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THE LEGAL FRAMEWORK OF ARTIFICIALLY INTELLIGENT BILLS OF LADING: CONTRACTUAL VALIDITY AND ENFORCEABILITY IN A DIGITAL ENVIRONMENT

Abstract: The progressive digitalisation of international trade and the emergence of artificial intelligence (AI) in maritime transport raise fundamental questions concerning the legal status, contractual validity, and enforceability of AI-generated bills of lading. This article examines whether an AI-generated bill of lading may function as a constitutive contract of carriage and a negotiable instrument, and under what legal conditions such a document is valid and enforceable across jurisdictions. The central problem addressed is the absence of a coherent, internationally harmonized legal framework capable of governing AI-generated transport documents, particularly in light of the fully autonomous, human-free issuance facilitated by modern AI platforms. Employing a comparative doctrinal methodology, the article analyses the legal treatment of the bill of lading as a contract of carriage under United States law and Greek law, and examines the regulatory frameworks applicable to AI-generated documents in the United Kingdom — notably the Electronic Trade Documents Act 2023 — and the European Union, with particular focus on the EU AI Act. The article further traces the historical development of the bill of lading as a standardized adhesion contract and negotiable instrument, and assesses the implications of AI-driven tokenisation for trade finance. It is concluded that whilst both the UK and the EU have taken meaningful steps towards accommodating

electronic and AI-generated trade documents, significant legal gaps persist, particularly regarding compliance with documentary credit requirements under UCP 600. The article advances normative proposals for the development of an internationally harmonised legal framework under the auspices of UNCTAD, the ICC, and the IMO.

Keywords: *artificial intelligence, bill of lading, contract of carriage, EU AI Act, electronic trade documents act*

1. INTRODUCTION

Global trade is fundamentally dependent upon maritime vessels for the transportation of cargo (Lane & Pretes, 2020; Haralambides, 2019). The bill of lading originated in the fourteenth century as a non-negotiable receipt issued by a ship-owner to a merchant for cargo received on board, later incorporating the terms of the contract of carriage and, by the eighteenth century, acquiring negotiability by endorsement, enabling merchants to dispose of goods in transit before the vessel reached its destination (Wilson, 2010). Historically, bills of lading have served three core functions in maritime commerce: as a document of title entitling the holder to demand delivery of the goods, as a receipt acknowledging cargo placed in the carrier's custody, and as the contractual instrument governing the carriage of goods by sea (Wilson, 2010). The legal effect of the bill as a document of title at common law resides in its capacity to confer on the lawful holder the right to receive delivery from the carrier, through the mechanism of constructive possession embodied in the instrument (Curwen, 2007). In its traditional paper form, however, the bill of lading carries inherent operational risks, including fraud, clerical error, and delivery delays (Institute of International Maritime Studies, n.d.).

A further feature of contemporary practice bears directly on the argument developed in this article. The bill of lading is properly classified as a contract of adhesion: oral contracts of carriage have been supplanted by the standardized contractual terms of shipping companies, as reflected in their bills of lading (Wilson, 2010). Since the document's content has long been fixed by the carrier's standard form rather than negotiated, the human role has traditionally been limited to inserting shipment-specific details — a point Section 2 develops to argue that AI-generated bills of lading represent an incremental development, not a wholesale departure from existing practice.

Electronic means of communication are already widely used in the industry for the transmission of various types of information, ranging from vessel manifests to bill of lading data, and the question is whether such facilities could be used for the development of electronic alternatives to traditional paper documents (Zhu, Cui & Zhang, 2022). There exists no legal impediment under the relevant instruments of international maritime law to the use of electronic bills of lading (eB/Ls): Article 8 of the Rotterdam Rules permits the use of electronic transport records provided that the carrier and shipper mutually consent to such an arrangement, whilst Article 14(3) of the Hamburg Rules similarly accommodates the electronic signature of the bill of lading.

The question of whether electronic bills of lading can perform all three functions of their paper counterparts has been specifically addressed by Al-Naseri (2020), who concludes that negotiable eB/Ls may function as documents of title equivalent to negotiable paper bills of lading under the Rotterdam Rules and cognate frameworks (pp. 247–248). The eB/L offers considerable practical advantages over its paper counterpart, enabling immediate transfer of the document of title and enhancing security and traceability (Zhu, Cui, & Zhang, 2022). Despite this, there is as yet no standard electronic bill of lading or electronic transport record in regular use internationally, although the 2026 publication of ISO 5909 and the International Group of P&I Clubs' approval of five interoperable platforms mark significant steps toward resolving this (Trade Treasury Payments, 2026; Wingrove, 2026; ICC Academy, n.d; Tsai, 2026).

Blockchain technology has also attracted considerable scholarly attention as a means of resolving the longstanding inefficiencies of paper-based documentary practice, a development examined in detail in Section 2 (Feng, 2021; Tsai, 2026). Greece's legal reforms show how the country has responded to these pressures. The Code of Private Maritime Law (Law 5020/2023), in force since May 2023, replaced the outdated 1958 Code, which was rooted in the Hague Rules of 1924 and ill-suited to modern shipping practice, and its treatment of the bill of lading as a constitutive contract — together with the supporting Greek jurisprudence — is examined in detail in Section 4.

These developments at the level of statute and case law do not, however, resolve a prior and more general difficulty: technological innovation of this kind routinely outpaces the categories that existing legal frameworks were designed to regulate. Brownsword et al. (2017) address this difficulty directly, identifying the "field, frame, and focal questions" that arise

whenever law is required to respond to emerging technology. Section 5 uses this framework to assess how AI-generated bills of lading are regulated.

Krebs (2023) warns that the shipping industry needs careful laws for electronic documents, as technology-neutral frameworks better achieve equivalence with paper bills than blockchain-specific solutions. This challenge is compounded as AI systems increasingly automate the generation of transport documentation e.g. smart contracts (Sotiropoulos, 2026a, 2026b): an AI-generated bill of lading, automatically issued on the basis of a carrier's standardized form, signals a trajectory towards full document tokenization that existing legal frameworks were not designed to accommodate (Tsai, 2026).

This article addresses a central research question: can an AI-generated bill of lading possess the legal status of a contract of carriage and a negotiable instrument, and if so, under what conditions? The article pursues four objectives: tracing the historical and doctrinal development of the bill of lading; examining its function as a constitutive contract of carriage under US law, Greek law, and relevant international conventions; analyzing the regulatory treatment of AI-generated transport documents under UK and EU law, with reference to the Electronic Trade Documents Act 2023 (ETDA 2023) and the EU AI Act; and advancing normative proposals for an internationally harmonized legal framework.

This paper is structured as follows; presents the origins of the bill of lading and examines its relationship with AI and blockchain technology; analyses its status as a contract of carriage under US and Greek law; assesses the ETDA 2023 and the EU AI Act; and displays a comparative evaluation of both frameworks before setting out its conclusions.

2. The Bill of Lading: Origins, Negotiability, and the Challenge of Digitalization

The bill of lading originated as a copy of the ship's logbook entry, serving as documentary proof of carriage and incorporating the terms of the contract — an arrangement through which the instrument gradually acquired negotiable status. Crump (1985) analogized it to the bill of exchange, whilst McLaughlin (1926) observed the paradox of treating it as mere evidence rather than as the original contract of carriage transferred upon endorsement. As Curwen (2007) has demonstrated, negotiability — the capacity to vest in the transferee the rights of suit under the contract of carriage — is the defining feature of the bill of lading and underpins its role in trade finance.

It follows that the bill of lading must function as the contract of carriage from the moment of its issuance and acceptance.

For a bill of lading to perform its functions as a document of title, it must be in writing and signed on behalf of the carrier. *Leduc & Co v Ward* confirms that contractual terms must be in writing to be enforceable against third-party holders (Todd, 2016).

The global adoption of blockchain technology addresses longstanding operational challenges in maritime sector and international transport (Kouroupis & Sotiropoulos, 2024) and yields significant economic benefits. Digital technologies are now pervasive in international trade (Zekos, 2016), and their increasing reliability has enabled the progressive automation of functions previously performed by human actors. The ICC Academy has noted that the eB/L is transforming digital trade by enabling real-time data sharing, reducing document fraud, and accelerating the processing of documentary credits (Comninos, 2024). Innovations in digital technology facilitate not only the exchange of data but also the automated issuance and transmission of AI bills of lading and other transport documents from the port of loading to the port of discharge across the world. In 2026, the International Group of P&I Clubs approved five eB/L platforms operating under a common Digital Container Shipping Association interoperability framework, removing the longstanding requirement that all parties to a shipment use the same system (Wingrove, 2026).

Feng (2021) argues that the adoption of blockchain bills of lading requires not merely recognition of electronic equivalence but a fundamental re-examination of the legal framework governing the transfer of rights in transport documents, identifying the absence of harmonized regulation as the principal obstacle to their widespread adoption. Given the evolution of contracts of carriage into adhesion contracts, all transport documents ought to be capable of issuance in electronic form.

The Athens Court of Appeal, in Decision 2360/2014, affirmed that the bill of lading evidences both the conclusion and content of the contract of carriage — a document embodying three distinct functions that would not exist absent the instrument itself. Notably, AI bill of lading platforms generate an additional contractual layer between shipping companies and customers, while expanding carriers' vertical integration as logistics providers (Grønbæk, 2023).

3. US Courts and the Bill of Lading as Contract of Carriage

The United States Supreme Court, as early as the cases of *Delaware* (1872) and *Pollard v Vinton*, established that the bill of lading constitutes the contract of carriage and supersedes any prior oral agreement concerning the terms of carriage. In *The Thames* case, the Supreme Court further held that even a written agreement is supplanted by the bill of lading, which, upon its issuance and acceptance, is treated as the governing contract of carriage. Cottingham (1906) similarly held that the bill of lading expresses the contract of carriage between the shipper and the carrier, covering the receipt, carriage, and delivery of the cargo from origin to destination (p.305). Upon its endorsement as a negotiable instrument, the bill of lading passes to the third-party holder (Zekos, 2025).

According to Mitchell J., the bill of lading must be regarded either as the original contract of carriage, with all its terms embodied therein, or as possessing no contractual function whatsoever; no intermediate position is logically sustainable. No satisfactory legal explanation has been advanced for how a bill of lading, conceived merely as an evidentiary document, is transformed upon endorsement into the original contract of carriage (Zekos, 2025).

4. The Constitutive Nature of the Bill of Lading in Greek Law

The endorsement of a negotiable instrument can convey only those attributes and functions which were embedded in the instrument at the time of its issuance. It follows that the endorsement of a bill of lading, if treated as merely evidential of the contract of carriage, cannot transform it into that contract. Greek legal scholarship (Zekos, 2025) is consistent on this point: Loukopoulos (1980), Potamianos (1962, pp. 13–15, 40, 46), and Sarlis (1969) each treat the bill of lading's legal and economic purpose as constitutive rather than merely declaratory, with Sarlis describing it as the constitutive form (ad solemnitatem) of the contract of carriage, a view consistent with Salmond and Winfield's (1927) broader account of the bill of lading as a negotiable instrument that simultaneously functions as the contract of carriage (pp. 123–124).

The bill of lading is thus the constitutive form through which the contract of carriage comes into existence, transferring upon endorsement to the third-party holder as the original contract itself. Its issuance creates independent rights and obligations of an abstract character, rather than

merely evidencing a pre-existing agreement, as confirmed by contemporary law's rejection of the prima facie evidence doctrine.

Article 121 of Greek Law 5020/2023 provides that the maritime bill of lading evidences the contract of carriage as against all parties. In practice, it operates as the original contract upon endorsement, with the holder's rights derived solely from its text; prior agreements bind the holder only if incorporated. Article 125 grants electronic bills of lading the same legal effect as paper documents (Government Gazette of the Hellenic Republic, 2023). This statutory framework forms part of a broader reform: the Code of Private Maritime Law (Law 5020/2023), in force since May 2023, replaced the outdated 1958 Code, rooted in the Hague Rules of 1924 and ill-suited to modern shipping practice, expanding the bill of lading provisions from six to eleven articles (121–131). Article 123 now permits bearer bills of lading, previously prohibited, while Article 124 specifies the mandatory contents required for a document to qualify as a bill of lading. Although not a bill of lading proper under the Hague-Visby Rules, the electronic version is treated as equivalent and thus triggers those Rules under Greek law, a conclusion supported by Goldby (2019), who suggests that the wording of the Hague-Visby Rules is broad enough to encompass the electronic bill of lading, citing the House of Lords' reasoning in *The Rafaela S* that the legislators' intention was not to restrict the Rules' scope but to prevent their circumvention ; the same interpretive approach could plausibly be extended to the AI-generated bill of lading.

Gaps remain in international harmonization, market uncertainty persists over authenticity technology, and Article 288's delayed ministerial ordinance highlights the framework's incompleteness. Greek courts confirm the doctrine: the Athens Court of Appeal (4466/78) treats carriage contracts as adhesion contracts, while the Piraeus Court of Appeal holds that bill of lading contracts are *contractus re* and third-party benefit contracts under Articles 410 *et seq.* of the Greek Civil Code (Zekos, 2025).

5. The United Kingdom's Regulatory Response to Electronic and AI-Enabled Bills of Lading

The United Kingdom has emerged as one of the foremost jurisdictions to provide an express statutory basis for the recognition (Sotiropoulos, 2023) and transfer of electronic trade documents, including electronic bills of lading. The Electronic Trade Documents Act 2023 (ETDA 2023) (Pejović & Lee, 2025) amends the common law rule — derived principally from Lickbarrow v Mason (Todd, 1997) and reinforced by the Bills of Lading Act

1855 — that a document could only be "possessed" and transferred as a document of title if it existed in paper form. Under section 2 of the ETDA 2023, an electronic trade document satisfying the prescribed reliability requirements may be "possessed" in law, enabling transfer, indorsement, and surrender in the same manner as its paper equivalent. Krebs (2023) observes that the Act was drafted with close, if unacknowledged, regard to the United Nations Commission on International Trade Law (UNCITRAL) Model Law on Electronic Transferable Records (MLETR), to the point that clause 2 mirrors Article 10 of the MLETR almost exactly, notwithstanding the Law Commission's insistence that "possession" differs meaningfully from the MLETR's language of "control." (p.333). Ioannou (2026) similarly notes that the Act's "gateway criteria" were deliberately framed in technology-neutral terms, requiring only that a reliable system identify the document, protect it against unauthorized alteration, and ensure exclusive control by a single party, without prescribing the technical means by which this is achieved (p.137). Krebs further notes that the Law Commission frames the reform as domestic law reform rather than international harmonization, omitting any reference to the MLETR and adopting what he characterizes as a "going it alone" approach reliant on the pre-eminence of English law in contracts of affreightment (pp.333-334). Frosinini and Borra (2025) place the Act within a broader international framework, noting that its technology-neutral drafting allows for future technological developments without new legislations (ch. 8).

Krebs (2023) argues that, whilst the Act removes the principal legal obstacle to the electronic bill of lading, it does not resolve the structural incompatibility between the decentralized, transnational character of blockchain networks and English law's requirements for identifying a controlling party. Although professedly technology-neutral, the Act's underlying assumptions plainly contemplate distributed ledger technology, notwithstanding that more conventional, centralized registry-based systems — such as BOLERO (Zhu, Cui & Zhang, 2022, p.21) — may represent a more cautious route to the same legal outcome, given the shipping industry's well-documented conservatism (pp. 326–328, 335–336). Ioannou (2026) echoes this caution from a different angle, arguing that the reliability requirement is confined to a system's technical functioning and does not extend to the commercial terms under which it operates, such that legal recognition alone cannot resolve the underlying "membership requirement" historically impeding eBL adoption (pp. 141-142). This applies with even greater force to fully autonomous AI-generated bills of lading, where the absence of any human deliberative act at issuance further complicates the

attribution of contractual intention. An AI layer generating or managing the record introduces a further, unaddressed variable into the reliability assessment under section 2(5): whether such a system can meet the transparency standard Krebs regards as critical, and the governance standard Ioannou regards as necessary to overcome the industry's persistent skepticism towards digitalization.

5.1. AI, e-Bills of Lading and the EU AI Act

The EU AI Act (Regulation (EU) 2024/1689), which entered into force on 1 August 2024 and whose operative provisions are being phased in progressively until August 2027, constitutes the world's first comprehensive horizontal legislative framework specifically regulating AI systems (Jougleux, 2025). The Act adopts a risk-based approach, classifying AI systems into four tiers — unacceptable risk (prohibited), high risk (subject to stringent ex ante requirements), limited risk (subject to transparency obligations), and minimal risk (largely unregulated) — and imposes obligations upon providers, deployers, importers, and distributors of AI systems deployed within the European Union or affecting persons therein (Regulation (EU) 2024/1689).

AI systems deployed in the context of international transport and trade finance do not straightforwardly map onto the high-risk categories enumerated in Annex III of the EU AI Act. An AI system that autonomously generates and issues bills of lading would not, on the face of it, fall within these categories, and would therefore not be subject to the Act's most onerous requirements. Nevertheless, where an AI bill of lading system is used in the context of trade finance — for instance, to determine creditworthiness or to execute payment obligations automatically — it may engage the high-risk category of AI systems used in financial services under Annex III, point 5(b), which encompasses AI systems used for credit scoring or for assessing the credit standing of natural or legal persons.

The EU AI Act's transparency obligations under Article 50 require providers to inform recipients when content has been generated by AI. As the ICC Academy has observed, eB/Ls already raise questions about the adequacy of existing trade documentation conventions, questions intensified where documents are generated entirely by AI. The Act's General-Purpose AI provisions (Articles 51–56) are also relevant where foundation models underpin document generation. Since AI systems cannot perform legal acts under EU Member State contract law, the automated generation of a bill of lading must be attributed to the deploying carrier or platform operator.

5.2. A Comparative Assessment — UK and EU Frameworks

The United Kingdom and the European Union approach the regulation of AI-generated bills of lading from opposite directions. The ETDA 2023 is document-centric: it asks only whether a record, however produced, satisfies the functional gateway criteria of identifiability, integrity, exclusive control, and transferability, remaining agnostic as to whether that record was generated by a human, a blockchain protocol, or an AI system (Krebs, 2023), p. 332). The EU AI Act is process-centric: it regulates the AI system according to the risk its functioning poses, rather than the legal status of any document it produces. This creates a structural mismatch. An AI system that autonomously generates a bill of lading sits outside the high-risk categories enumerated in Annex III unless it strays into adjacent functions such as credit scoring or automated payment execution under point 5(b), meaning that the act of generating a transferable trade document — arguably the more consequential function from a commercial law perspective — escapes the Act's most stringent obligations. Where the United Kingdom asks whether the *output* is reliable enough to be possessed in law, the European Union asks whether the *system* is risky enough to be regulated at all; an AI generator might clear one threshold whilst failing the other.

Both frameworks nonetheless converge on a shared, unresolved point: neither attributes legal personality to the AI system itself. Under the ETDA, attribution operates indirectly through the requirement that a "person" be capable of exercising control of the document, channeling responsibility back to a human or corporate operator (Ioannou, 2026, p. 137). Under the EU AI Act, attribution is express: since AI systems cannot perform legal acts under Member State contract law, automated generation must be attributed to the deploying carrier or platform operator, reinforced by the Article 50 disclosure obligation. Neither framework, however, addresses the bill of lading as the specific artefact situated at the intersection of these two regimes.

A further gap concerns the status of AI-generated bills of lading as documents of title under letters of credit governed by the Uniform Customs and Practice for Documentary Credits (UCP 600), which requires identification of the carrier and the signatory (International Chamber of Commerce, 2007). Where a bill is generated and "signed" autonomously, compliance with this requirement remains legally uncertain, exposing issuing and confirming banks to considerable risk (Yen Low, 2010). As Krebs (2023) observes in relation to blockchain bills of lading, such uncertainty cannot be resolved through interpretation alone and instead

requires targeted legislative intervention. A coherent international legal framework — building upon the ETDA 2023, the EU AI Act, the Rotterdam Rules, and UNCITRAL's Model Law on Electronic Transferable Records — therefore remains an urgent priority.

CONCLUSIONS

To conclude, in shipping and trade, eB/Ls offer enormous benefits as the most effective paperless delivery solution (Zhu, Cui & Zhang, 2022) p.25), and an AI-generated bill of lading could satisfy the legal requirements of a contract of carriage and negotiable instrument if it is attributable to a responsible human or corporate actor, meets the ETDA 2023's requirements for possession and transfer, and its high-risk AI functions comply with the EU AI Act. The foregoing analysis discloses the need for clear convergence between United States, Greek, United Kingdom, and European Union law on the functions of the bill of lading as a carriage of goods contract, evidence of loading, and a negotiable instrument. The digitalization and circulation of documents in global trade and transport in the age of artificial intelligence require the prompt harmonization of national laws concerning the characteristics and functions of such documents, in order to enable their use and circulation as AI systems become more capable (Arshi & Chaudhary, 2024). The characterization of the contract of carriage as an oral agreement is difficult to sustain when, in practice, cargo is transported exclusively on the standardized terms of the bill of lading. As Curwen (2007) has demonstrated, the bill of lading's function as a document of title is inseparable from its character as the embodied contract of carriage — an analysis that applies with equal force to AI-generated instruments. Since individual negotiation of contractual terms does not occur in the carriage of goods, oral contracts of carriage are even less likely to survive in the AI era. Applying the analytical framework proposed by Brownsword et al. (2027), it is submitted that this calls urgently for the development of legal instruments tailored to the specific capabilities and risks of each new technology, rather than the mere extension of existing rules.

As AI deployment in international transport accelerates, a global system for the registration and circulation of AI bills of lading, operating under UNCTAD's auspices and interconnected with national recording systems, is necessary. The European cyber security framework and its relationship to AI regulation (Sotiropoulos, 2025) provides a model for the integrated, multi-layered regulatory approach this would require. The prevailing reliance on blockchain technology for the circulation of transport documents

risks yielding a fragmented and decentralized system that is ill-suited to fostering uniformity in international transport (Feng, 2021). Consequently, the development of a coherent international legal framework therefore remains the same priority identified in Section 5 in respect of UCP 600 compliance, building upon the ETDA 2023, the EU AI Act, the Rotterdam Rules, and UNCITRAL's Model Law on Electronic Transferable Records.

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