

Navigating the Regulatory Gap: From Fault-based to Strict Liability in Autonomous Vessel Collisions

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Abstract: The development of autonomous maritime vessels presents fundamental challenges to the traditional fault-based liability framework for ship collisions. This article examines whether existing collision liability rules can be directly applied to unmanned ship scenarios and argues that the fault-based regime encounters systemic and practical obstacles. Through an analysis of English maritime law, this article identifies three structural predicaments that render the fault-based framework inapplicable, namely, an evidentiary vacuum arising from the disjunction between technological advancement and the legal concept of fault, significant uncertainty in liability attribution generated by the multi-agent structure of autonomous vessel operations, and the diminished risk-transfer function of contractual recourse mechanisms. In response, this article advocates a strict liability framework centred on the shipowner, supplemented by liability limitation regimes and recourse mechanisms. This approach circumvents the evidentiary vacuum by decoupling liability from proof of specific human fault and provisionally resolves attribution uncertainty by concentrating external liability upon a single identifiable entity, while preserving the possibility of internal risk allocation through the shipowner's right of recourse against suppliers. The article concludes that this framework offers a viable institutional pathway for constructing future liability regimes suited to autonomous navigation technology.

1. Introduction

With the rapid advancement of autonomous maritime vessels, the traditional maritime liability framework centred on fault-based principles faces significant challenges. The current system exhibits a composite structure, in which ship collisions are governed by fault-based liability while strict liability applies in areas such as oil pollution and passenger personal injury. This divergence stems from institutional responses tailored to distinct risk profiles. However, as vessel operations transition from human control to automation, vessel collision risks become increasingly uncertain due to the inherent complexities of automated systems[9]. Therefore, the central question addressed in this article is whether collision rules grounded in fault can be directly applied to collision scenarios for unmanned ships. Through analysis of the existing regime, this article argues that fault-based liability faces a range of systemic and practical obstacles. In light of this, the article

advocates for strict liability of the shipowner as an alternative solution supplemented by liability limitation and recourse mechanisms. Then, regarding to the structure, this article first outlines the existing collision liability framework, then dissects its institutional limitations in the context of autonomous vessels, and finally argues for the introduction and institutional design of strict liability[2].

2. Review of Current Rules

Based on the discussion above, it is necessary to first examine the current rules governing ship collision liability to reveal their institutional logic in addressing traditional collision risks. Meanwhile, comparing these rules with the new risk characteristics introduced by autonomous vessels clearly exposes the limits of traditional rules. By critically analyzing the current framework, this section will provide a theoretical foundation for the future construction of a liability system tailored to the autonomous vessels.

Before commencing the discussion, it is necessary to explain why this article selects English law as the primary analytical sample. The principal reason is that English law constitutes the historical origin and institutional archetype of modern maritime law[1]. As a traditional maritime power, the United Kingdom has accumulated centuries of case law in admiralty, and the basic framework of ship collision liability types was in fact gradually established by British courts and has been adopted by most maritime legislation. More importantly, for historical reasons, English maritime law has exerted a profound influence on Commonwealth countries and traditional shipping nations. The collision liability legislation of many countries either draws upon English law in its textual formulation or cites English precedents as reasoning authority in judicial practice. In most civil law countries, their collision liability rules are largely consistent with the principles established by English law. In other words, the relevant legal rules of countries around the world maintain a high degree of consistency with English law in terms of their basic framework and core concepts. Based on this understanding, this article selects English law as its entry point and relies upon typical English precedents as its reasoning foundation.

Presently, the liability regime within maritime law generally exhibits a hybrid structure. The basis for liability varies across different types of maritime damage. On the one hand, liability for ship collisions has traditionally been grounded in fault-based liability. On the other, in specific domains such as liability for marine pollution damage and passenger personal injury, the international community has universally established strict liability rules. This divergence reflects institutional choices between different risk types and distinct approaches to damage allocation. Regarding strict liability, its justification typically hinges on the activity in question which carries a high degree of risk. Even where the actor lacks subjective fault, if their activity objectively entails the potential for significant harm, the law necessitates the internalisation and equitable distribution of such risks through strict liability mechanisms. This logic constitutes the primary rationale for decoupling pollution liability and passenger injury liability from fault-based foundations[8][9].

As mentioned above, the application of strict liability is confined to specific domains such as pollution and passenger injury. Nevertheless, in the context of ship collisions, the operation of strict liability encounters inherent limitations, and fault-based liability remains the principle applicable to the majority of such incidents. This position is equally well-established under English law where collision liability is also firmly grounded in fault. Indeed, English law established the principle of fault in collisions at an earlier stage, although the development of English common law diverged from civil law in its conclusions. Fault remained central to its liability framework[6]. In *Harbyn v Berry* (1648), even where only one vessel sank, the court required both parties to share the loss, reflecting an early recognition of the shared nature of navigational risks. Subsequently, in *Wildman*

v Blakes (1789), the court further clarified that losses should be apportioned equally even where the degree of fault between the two vessels was not identical. By the time of *The Woodrop-Sims* (1815), the courts had systematically summarised collision liability, clearly distinguishing four typical scenarios: force majeure, mutual fault, fault of the solely injured party, and sole tortious liability[1]. This established a structural foundation for the subsequent development of collision liability law. This demonstrates that within the common law system, liability for ship collisions has always been predicated on the existence of fault. Fault in the tort law sense is typically understood as the failure of the actor to exercise reasonable care, coupled with a causal link between the wrongful act and the damage incurred. Lord Atkin observed that regardless of whether this concept is termed "negligence" or "culpa" across different legal systems, its fundamental principle remains consistent where one causes harm to another through improper conduct, they should bear legal liability for that harm[3].

At the international level, unlike oil pollution damage and passenger personal injury which have developed relatively unified liability regimes, compensation liability for collision damage remains without a fully harmonized set of international rules[4]. Although the United Nations Convention on the Law of the Sea does not directly prescribe a collision compensation regime, it indirectly provides a normative framework for determining collision liability through principles such as "freedom of navigation must be exercised with due regard to the rights and interests of other States" and the obligation of flag States to exercise effective jurisdiction and control over their vessels. Consequently, in practice, the specific determination of collision liability remains highly dependent on the application of national domestic laws. Building upon this foundation, the International Regulations for Preventing Collisions at Sea Convention, adopted in 1972 and entered into force in 1977, established uniform international standards for collision avoidance conduct. It further enhanced flexibility for updating these rules through an implied acceptance procedure. It is important to note that this Convention does not directly address issues of damages, focusing instead on the formulation of navigation and collision avoidance rules. However, Article 2 explicitly stipulates that ships, shipowners, and masters shall not be exempted from liability by reason of compliance with the rules, nor shall they be relieved of liability for failing to take other necessary precautions. It is in this sense that, while the International Regulations for Preventing Collisions at Sea do not directly prescribe a compensation mechanism, they provide an important normative starting point for determining liability in ship collisions.

3. Evaluation of the Shortcomings of Current Regulations

First, there exists a structural disconnect between technological advancement and the concept of fault within the law. Fault-based liability requires the clear identification of a specific human error, which is often difficult to achieve in the context of autonomous vessels. On the one hand, the duty of care for Remote Operator Control (ROC) operators has not been clearly defined. Specifically, or conventional vessels crew responsibilities and operational protocols are relatively clear. Conversely, ROC no uniform legal standard to determine whether their actions constitute negligence. For instance, when a Level 3 autonomous vessel makes an erroneous collision avoidance decision, there is currently no definitive answer regarding the timeframe within which an operator must take control to be deemed to have exercised reasonable care[14]. Secondly, the "black box" nature of AI further complicates fault attribution. Accidents may stem from software design flaws, training data biases, or the combined effects of real-time environmental variables[6]. But victims face near-impossible challenges in uncovering the system's internal decision-making logic or determining human and technical Failures[5][12]. It can thus be observed that the absence of clear standards for evaluating human conduct coupled with the opacity of AI decision-making, ultimately

creates a fundamental evidentiary vacuum. The core challenge is that the lack of evidence makes it nearly impossible to apply fault-based liability to MAV collisions. This plays out in two main ways. First, when the boundary between human and machine decision-making becomes blurred, determining a breach of the duty of care becomes exceedingly difficult. Taking a Level 3 autonomous vessel collision as an example[7], if an accident occurs during the handover phase between the AI system and the remote operator, it becomes notably challenging to ascertain whether the operator's reaction time failed to meet an acceptable standard, or whether the AI system's prior decision-making had already rendered the situation irrecoverable. Second, even if a breach could theoretically be identified, claimants are unable to prove the causal link between specific human conduct and the collision damage. The decision-making process of artificial intelligence remains largely inaccessible to external scrutiny. This "technological black box" obscures whether the root cause of the collision was human error, a software design flaw, or an unforeseeable interaction between the system and environmental variables. Consequently, under a fault-based regime that requires proof of both breach of duty and causation, victims of MAV collisions are effectively left without access to effective legal redress.

Secondly, the multi-agent structure within autonomous vessels creates significant uncertainty regarding liability attribution. Traditional systems identify responsible parties through employment, agency[11], or contracting relationships while autonomous vessels disrupt this framework. Under the control principle established in Mersey Docks, liability typically rests with the party exercising control. However, in autonomous vessels, control is shared among multiple parties such as shipowners, ROC service providers, system manufacturers, and software developers which creates highly complex legal relationships[10]. Specifically, although the ROC operator formally controls the vessel, their authority remains heavily constrained by decisions made by the AI system. Meanwhile, the system manufacturer is responsible for technical design but does not operate the vessel. Although it does not physically control the vessel, its design and products substantially influence the decisions made by the vessel's systems. For instance, even if the ROC service provider constitutes the shipowner's agent under a management agreement, the agent may struggle to be held liable if the accident stems from software defects rather than operational errors[13]. The issue is further compounded by the fact that no human negligence may be attributable at all in certain circumstances. Furthermore, proving that the shipowner could have foreseen the system defect proves exceedingly difficult, thereby rendering the determination of liability exceptionally challenging and leading to mutual recrimination among the parties involved.

Thirdly, contractual recourse mechanisms maybe ineffective in autonomous vessels in collision scenarios. Under traditional frameworks, shipowners could pursue contractual recourse against agents or contractors causing damage to achieve risk allocation. However, this mechanism is markedly constrained in the autonomous vessel context. On one hand, shipowners typically can only assert breach of contract claims against the ROC service provider. If the true cause of an incident lies in sensor defects or software design flaws, and no direct contractual relationship exists between the shipowner and the relevant technology provider, recourse becomes impracticable. On the other hand, technological risks are often latent; even if a shipowner asserts rights under product liability, proving that damage stemmed from the provider's negligence rather than inherent limitations or unavoidable risks of the technology itself proves challenging. Consequently, the risk-transfer function of contractual mechanisms is significantly diminished.

In summary, the inapplicability of the fault-based collision liability regime to autonomous vessels stems from three structural predicaments. Firstly, the fault-identification difficulty caused by the technology-law disjunction. Secondly, the liability uncertainty stemming from multi-actor participation and the obsolescence of the "control" test. Thirdly, the weakening of contractual recourse due to privity doctrine, technological opacity, and multiplicity of parties. Together, these

predicaments entail that direct application of traditional rules would result in liability confusion and gaps, underscoring the need to re-examine the current framework and devise a liability regime suited to autonomous technology. Therefore, the following section will discuss potential adjustments and improvements to the regulatory framework in response to these challenges.

4. Adjusting Regulatory Framework

As previously noted, strict liability typically applies to activities inherently involving high risk, or to parties exercising control over hazardous substances. For instance, the 1992 International Convention on Civil Liability for Oil Pollution Damage imposes strict liability on shipowners for damage caused by persistent oils carried on board vessels. In passenger transport, the 1974 Athens Convention establishes carrier liability for personal injury or death resulting from shipping accidents, unless the carrier can prove the accident was not attributable to its fault. This approach holds significant implications for autonomous vessels. Although AI systems possess a degree of technical autonomy, risk control and operational interests remain concentrated with the shipowner. Consequently, for Level 3 autonomous vessels or scenarios where navigation decisions are primarily made by the system, the most direct solution is to attribute external liability to the shipowner rather than the system manufacturer[10].

However, this article emphasises that strict liability does not equate to absolute liability. Its core principle lies in shifting the burden of proof, namely that the shipowner must demonstrate that the damage was not caused by their negligence[8]. Should the system fail to perform as contractually agreed, the shipowner may still seek recourse against the supplier. If an incident stems from the developer's negligence, the shipowner's liability should remain contingent upon whether they exercised due diligence in selecting a qualified supplier, which is a limitation that must be respected even within a strict liability framework.

The introduction of this mechanism, by assigning external liability for collision damage primarily to the shipowner irrespective of the source of the error. THIS offers a coherent response to the structural predicaments identified in the preceding analysis. Specifically, by decoupling liability from the necessity of proving specific human fault, it circumvents the evidentiary vacuum created by the absence of clear standards for evaluating conduct and the opacity of technological black boxes. Furthermore, by concentrating liability upon a single identifiable entity, namely the shipowner, it provisionally resolves at the surface level the uncertainty in liability attribution that arises from the multi-actor structure of autonomous vessel operations. Simultaneously, by preserving the shipowner's right to seek recourse against suppliers under contractual or product liability principles, it maintains the possibility of internal risk allocation without compromising the clarity and predictability of external liability for victims.

However, this approach carries inherent risks. Firstly, imposing strict liability solely on shipowners without incorporating AI developers into the liability framework may diminish the latter's incentive to enhance system safety. Modern autonomous vessels typically integrate multiple AI systems from different suppliers, making accident causation harder to pinpoint and potentially diluting risk control responsibilities[5]. Secondly, this regime raises fairness concerns. If traditional vessels in comparable circumstances avoid strict liability despite failing to prevent accidents, imposing heavier liability solely on autonomous vessel owners may contravene the fundamental principle of "liability matching fault". Thirdly, even within a strict liability framework, fault-based rules retain supplementary value. As Chief Justice Erle noted, where the cause of an accident lies within the defendant's control, would not typically occur with reasonable care, and the defendant cannot provide a reasonable explanation, negligence may be presumed. However, in autonomous vessels, the presence of automated decision-making and machine learning mechanisms leaves

unclear standards for applying this presumption.

Consequently, while this article advocates introducing strict liability, further institutional refinement remains necessary. Therefore, this article contends that a liability framework centred on strict liability for shipowners, supplemented by liability limitation regimes and recourse mechanisms, represents a prudent choice.

5. Conclusion

In summary, the existing collision rules centered on fault-based liability face structural challenges in the context of autonomous maritime vessels, stemming from technological advancements that introduce multi-party involvement. This, in turn, creates uncertainty in liability attribution and consequently undermines contractual recourse mechanisms. In light of this, the strict liability framework proposed herein, supplemented by liability limitations and recourse mechanisms, both addresses the challenges posed by autonomous navigation technology to traditional attribution principles. It thus offers a viable institutional option for constructing future liability regimes.

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