

Critical innovation

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In a collaborative effort, BM Bergmann Marine and the Fraunhofer Center for Maritime Logistics and Services CML have conducted an extensive study on autonomous maritime systems (AMS) on behalf of the German Maritime Center DMZ. This research provides a detailed exploration of the sector, highlighting technological advancements, regulatory progress, and insights from European stakeholders. Through a methodical, in-depth survey, the study assesses relevant research & development activities and the current adoption landscape of AMS, identifies potential growth areas, and outlines the challenges facing the industry. Among the findings, different sources of uncertainty are detected as the main barriers to market entry, revealing critical hurdles that the industry must overcome to fully embrace the potential of AMS.

The maritime industry is on the cusp of a significant transformation driven by digitalisation, automation, and sustainability efforts. Within this context, AMS stands out as a critical innovation with the potential to enhance operational efficiency, reduce human error, and contribute to environmental sustainability. However, the path to AMS integration is full of challenges, including technical complexities, regulatory uncertainties, and market readiness. The study analysis, evaluation, and outlook of the future market for AMS was designed to shed light on these aspects, providing a basis for informed decision-making among industry stakeholders.

To paint an accurate picture

The design of the study was methodically structured to capture a comprehensive view of the AMS landscape through a multi-faceted approach combining quantitative and qualitative research methods. A key component was a detailed survey distributed to a broad spectrum of European maritime stakeholders. This investigation aimed to gauge current levels of AMS adoption, identify technological and regulatory challenges, and understand market perceptions and barriers to entry. The study also incorporated expert interviews and scenario analysis to complement the survey data, providing deeper insights into specific industry challenges and future market potentials.

This mixed-methods approach allowed for a robust analysis of the AMS sector, offering a well-rounded perspective on the opportunities and challenges that lie ahead for the integration of autonomous technologies in maritime operations.

Stakeholders from different segments of the European maritime industry were asked to participate in the study, including representatives from shipping companies, port authorities, shipbuilders, technology providers, offshore operators and hinterland logistics providers, as well as regulatory agencies and academic experts specialising in maritime studies and autonomous systems. This selection aimed to encompass a wide range of perspectives on AMS, from those developing the technology to the ones tasked with its implementation and oversight. Efforts were made to include participants representing various sizes of organisations (from large multinational corporations to small- and medium-sized enterprises) to capture a broad spectrum of experiences and viewpoints. The diversity in participant selection was instrumental in painting an accurate picture of the AMS landscape.

The demographic profile of the survey's 52 participants highlighted a primarily German representation (61%), with a varied presence from other European countries, ensuring a broad insight base into AMS. Positions of respondents ranged from executive to technical and research roles, indicating a broad spectrum of industry

perspectives. However, the survey, while comprehensive, faced limitations, particularly in the uneven levels of participation across different maritime segments. Notably, hinterland logistics and offshore showed comparably lower participation. This disparity in engagement levels across segments suggests that while some areas of the maritime industry are actively exploring AMS, others may still be in the nascent stages of consideration or adoption.

Innovators, laggards, and everybody in-between

With the above in mind, the study applies the diffusion theory to analyse the adoption of AMS across different maritime segments. This theoretical framework allows for an examination of how innovations spread within a social system over time. According to the theory, innovations are adopted in a sequential manner by different adopter categories: innovators, early adopters, early majority, late majority, and laggards.

In the context of AMS, shipping, suppliers, and ports emerged as segments showing higher levels of activity and engagement, indicative of being in the early adopters or early majority phase. These groups exhibit a proactive approach to exploring and integrating AMS technologies, driven by the potential operational and environmental benefits.

Conversely, shipbuilding, offshore operations, and hinterland logistics were identified as segments with lower levels of AMS

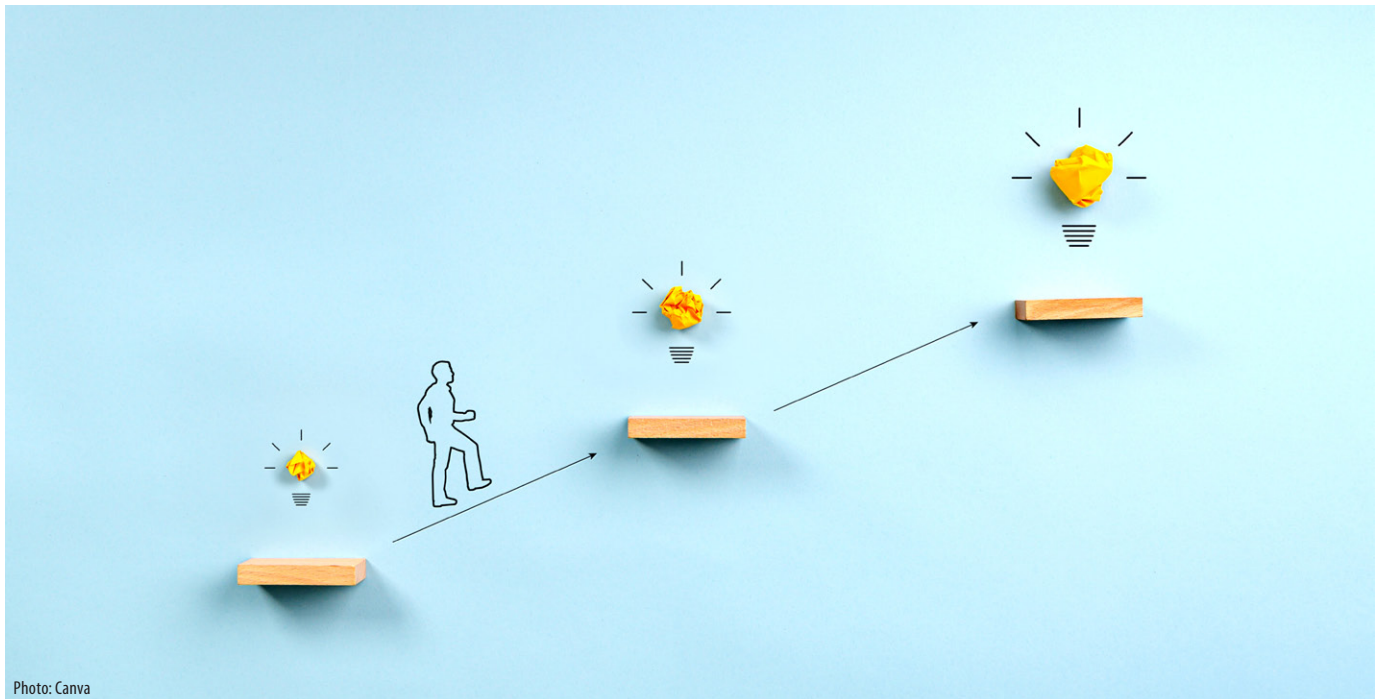


Photo: Canva

engagement. These areas are possibly in the innovators or early adopters phase, where AMS technologies are still being explored, and widespread adoption has not yet occurred. The challenges in these segments are more pronounced, with significant barriers related to technical feasibility, regulatory clarity, and market acceptance.

Optimistic

– but not without a handful of concerns

The prospects and potentials of AMS, as identified through the survey, highlight the industry's optimistic view of AMS as a transformative force in the maritime sector. Stakeholders across various segments anticipate AMS solutions comprising up to 20% of their operations within the next decade, with some sectors (like suppliers and ports) forecasting even greater adoption.

This positive outlook is driven by the anticipated benefits of AMS, including enhanced safety, increased operational efficiency, and significant cost savings. Particularly as the technology matures, stakeholders expect these gains to become more pronounced, underscoring AMS' potential to revolutionise maritime logistics, enhance environmental sustainability, and bolster safety measures across diverse maritime operations. The widespread engagement in research and development projects further illustrates the industry's commitment to exploring AMS' capabilities and integrating them into future operational frameworks.

At the same time, the challenges and weaknesses with regard to AMS adoption,

derived from the survey results, are centred around both internal and external hurdles faced by industry players. Key among these challenges is the ubiquitous issue of regulatory uncertainty, cited across multiple segments as a significant barrier to AMS adoption. The lack of clear regulations and standards introduces a degree of risk and directly hampers investment and development efforts.

Internally, the industry grapples with questions of technological readiness, societal acceptance, and the integration of AMS within existing operational and logistical frameworks. However, most of these issues can be circled back to regulatory uncertainty as well. External challenges such as safety concerns, behaviour in unpredictable emergency situations, and integration with existing maritime traffic handled by people further compound the difficulties.

Moreover, the capital intensity required for AMS development and implementation, coupled with a shortage of qualified professionals and a perception of insufficient support programmes, poses substantial challenges. These barriers highlight the need for a concerted effort to address regulatory gaps, societal concerns, and technological challenges to fully unlock AMS' potential to enhance maritime operations.

Facilitating market adoption

Based on these results, the study puts forth strategic policy & administrative recommendations for the maritime industry (mainly in the German context, given the surveyees' dominant origin) to facilitate market adoption of AMS in the face of the identified potentials and challenges.

As the overarching goal needs to be the reduction of uncertainty in the market, initiatives such as establishing a national AMS mirror group for standardisation and bolstering AMS-focused educational programmes are recommended to mitigate regulatory uncertainties and bridge the skill gap.

Furthermore, the study suggests segment-specific strategies, including regulatory sandboxes for AMS testing, centralised approval points for AMS projects, and a 'Ready4MASS' (autonomous ship-ping) investment programme to stimulate initial market traction. Cross-sector dialogues are recommended to elevate AMS awareness and synchronise strategies across the maritime value chain, ensuring a cohesive approach towards overcoming technical and regulatory barriers while leveraging the inherent benefits of AMS for improved safety, efficiency, and cost-effectiveness. ■

The Fraunhofer Center for Maritime Logistics and Services CML develops and optimises processes and systems along the maritime supply chain. Through practically oriented research projects, CML supports public and private sector clients involved in port operations, logistics, and shipping. Visit cml.fraunhofer.de/en for more details. The German Maritime Center published the full study in the fall of 2023 (go [here](#) for the English Management Summary).