavy duty use.	35	25200
C-Personnel (€/hour)*	Training and operation for: Industrial UAV + Ind. UAV in mil. ISR missions.	35	25200
C-Logistics (approx. 1 year use)*	More frequent repair parts, periodic testing/maintenance.	5000	15000
C-Software (1 year subscr.)*	DJI software, military C2 and AI adaptation software.	3000	9000
OPEX S2 (€)*	***Hourly cost:***	***103***	***74400***
	S3 (€)	(€)	T.Val. (€)
C-Op (€/hour)*	Inexpensive commercial batteries, but with many replacement cycles.	15	10800
C-Personnel (€/hour)*	Minimal training. Operation in contested environments.	20	14400
C-Logistics (approx. 1 year use)*	Very frequent repair parts.	2000	6000
C-Software (1 year subscr.)*	Minimal military grade C2. Other DJI licenses	1500	4500
OPEX S3 (€)*	***Hourly cost:***	***50***	***35700***
* - Due to classified military nature of this information, the values are estimates.			

Table 7

LC – Loss Cost

Loss Cost (LC)				
CAPEX	Value (€/Drone)	Annual loss rate (%)	(€/Year)	***(€/3 Years)***
S1	125000	10	12500	***37500***
S2	45000	25	11250	***33750***
S3	6500	40	2600	***7800***

Table 8

TCO

Total cost of operating a drone over its entire life cycle			
Scenario	**S1(reference)**	**S2**	**S3**
CAPEX (€/Drone)	125000	45000	6500
OPEX (€/year)	45400	24800	11900
LC (€/year)	12500	11250	2600
Interval (Years)	3	3	3
TCO (€)	***298700***	***153150***	***50000***
TCO/ref. Index	***1***	***0.51***	***0.17***

4.3 Correlation technological culture, spillover, and economic-operational performance

The considered correlation is made in the construction of drones for ISR missions, and within specific environments. The CBA analysis conclusions are as follows:

I4.0 maturity and the type of technological culture act as amplifiers or braking forces on the efficiency of the platforms' development. In the absence of a sound technological culture, the

spillover phenomenon can actually produce vulnerabilities and losses of an economic nature and, above all, of an operational nature. Thus, it can be considered that TC, to which I4.0 maturity is directly correlated, is not a subjective factor, but the mechanisms that describe its functionality is more complex and have real effects on CBA.

An interesting aspect of CBA is coming from the impact of drone operator training perspective [10]. The final performance in the use of the platforms obtained through the conversion is directly correlated to the degree of training, and therefore to the final cost of these platforms**.**

Table 9

CBA Index of each scenario

CBA Analysis			
	S1(reference)	**S2**	**S3**
TCO (€/3 years)	298700	153150	50000
TCO Index	1	0.51	0.17
Operational Capabilities Index	1	0.6	0.3
CBA Index	***1***	***0.56***	***0.23***
CBA Value (€ Spent vs € Earned)	***298700***	***85207***	***11685***

4.4 Sensitivity analysis

To assess the viability of the proposed CBA analysis, a sensitivity analysis was performed. This consisted of varying the initial assumptions related to operational loss rates (+/- 5%), personnel costs (+/- 20%), and operational capacity indices (+/- 15%).

These ranges were chosen to reflect a realistic degree of variation, and not extreme situations.

This sensitivity analysis is not intended to illustrate real-life cost variations, but to assess the stability of the conclusions in different scenarios of variability.

The results obtained are shown in Table 10.

Table 10

Sensitivity analysis

Sensibility analysis			
CBA Analysis (+/-)	**S1(reference)**	**S2**	**S3**
CBA Index Var. Set1	1	0.49	0.16
CBA Index (Initial)	***1***	***0.56***	***0.23***
CBA Index Var.Set2	1	0.63	0.31
Average Variation (Index Value)	**0.00**	**0.07**	**0.07**
Average Variation (%)	**0**	**7**	**7**
CBA Value Var. Set1	271310	68632	7385
CBA Value (Initial)	***298700***	***85207***	***11685***
CBA Value Var. Set2	326090	103567	16565
Average Variation (€ Value)	**27390**	**17467**	**4590**
Average Variation (%)	**9.2**	**20.5**	**39.3**
Variable Set 1, relative to initial values: Annual Loss Rate -5%; Personnel Cost: -20%; Oper. Capab. Index* -15%			
Variable Set 2, relative to initial values: Annual Loss Rate +5%; Personnel Cost: +20%; Oper. Capab. Index* +15%			
*The S2 and S3 values were calculated with a variation of +/-15% from the initial values relative to the S1=1 index.			

S1 shows lowest sensitivity, average deviations below 10%, thus demonstrating high stability in uncertain operating conditions. Scenario S2 shows acceptable stability, at 20%. Scenario S3 shows high sensitivity compared to the other two, at 39%, which highlights the scenario dependence on highly controlled conditions.

5. DISCUSSIONS ON THE TOPIC

The comparative cost-benefit analysis of the three considered platform shows no universal optimal solution. Although the military-dedicated construction scenario fully meets the necessary operational capabilities and serves as a benchmark for the other two variants, it comes with high development and operating costs in theaters of operations [1].

The civil and industrial conversion scenarios exploit the spillover and reduce CAPEX and

OPEX, and therefore TCO, at the cost of acceptable compromises.

The results show: if supported by a good technological culture, spillover can act as a factor in increasing efficiency, but, the limitations of the platforms obtained through conversion must be understood.

The sensitivity analysis confirms that the relative ranking of scenarios remains stable under reasonable basic assumptions, while civil conversions show greater sensitivity.

A mature I4.0-driven technological culture enables the military to convert civil or industrial drones into operationally viable systems at acceptable risk.

6. LIMITATIONS AND FURTHER DIRECTIONS

Although the research is based on a transparent analysis, it is subject to certain limitations related to the military field, as the concrete, detailed data related to the cost of dedicated military drones, whether acquisition, operating, or other costs, are not publicly available. To manage this constraint, the values have been estimated or expressed in the form of an index. The approach does not claim absolute accuracy, but aims to facilitate the comparison of the platforms and ensure consistency in their analysis.

The analysis presumes a good level of TC in all three scenarios. Organizations with a low TC and different I4.0 maturity could obtain significantly different results.

Future research directions could include the analysis of platforms from different environments, NATO and non-NATO, or the assessment of the influence of technological culture on the military domain in relation to areas, countries, or continents.

7. CONCLUSIONS

The answer to the central question of the article is that there are situations in which it is not necessary to build strictly dedicated military platforms, if civilian industrial platforms obtained through conversion have sufficient operational capabilities, they can serve as a viable and more economical option.

In critical missions, scenario S1 remains the benchmark where the required capabilities are high and where high costs are justified. However, for ISR missions, scenarios S2 and S3 can offer a superior cost-benefit ratio if they are developed, implemented, and used properly. Technology transfers offer cost advantages but remain much more sensitive to variability than specialized military development.

The advantage does not necessarily lie in the technology itself, but in the technological culture of the organization: its ability to convert what it has at its disposal to obtain the benefits it desires.

Spillover, therefore, is correlated with Industry 4.0 maturity and the integration of technologies specific to the civil and industrial sectors into the military. The absence or presence of a certain TC makes the difference between improvisation and strategic innovation. At the same time, although the spillover is economically efficient, it remains fragile compared to dedicated development, which is expensive, but robust. The main contribution of the article is considered to be the CBA analysis related to the TC perspective and I4.0 maturity, providing a relevant framework for evaluating acquisition and operational options for ISR drones.

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Dronele ISR ca tehnologie cu dublă utilizare. Economia cost-beneficiu sub influența industriei 4.0

Rezumat: Câmpurile de luptă moderne trec prin transformări radicale, dronele ISR devenind o capacitate esențială pentru superioritatea operațională. În paralel, migrarea către Industria 4.0 vine la pachet cu sisteme tehnologice civile mult mai performante, cu un potențial semnificativ de extindere în industria militară. Articolul analizează comparativ dronele cu dublă utilizare, cu trei scenarii specifice de dezvoltare și utilizare pentru dronele ISR: dezvoltare militară dedicată, conversie industrială și civil-militară. Folosind o analiză cost-beneficiu (ACB) corelată cu maturitatea Industriei 4.0, specifică fiecărui sector și cu impactul culturii tehnologice asupra efectului de extindere, studiul examinează costul total de proprietate (TCO), performanța operațională în medii contestate și impactul pierderilor în conflict, pentru cele trei variante constructive, care pot fi luate în considerare și pentru soluțiile de robotică adaptivă.

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