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RESEARCH ARTICLE

Application of context-aware microtasks and feedback loops to enhance decision support during execution of operational procedures in the border management domain

[version 1; peer review: 1 approved with reservations]

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Abstract

Background

Maritime border surveillance has been encountering other problems such as irregular migration, smuggling, and illegal fishing which require enhanced situational awareness and organized multi-authority reaction. Current surveillance technology has been successful in detecting threats, and is frequently not yet equipped with a systematic, context-aware tool for operational decision making. We present in this study a Decision Support System (DSS) developed in the context of the EURMARS project to facilitate the implementation of Common Operational Procedures (COPs) by means of microtask suggestions and feedback.

Methods

The DSS integrates fused sensor data and threat assessments from the EURMARS platform and gives operators contextualized microtasks with respect to designated COP steps. The microtasks are then derived and polished using feedback from real-time (online) and post-operation (offline) user feedback processed through natural language algorithms. A voting system prioritizes microtasks on relevance and operational value. The system was investigated in three field demonstrations with real field staff from various EU authorities.

Results

Using multiple demonstrations in Cyprus, the UK and Bulgaria, users

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version 1 09 Feb 2026	? view

1. **Marko Perkovic**, University of Ljubljana, Portorož, Slovenia

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delivered microtasks that increased the effectiveness of COP execution. Some of the initial microtask directions were provided in early deployments and subsequent demonstrations grew, refined, and validated these suggestions. Operators also described greater clarity in the procedural process, greater reliability among agencies, and better confidence in making decisions in situations like AIS spoofing and unsanctioned vessel action.

Conclusions

The DSS does well linking the top-down management and the bottom-up operational decision-making process with grounded, contextual, form-specific microtasks that are responsive to user feedback. Its dynamic learning mode allows for procedure to be standardized, enhances situational awareness and better operation coordination of the various authorities. The system's potential to improve maritime surveillance workflows and align with the changing security needs of border management is evident in these results.

Keywords
Maritime border surveillance, Decision Support System (DSS), Natural Language Processing (NLP), Operational procedures, Multi-authority collaboration



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Introduction

The maritime domain has become increasingly vulnerable to complex and evolving security threats, including irregular migration, human trafficking, smuggling of drugs and arms, and illegal, unreported, and unregulated (IUU) fishing. These challenges, outlined in the FRONTEX "Risk Analysis for 2021" report, underscore the pressing need for advanced technological solutions (Nguyen *et al.*, 2018), including the use of AIS data and machine learning for real-time maritime monitoring. Additionally, the fragmented nature of surveillance systems and operations across national, regional, and EU-level authorities highlights the importance of fostering multi-authority cooperation to address these challenges effectively.

To address these needs, the European Union's Horizon-funded EURMARS project introduces an innovative surveillance framework aimed at enhancing multi-authority border security. EURMARS proposes a unified surveillance platform that integrates advanced sensing technologies, including high-altitude platforms, satellite imagery, uninhabited vehicles (UxVs), and ground-based sensors, into a cohesive and multitasking system. The framework promotes collaboration through its open architecture, which incorporates lessons learned from prior initiatives and aligns with the Common Information Sharing Environment (CISE) (Agency & EUCISE2020, 2022) to enable greater interoperability and coordination among stakeholders.

As part of this groundbreaking framework, this paper introduces a Decision Support System (DSS) designed specifically to address operational challenges in maritime border surveillance. The DSS leverages advanced Natural Language Processing (NLP) capabilities, powered by Meta-LLaMA-3-8B, to analyze user feedback gathered during and after operations. Real-time (online) feedback from incident handlers and post-incident (offline) feedback from reviewing officers are processed to extract actionable insights. These insights are then used to generate microtask recommendations aligned with predefined common operational procedures, enabling users to address complex maritime incidents with greater efficiency and accuracy.

A key innovation of the DSS is its voting mechanism, which aggregates feedback from multiple users to prioritize critical microtasks. This ensures the system remains both adaptable to diverse incident scenarios and consistent in maintaining procedural standards required for multi-authority collaboration. For example, during incidents such as AIS spoofing, vessel distress, or unauthorized maritime activities, the DSS provides context-specific microtask recommendations that enhance operational decision-making and coordination.

The DSS integrates seamlessly into EURMARS's broader maritime surveillance architecture, complementing advanced sensing technologies such as high-altitude platforms, satellite imagery, and UxVs. By clustering and analyzing sensing results, the system delivers actionable intelligence to decision-makers, improving situational awareness and operational efficiency. Furthermore, the DSS incorporates AI-driven risk assessment and feedback-based adaptation, ensuring it evolves to meet the dynamic challenges of maritime border security.

This paper details the design, implementation, and evaluation of the DSS within the EURMARS framework. It focuses on the DSS's NLP-driven feedback analysis module, microtask recommendation engine, and voting mechanism, as well as its integration into a multi-authority surveillance system. Preliminary evaluations demonstrate the DSS's ability to improve decision accuracy, reduce response times, and promote procedural consistency, making it a valuable tool for addressing the growing complexity of maritime security threats.

Background / Related work

Border security has always been a critical concern for nations, requiring a balance between effective surveillance and strategic decision-making. Over the years, researchers have explored various technological approaches to enhance border surveillance, ranging from sensor fusion and computer vision to machine learning-based detection systems. While these innovations have significantly improved detection capabilities, they often lack structured decision-making frameworks to guide security operators in handling threats effectively. Our approach builds upon these advancements, but with a key distinction—we focus on supporting decision-making rather than merely providing detection alerts.

In the study by Essendorfer *et al.* (Essendorfer *et al.*, 2009), One of the foundational works in border surveillance is the SOBCAH (Surveillance of Borders, Coastlines and Harbors) project, which introduced an architecture for integrating heterogeneous sensor data to improve situational awareness. The system fuses infrared cameras, radar, sonar, and external intelligence sources into a Common Operational Procedures (COP) to support decision-making at different levels. However, while their approach modifies the COP dynamically based on new data, it does not provide a structured framework for operators to process, analyze, or respond to threats efficiently.

Our work takes a different approach. Rather than modifying the COP, we focus on enhancing it through micro-tasks that support security operators. By incorporating both online and offline feedback loops, we allow for continuous performance improvement while ensuring strict adherence to Common Operational procedures COPs. This ensures that automation augments, rather than replaces, human decision-making.

Another significant work by Bein *et al.* (Bein *et al.*, 2013) introduces a data-driven adaptation system that dynamically adjusts sensor behavior based on the contextual value of incoming data. Using influence diagrams and probabilistic decision models, this approach determines when to engage higher-level sensors, such as UAVs or advanced imaging systems, based on the cost-benefit tradeoff of additional information.

While this method enhances sensor network efficiency, it remains a computational decision model rather than an

operational decision-support system. The influence diagram guides sensor allocation but does not assist operators in real-time threat evaluation or tactical decision-making. Our approach, in contrast, focuses on how security personnel interact with the data, ensuring that they receive structured support in responding to detected threats.

With the rise of computer vision and IoT, several studies have explored automated object and face detection as a means of monitoring border regions. A study by Ahamed Yasar *et al.* (Ahamed Yasar *et al.*, 2020), presents a Raspberry Pi-based surveillance system that detects intruders using OpenCV for facial recognition. If an unrecognized face is detected, the system triggers an alert via LoRa communication.

While such an approach is useful for automating surveillance tasks, it is not a decision-support system—it simply detects and alerts without providing any structured response mechanisms. Our work acknowledges the importance of computer vision in surveillance, but we emphasize structured operator decision-making over simple detection alerts.

Another approaches in the field by Fatima *et al.* (Fatima *et al.*, 2021), proposes a smart border surveillance system using machine learning for intruder detection. The system employs Raspberry Pi cameras, GSM-based alerts, and cloud-based encrypted image storage to detect unauthorized individuals. A deep learning model classifies detected individuals as either intruders or soldiers, with an additional face recognition layer to verify authorized personnel.

Despite its sophistication in intruder detection and classification, this approach remains an alert-based system rather than a suggestive or decision-making system. It provides detection but not guidance—security forces receive an alert, but there is no structured framework for responding to threats. False positives or uncertain detections could overwhelm operators with unnecessary alerts, reducing overall effectiveness.

In contrast, our approach does not aim to replace operators with machine learning models but rather to support them through structured workflows. By integrating micro-tasks and decision-support tools within the COP, we ensure that security personnel can assess, verify, and respond to threats systematically.

While existing research has significantly advanced border surveillance through enhanced detection, sensor fusion, and automated threat identification, operational decision-making remains a human-driven responsibility that requires structured support. Our approach is not a replacement but a complement to these advancements, ensuring that security personnel are equipped with the necessary tools to respond effectively.

Rather than modifying the Common Operational Procedures (COPs) dynamically (as seen in SOBCAH) or relying solely on automated AI-based alerts (as in IoT-driven and computer vision-based models), our system reinforces operational workflows through:

- Active Operator Involvement: Decisions remain under human control, with structured support rather than full automation. This prevents over-reliance on AI-driven alerts and ensures context-aware responses to security events.
- Preservation of Common Operational Procedures (COPs): Unlike some approaches that alter operational protocols, our system introduces micro-tasks that work within established security frameworks, enhancing rather than modifying existing COPs.
- Integrated Feedback Loops: Both online and offline feedback mechanisms enable continuous system adaptation and performance refinement without disrupting security operations.

By integrating structured decision-support with adaptive learning, our approach ensures that border surveillance operators can efficiently translate threat detection into actionable intelligence. Rather than burdening personnel with raw sensor data or unverified alerts, our system streamlines threat response, providing clear, structured insights that enhance situational awareness. Automation is leveraged selectively to support, rather than replace, human judgment—ensuring that decision-making remains transparent, accountable, and aligned with established border security protocols. This approach reinforces EURMARS as a robust border surveillance platform, emphasizing operational efficiency, adaptability, and continuous improvement in managing security challenges.

Methods

The EURMARS platform operates as an integrated maritime surveillance framework, designed to consolidate and analyze data from a wide range of heterogeneous sources—including Automatic Identification System (AIS) data, satellite imagery, Uncrewed Aerial Vehicles (UAVs), and ground-based sensors. These data streams are processed and fused within the system's central data fusion module to generate a unified operational picture.

Once fusion is complete, the Risk Protocol Module evaluates each detected event based on predefined threat assessment criteria. If an event is classified as high-risk—such as an instance of AIS spoofing, unauthorized vessel activity, or distress signaling—the system initiates the Decision Support System (DSS). At this stage, the DSS receives contextualized information about the threat, including location, involved assets, sensor metadata, and the assessed threat level.

Upon activation, the DSS retrieves the Common Operational Procedures (COPs) associated with the identified threat. These procedures represent structured, multi-step workflows codified by domain experts and aligned with the protocols of border and maritime authorities.

Confidentiality of COP steps

The detailed content of individual COP steps is confidential. Therefore, throughout this paper we refer to steps only by their ordinal labels (Step 1, Step 2, …) without disclosing their specific actions or descriptions. However, the microtasks associated with each step are not confidential and are presented as representative guidance generated by the DSS.

Rather than presenting the procedures as static checklists, the DSS enhances operator guidance through context-aware micro-tasks—specific, actionable units of work dynamically adapted to the operational context and sensor-derived information.

As an illustrative example, consider the scenario of a Vessel in Distress, which the Risk Protocol Module classifies as a high-priority threat. The DSS presents the operator with the relevant COP structured into five sequential steps (denoted only as Step 1–Step 5 due to confidentiality). Interface snapshots for these steps are depicted in Figure 1–Figure 5; captions are anonymized accordingly.

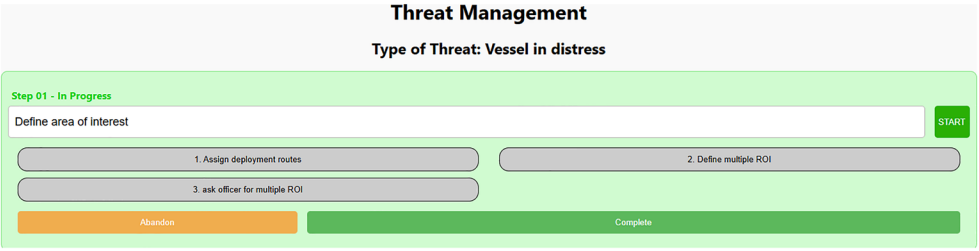

Figure 1. User interface view for Step 1 of the Common Operational Procedure (COP) related to a Vessel in Distress scenario. The COP content is confidential; only the system interface is shown.

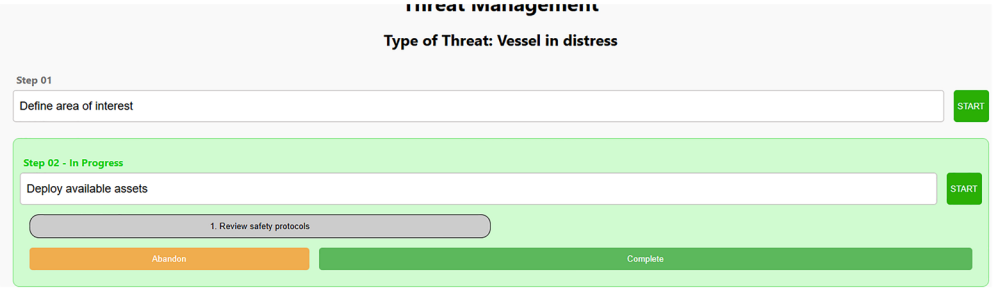

Figure 2. User interface view for Step 2 of the COP in a Vessel in Distress scenario. The COP content is confidential; only the interface layout is illustrated.

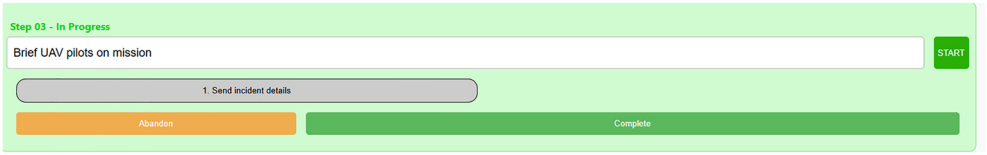

Figure 3. User interface view for Step 3 of the COP in a Vessel in Distress scenario. The COP content is confidential; the figure depicts the DSS operator interaction screen.

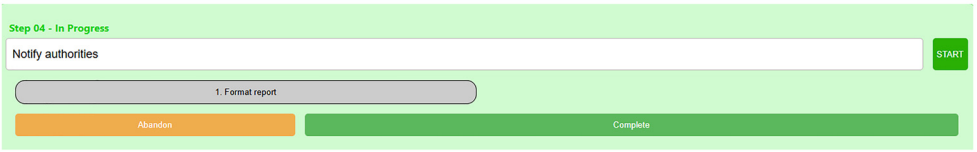

Figure 4. User interface view for Step 4 of the COP in a Vessel in Distress scenario. The COP content is confidential and has been removed; the figure shows only the system interface.



Figure 5. User interface view for Step 5 of the COP in a Vessel in Distress scenario. The COP content is confidential; only representative UI elements are displayed.

Microtasks can be updated dynamically via user feedback, which is processed through a structured mechanism described in the following subsections.

Microtask extraction and feedback loop processing

The DSS employs a two-phase feedback loop mechanism —integrating real-time user input during operation and post-operation feedback—to continuously refine microtask recommendations associated with each step in a Common Operational Procedure (COP).

To extract relevant microtasks from user input, the system uses the Meta-LLaMA-3-8B language model (Touvron *et al.*, 2024) via a prompt-based mechanism. Free-text feedback from users is passed to a tailored prompt, and processed by the locally hosted quantized model Meta-LLaMA-3-8B-Instruct. Q4_0.gguf. Extracted microtasks are filtered for semantic richness and uniqueness to ensure clarity and actionability.

Example use:

> Input:
>
> "We approached the vessel, confirmed its status, and began coordination."
>
> Extracted Microtasks:

- Approach and identify the vessel
- Confirm vessel status
- Initiate coordination protocol

Microtask aggregation and recommendation updating

To improve consistency, the system aggregates semantically similar microtasks submitted by different users for the same operational step. Sentence-level embeddings are generated using a transformer-based model, specifically paraphrase-MiniLM-L6-v2 from the Sentence-BERT family (Reimers & Gurevych, 2019). Cosine similarity is computed across microtask pairs, and those exceeding a similarity threshold (e.g., 0.7) are considered equivalent and merged. Their scores are combined for later prioritization.

To improve accuracy in edge cases, this similarity-based process is augmented with LLM-based reasoning via either Meta-LLaMA-3 or GPT-3.5. This hybrid design ensures that both lexical variation and contextual nuances are accounted for.

Merged microtasks are stored in a persistent database indexed by threat type and procedural step. Over time, this knowledge base grows and enables the DSS to offer progressively refined and context-aware recommendations.

Step-level recommendation synthesis

Beyond microtask guidance, the DSS also collects and refines full-text step recommendations. After operations, users may submit reflections on how a procedural step could be improved. These suggestions are grouped and summarized using a prompt-based interaction with an LLM to produce a concise, representative recommendation that maintains alignment with majority opinion without introducing speculative content.

This process ensures each procedural step benefits not only from granular microtask guidance but also from a coherent, high-level suggestion informed by operational experience.

Feedback collection and voting mechanism

The DSS integrates a structured voting mechanism to capture user perceptions about the relevance and quality of microtasks. Feedback is collected both in real-time (online) and after operations (offline).

Online feedback allows users to submit microtasks during live incidents. These are assigned a default weight of to reflect their provisional nature while still contributing to system learning.

Offline feedback, submitted post-operation, is more deliberate and includes ratings that follow a structured scale, as presented in Table 1.:

Votes are translated into cumulative scores, allowing the system to rank microtasks. Those consistently rated as "Helpful" or "Essential" are elevated in future recommendations, while lower-rated tasks are demoted or discarded. Offline feedback carries greater weight in aggregation due to its reflective nature.

By combining user feedback with semantic analysis and adaptive weighting, the system creates a robust loop that aligns evolving operational knowledge with structured procedure execution.

Ethics and informed consent

This study involved human participants in the form of operational personnel who interacted with the Decision

Table 1. Feedback labels and weighting scheme used in the DSS voting mechanism for microtask prioritization.

Feedback Label	Weight
Not Applicable	–2
Inaccurate	–1
Insignificant	0
Helpful	+1
Essential	+2

Support System (DSS) during demonstration exercises. No personally identifiable information was collected at any stage, and all interactions were performed in a professional, duty-related context.

According to the institutional and national guidelines applicable to the participating organizations, the demonstration activities did not require formal review or approval by an institutional ethics committee, as they consisted of operational training exercises without the collection of sensitive or personal data.

All participants were informed about the purpose of the study and the use of their feedback for system evaluation and research purposes. Informed consent was obtained verbally prior to participation. Verbal consent was considered appropriate due to the minimal-risk, operational nature of the demonstrations and the absence of personal data collection.

Results

To evaluate the Decision Support System (DSS) and its ability to enhance operational procedures through microtask generation and user feedback integration, three field demonstrations were conducted across different EU member states in collaboration with national authorities and maritime agencies.

Note on confidentiality in reporting

For all results below, COP steps are referenced only as Step 1, Step 2, etc. The contents of the COP steps are confidential and not disclosed. We report representative microtasks per step, which are non-confidential.

Evaluation setup and demonstration scenarios

The DSS was tested through scenario-based exercises in the context of the EURMARS project, simulating realistic maritime threats. Each demonstration included structured user interaction with the system, involving live scenario execution and feedback submission. Two common threat scenarios were selected for longitudinal tracking across all demos to assess the progressive development of microtask recommendations:

- Vessel Shut Down AIS Transmission
- Vessel Entering Area of Interest

These threats were accompanied by static Common Operational Procedures (COPs), composed of predefined steps codified by domain experts. Initially, these COPs included no microtasks. Over time, user interaction via the DSS interface contributed actionable microtasks based on real-world operator behavior.

Demo 1: Cyprus (15–16 October 2024)

Host: Joint Rescue Coordination Centre (JRCC), Larnaca, Cyprus

Participating End Users: Romanian Border Police, Bulgarian Defence Institute (BDI)

During the first demonstration, the DSS was introduced to operational personnel for the first time. Each threat scenario was executed approximately 20 times across training and evaluation rounds. The users provided online and offline feedback, which was used to generate initial microtasks for the most commonly executed steps.

The initial set of extracted microtasks is summarized in Table 2.

The outcome demonstrated the usefulness of real-time feedback in rapidly generating operationally relevant guidance. Operators felt better supported and more confident in taking next actions, especially in ambiguous scenarios.

Demo 2: Portland, UK (12–15 May 2025)

Host: UK Home Office

Participating End Users: JRCC, Romanian Border Police, Bulgarian Defence Institute

Following the first success, the DSS was deployed in a more complex environment involving approximately 25 full scenario executions per threat. Users interacted more extensively with the DSS, now equipped with partial microtask recommendations.

The microtask lists expanded considerably as users refined earlier contributions and added feedback to additional steps in the COPs.

The refined and expanded microtask set is presented in Table 3.

Feedback from this demo indicated that users found the DSS particularly helpful in clarifying procedural priorities during high-tempo operations. The growing list of validated microtasks contributed to increased procedural consistency among different agencies.

Demo 3: Shabla, Bulgaria (2–3 July 2025)

Host: Bulgarian Defence Institute (BDI)

Participating End Users: Romanian Border Police, JRCC

The final validated microtask recommendations are shown in Table 4.

Table 2. Initial microtasks generated after Demo 1 (Cyprus) for the threats "Vessel shut down AIS transmission" and "Vessel entering area of interest," organized by Common Operational Procedure (COP) step.

Threat	Step	Example Microtasks
Vessel shut down AIS transmission	Step 1	Confirm AIS signal loss; Identify the vessel
	Step 2	Locate last AIS transmission
Vessel entering area	Step 1	Confirm vessel identity; Validate entry area
	Step 2	Evaluate proximity to hazards

Table 3. Expanded microtasks generated after Demo 2 (UK), showing refinement and extension of recommendations across additional COP steps.

Threat	Step	Example Microtasks
Vessel shut down AIS transmission	Step 1	Confirm AIS signal loss; Identify the vessel; Check for system malfunction
	Step 2	Locate last AIS transmission; Determine proximity to high-traffic areas
	Step 3	Assess potential illegal intent
Vessel entering area	Step 1	Confirm vessel identity; Review AIS/radar data
	Step 2	Assess environmental conditions; Check vessel course
	Step 3	Confirm regulatory requirements

Table 4. Final validated microtasks after Demo 3 (Bulgaria), reflecting mature, consensus-driven procedural guidance.

Threat	Step	Example Microtasks
Vessel shut down AIS transmission	Step 1	Confirm AIS signal loss; Identify vessel; Check for intentional shutdown
	Step 2	Determine proximity to sensitive areas; Check sea conditions
	Step 3	Attempt alternative communication; Assess illegal intent
	Step 4	Inform maritime authorities; Escalate to law enforcement
Vessel entering area	Step 1	Confirm vessel identity; Review AIS/radar data; Check vessel behavior
	Step 2	Evaluate proximity to hazards; Assess environmental conditions
	Step 3	Confirm regulatory requirements; Validate compliance
	Step 5	Establish communication; Confirm purpose of entry

The final demonstration focused on testing the maturity of the DSS under real-world complexity. With 16 full scenario executions per threat, users now engaged with a robust set of microtasks integrated directly into the DSS interface.

End users highlighted that microtasks improved both situational awareness and operational consistency. The DSS was especially appreciated for enabling structured, inter-agency coordination.

Impact and observations

Across all three demonstrations, the DSS proved valuable in supporting maritime operators through:

- Progressive learning: Each round of user interaction expanded and refined the microtask knowledge base.
- Consistency: Shared microtasks led to uniformity in how different agencies executed the same COP.
- Decision assurance: Operators reported increased confidence in action selection and inter-agency handovers.

By the final demonstration, the DSS offered actionable, context-aware guidance tied to operational procedures, significantly improving real-time decision-making and long-term procedural learning.

Discussion

The iterative deployment and evaluation of the Decision Support System (DSS) across three real-world demonstration exercises revealed key insights into its utility, adaptability, and

user-centered design. The structured inclusion of microtasks—initially absent from both operational procedures—evolved through successive interactions with domain experts and end users, highlighting the DSS's ability to learn from operational behavior and support procedural standardization over time.

One of the most significant outcomes of the evaluation was the progressive enrichment of Common Operational Procedures (COPs) through contextualized microtasks. In the case of both threats—Vessel Shut Down AIS Transmission and Vessel Entering Area—the system began with no predefined microtasks, relying solely on the high-level procedural steps. Following each demo, the DSS incorporated feedback from live use cases, transforming abstract steps into actionable guidance while preserving the confidentiality of the step definitions. This transformation showcases the system's capability to bridge the gap between strategic procedures and tactical execution.

Conclusions

This paper presented a Decision Support System (DSS) designed to enhance maritime border surveillance operations through the integration of context-aware microtasks and a structured feedback loop. Developed within the EURMARS framework, the system addressed the persistent gap between high-level operational procedures and real-time decision-making demands by providing step-level guidance in the form of dynamically extracted and evolving microtasks.

Data availability

This study is based on operational data and Common Operational Procedures (COPs) that are classified as EU RESTRICTED. These materials include sensitive information related to maritime security operations, operational workflows, and decision-making procedures used by national authorities. Due to security, confidentiality, and legal restrictions, these datasets cannot be made openly available.

In accordance with EU information security regulations and the data protection requirements of the participating authorities, the underlying datasets, COP content, and demonstration data remain restricted and cannot be deposited in an open-access repository.

However, all non-confidential illustrative examples, methodological descriptions, and aggregated, anonymized results necessary to understand the system architecture and evaluation approach are fully provided within the paper.

Extended data

No extended data can be made available for this study.

The materials that would normally constitute extended data—such as operational scenarios, COP step descriptions, internal system logs, and user interaction data—are classified as EU RESTRICTED because they contain sensitive operational and procedural information used by national maritime authorities.

As a result, these materials cannot be deposited in a public repository or shared openly in accordance with EU security regulations and institutional data protection requirements.

All non-confidential illustrations of system functionality and representative microtask recommendations are already included within the manuscript.

Acknowledgments

To all EURMARS project partners and to relevant end-user organizations (border surveillance personnel) involved in the demonstration exercises, the authors would like to express their gratitude for their valuable contributions, insights, and engagement. The authors also acknowledge the operational personnel who interacted with the Decision Support System (DSS) during the field demonstrations in Cyprus, the United Kingdom, and Bulgaria, providing essential feedback that contributed to the refinement of the system.

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The article presents a Decision Support System (DSS) developed within the EURMARS project, designed to bridge the gap between strategic Common Operational Procedures (COPs) and tactical field execution.

a) While the topic is highly relevant and the use of Large Language Models (LLMs) such as Meta-LLaMA-3 for operational feedback is innovative, the manuscript currently resembles a technical project report rather than a rigorous scientific contribution. The scientific framing, methodological depth, and evidence of utility require substantial improvement. Although the authors reference current NLP models such as Meta-LLaMA-3 (2024) and Sentence-BERT (2019), the citations for the maritime and border security domain are either outdated (e.g., from 2009 and 2013) or describe technically basic systems (e.g., Raspberry Pi-based solutions) that do not reflect the current state of the art for advanced EU surveillance platforms. There is also a significant lack of references regarding decision-making theory and hybrid intelligence.

b) The narrative structure focuses primarily on documenting project milestones (field demonstrations in Cyprus, the UK, and Bulgaria) rather than exploring a scientific hypothesis or conducting a comparative analysis. The "Results" section is mainly descriptive. The authors should reframe the paper to highlight the underlying logic of the context-aware microtask generation and the voting mechanism as a novel contribution to decision science, rather than merely a project deliverable.

c) Although the authors cite "EU RESTRICTED" data as a reason for limited disclosure, the absence of a detailed operational walkthrough prevents the reader from assessing the system's actual utility. The inclusion of at least one comprehensive simulation using synthetic or anonymised data is essential. This simulation should illustrate how a specific input leads to a particular microtask suggestion and how the feedback loop modifies future outputs in a scenario resembling real-world conditions.

d) The paper states that operators reported "increased confidence" and "procedural consistency."

These findings are presented as general assertions without sufficient qualitative data. A more in-depth analysis of feedback is necessary. The authors should provide more detailed data from the offline feedback sessions, such as anonymised excerpts from operator interviews or a more thorough thematic analysis of the "Helpful" versus "Essential" ratings.

e) Figures 1 to 5 show the system's user interface for sequential steps of a "Vessel in Distress" scenario. As the content is censored for confidentiality, these figures offer little information to the scientific reader and appear redundant. It is recommended to remove the repetitive screenshots and instead provide a single, detailed technical flowchart or architecture diagram. This flowchart should illustrate the construction of the decision logic, the integration of sensor data, and the NLP-driven feedback loop, offering a more technical and scientific visualisation of the system.

f) The transition from high-level COPs to "microtasks" requires further formalisation. The paper would benefit from a more precise mathematical or logical description of the voting mechanism and the semantic similarity thresholds used for merging tasks.

Is the work clearly and accurately presented and does it cite the current literature?
Partly

Is the study design appropriate and does the work have academic merit?
Partly

Are sufficient details of methods and analysis provided to allow replication by others?
Partly

If applicable, is the statistical analysis and its interpretation appropriate?
Not applicable

Are all the source data underlying the results available to ensure full reproducibility?
No

Are the conclusions drawn adequately supported by the results?
Partly

Competing Interests: No competing interests were disclosed.

Reviewer Expertise: Navigational safety, VTS, remote sensing and maritime engineering

I confirm that I have read this submission and believe that I have an appropriate level of expertise to confirm that it is of an acceptable scientific standard, however I have significant reservations, as outlined above.