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TECHNICAL IMPLICATIONS OF SMART CONTRACT ARCHITECTURE FOR SHIPBUILDING STAGES AND PAYMENTS

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ABSTRACT

Smart contracts are a technology that has been applied, or is being considered for application, in a variety of sectors to expand the way we transact based on the trustworthiness of the blockchain, beyond the basic functionality of simple payment methods such as the existing Bitcoin-based blockchain. However, there are limitations to the application of smart contracts in shipbuilding contracts due to the complexity of the transaction steps. Therefore, this study examined the applicability of blockchain-based smart contracts to shipbuilding contracts by comparing the legal precedents and jurisprudence of English law, which is most often used as the governing law for shipbuilding contracts, and Korean law, which is most often used for shipbuilding contracts. Through this, we identified major legal issues from the collateralization and prevention perspectives of legal stability, and proposed improvements by applying the conceptual level architecture and algorithms of smart contracts in shipbuilding contracts to the payment conditions. While this study was not able to program the algorithm to apply to all shipbuilding contracts, it is important to note that the study examines the legal issues that can be expected from a legal perspective.

Keywords: *Block Chain, Smart Contract, Shipbuilding Contract, Contract Algorithm, Shipbuilding Payment*

1. INTRODUCTION

1.1 Background

With the development of the Fourth Industrial Revolution technologies, global maritime leaders such as Greece, Japan, Germany, China, Norway, and the United States are building a system for the construction and operation of autonomous ships, the design and operation of intelligent ports, the establishment and utilization of digital maritime communication, and the construction of smart shipyards by converging artificial intelligence, Internet of Things, and big data technologies[1]. The core of this smart technology system is whether it can ensure the stability of various maritime data accumulated through research and demonstration, while protecting the rights and property rights of each party through smart contracts in the production, sharing, processing, trading, and distribution stages based on digital platforms.

These Smart Contracts, based on the Bitcoin-based blockchain, are being applied to the valuation, exchange, and trade transactions of all goods, including tangible and intangible assets, in addition to their original business areas as a means of currency and payment[2]. For example, in 2017, based on a blockchain demonstration project in the field of international logistics, IBM and Maersk combined Hyperledger Fabric and IBM's own technology to eliminate the forgery and alteration of various documents essential to international trade transactions, and solve the problems of data errors, unnecessary time spent on transportation, and wasted inventory through smart contracts based on TradeLens[3]. Therefore, in the future, smart contracts based on blockchain-based digital platforms are expected to expand not only to general commerce linked to Bitcoin, but also to the evaluation and collateralization of all goods, including assets such as ships and drawings in the shipbuilding field. Of course, we are still seeing automated, customizable smart contracts in shipping, such as Blockchain Bill of Lading, Blockchain empowered port supply chain system, etc. that are based on the benefits of decentralized cryptocurrencies[4]. However, the shipbuilding contract, which is a representative contract in the shipbuilding field, is composed of a relatively complex payment relationship compared to the purchase and sale of cargo in the international logistics level, so there are limitations in applying

smart contracts. This is because it is common for shipbuilding contracts to use relatively standardized contracts such as SAJ Form, AWES Form, MARAD Form, NEWBUILDCON, etc. to minimize possible legal problems considering the complexity and interpretation ambiguity of the provisions stipulating the specifications and performance of the ship, construction procedures and construction methods, claims for shipbuilding payments, payment methods and timing, reasons for default, liability for breach of contract, and the high cost of the contract object[5].

1.2 Aims

Large-scale projects such as shipbuilding are characterized by complex interconnectedness of stakeholders, both domestically and internationally, due to the large amount of financing involved, the complexity of ownership related to expediency, and the short volatility cycle of the shipping industry, which can lead to mismatches between shipbuilding and delivery cycles[6]. In addition, as shown in Table 1 below, legal disputes are constantly arising due to payment and delivery issues between shipowners and shipbuilders due to fluctuations in the shipping industry. Therefore, this study is primarily aimed at verifying the legal status and scope of smart contracts in order to empirically confirm the applicability of smart contracts so that ship owners and ship builders can objectively and transparently protect their contractual rights and property rights by utilizing blockchain 2.0 technology in the stages of verifying, recording, and storing information for each stage of construction of the contract object.

Secondly, this study compares the application, design, and development of blockchain 2.0 technology, as well as the risks of introducing such technology to shipbuilding contracts, with the case law and jurisprudence of the English law, which is the most applicable law, and the Korean law, which builds the most ships. Through this, we will examine whether the application of blockchain-based smart contracts to shipbuilding contracts can ensure legal stability, identify key legal issues from a preventive perspective, and suggest improvement measures.

The purpose of this study is to invent the payment system of blockchain-based smart contracts for the shipbuilding industry and ultimately design new architecture consisting of milestones with sub-key events that meet the mutually agreed-upon procedures and regulations for shipowners and shipbuilders.

This study can contribute to legal stability by minimizing the expected legal issues related to the management of complex process schedules and the payment of installation payments and minimizing delays in ship delivery and contractual legal disputes between ship owners and shipbuilders as well as various stakeholders by objectifying the contract execution conditions from the detailed level of architecture and applied algorithms at the conceptual level.

Table 1. Major cases of legal disputes between shipowners and shipbuilders over payment and delivery issues due to fluctuations in the shipping economy

Year	Case	Key Issues	External / Internal environment
2004	Sembawang Corp Ltd v Pacific Ocean Shipping Corp (No 3) [2004] EWHC 2743 (Comm)	Shipyard expense exceeded the contract price.	[I·E]shipowner had been in breach of duty
2009	Stocznia Gdynia SA v Gearbulk Holdings Ltd [2009] EWCA Civ 75	Each party exercises a contractual right to terminate for breach	[E·E]The 2007–2008 financial crisis effected to pay instalments
2011	Adyard Abu Dhabi v SD Marine Services [2011] EWHC 848 (Comm)	Due to the delay for sea trials, return of the price paid	[I·E] Shipyard fail to comply with the notice under contract
2011	Rainy Sky SA & ors v Kookmin Bank [2011] UKSC 50	the shipbuilder refused to refund the instalments paid	[E·E] The 2007–2008 financial crisis effected Refund Guarantee
2014	Zhoushan Jinhaiwan Shipyard Co Ltd v Golden Exquisite Inc and Others [2014] EWHC 4050 (Comm)	delay in delivering the vessel	[I·E]shipowner's supervise imposed unreasonable requirement

[1] I ·E = internal environment, E ·E = external environment

1.3 Literature Review

Smart contracts have a framework for application in various industries, and their effectiveness has been verified by several studies[7].

Smart contracts can be a suitable alternative in the electricity use system, where it is necessary to make the supply and demand as close as possible [8]. Ssmart contracts and blockchain tokens can be used to improve the distribution process of agricultural products, providing transparency and shared economic benefits to stakeholders along the supply chain[4]. This is because the port supply chain is based on mutual trust between stakeholders such as ships, cargo, terminals, customs, maritime police, and agents. For example, the shanghai yangshan port in China has successfully commercialized the DTMC (Discrete-Time Markov Chains) model applied to customs clearance process information in the form of automatic conversion through BPMN (Business process Model and Notation)[9]. Smart contracts as a means to solve trust and coordination problems that hinder the efficiency and effectiveness of the supply chain. There has also been legal research on approaches to lightweight smart contracts that can be used without a blockchain when trusting the operating system [10] and on contracting using languages other than written contracts [11].

However, the literature has also identified a number of challenging issues for the utilization of smart contracts. A typical problem in e-contracts is an informational imbalance in which one of the contracting parties is objectively vulnerable, which can worsen the contractual relationship [12]. In addition, similar to the problem of information vulnerable classes, it was analyzed that invalidation due to mistake or identity theft, uncertainty at the time of contract acceptance, problems with legal "intent" for subsequent contracts, uncertainty between legal terms and coding languages, and uncertain legal status of smart contracts are also expected [13]. In addition, cyberattacks such as Trojan, Worm, etc. and malware are also recognized as vulnerabilities of smart contracts[14].

In addition to efforts to overcome these technical challenges and limitations, there have been some approaches to the legal issues of smart contracts[15]. categorized the existing literature on the technical features and legal significance of each model related to smart contracts. The study categorized smart contracts into 10 different models and identified 11 legal contract parameters. Of course, the legal questions of these smart contracts can be raised, but smart contracts should really be applied strictly from a technical point of view, and the legal response should be based on their technical capabilities [16]. Several studies have been conducted on the application of smart contracts in shipbuilding contracts, mainly in the areas of payment and schedule compliance during shipbuilding contracts. This is because if a shipyard does not have a system in place to verify and validate the basis for the extension of time clauses in the shipbuilding contract, it may face legal challenges for various damages[17]. Despite the various issues under contract law with such smart contracts, a program that automatically enforces the terms of a contract between parties has the advantage of eliminating the risk of fraud, coercion, and undue influence affecting the contract [18]. And smart contracts can be another opportunity to promise the future, the significance of which lies in the fact that contracts can be finalized through automated fulfillment [19].

1.4 Research Questions

The focus of this research is to explore logical answers to the Sub-Research Questions that are derived from the Original Research Question: What are the risks that may arise when blockchain-based smart contracts are applied to shipbuilding contracts when the simultaneous offer and acceptance, which are executed by a computer program with guaranteed automatic execution, are not interpreted according to traditional contract theory?

Therefore, in order to derive logical results, this study firstly derived sub-research questions by collecting 3,358 SCIE and above papers centered on 'smart contract' and 'shipbuilding contract' as keywords in the abstract from January 1, 2018 to December 30, 2022 from the Web of Science homepage, and firstly derived key issues through semantic network analysis using Gephi, an open-source network analysis and visualization software package written in Java program. Summarizing the results of the analysis as shown in Table 2 below, the core keywords of the previous studies were identified in the order of frequency: blockchain (1,527), smart (966), data (910), and contract (868), and the central connectivity between the core keywords was confirmed through semantic network analysis, and it was confirmed that smart, contract, management, service, and IoT were intensively connected around blockchain.

Identifying these key words and the centrality of Semantic Network as the core needs of this study, the authors secondarily derived the sub-research questions as shown in Figure 1 based on the needs analysis theory, which was derived by analyzing the authors' insights and previous studies.

Table 2. Word frequency and semantic network analysis for 'smart contract' and 'shipbuilding contract' in Web of Science

Words	Freq.	Semantic Network analysis				
		Item	Node	Edge	Distance	Centrality
Blockchain	1,527	Blockchain	100	31	1.892473	0.967742
Smart	966	Smart	100	31	1.892473	0.16129
Data	910	Contract	100	31	1.892473	0.193548
Contract	868	Management	100	31	1.892473	0.193548
Management	694	Service	100	31	1.892473	0.129032
Cryptocurrency	668	IoT	100	31	1.892473	0.258065
network	334	Internet	100	31	1.892473	0.96774
Algorithm	307	Consensus	100	31	1.892473	0.32258
privacy	243	Public	100	31	1.892473	0.32258
		cryptocurrency	100	31	1.892473	0.32258
		algorithm	100	31	1.892473	0.32258

[1] sub-RQ
No.1 : Issue for Recognizing the legal status of shipbuilding contracts with blockchain-based smart contracts
No.2 : Issue for Managing legal risk in the contract formation phase
No.3 : Issue for Legal risk management issues in the post-agreement retention phase
No.4 : Issue for Managing Legal Risks After Delivery

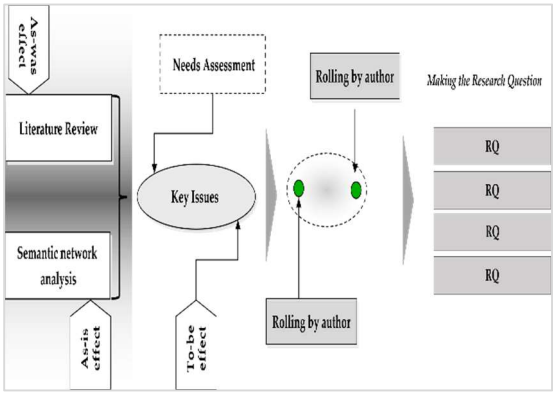


Figure 1. Research Questions design process based on the needs analysis method.

2. THEORY AND METHOD

2.1 Legal Status and Core Theory of Shipbuilding Contracts

A shipbuilding contract is an agreed upon and formally documented process by which a shipowner pays a shipbuilder to build and deliver a ship to the shipowner for the purpose of the contract. The contractual arrangement between the shipowner and the shipbuilder is usually designed to transfer ownership to the shipowner upon payment of a 30% down payment, with the balance due after the ship is delivered to the shipowner on agreed terms at key milestones such as steel cutting, keel laying, launching, shore power connection, mooring trial, sea trial, and delivery[20]. In Section 2.1, we will examine the theoretical legal status of these shipbuilding contracts in terms of the different views and positions between English and Korean law.

Under English law, shipbuilding can be categorized into 'pre-construction', 'construction', and 'completed construction', and the legal status of shipbuilding contracts is governed by "The Sale of Goods Act 1979", which treats all 'pre-construction', 'construction', and 'completed construction' contracts as contracts for the sale of goods, subject to delivery, unless otherwise specified in the contract[21]. In Hyundai Heavy Industries Co. v. Papadopoulos [1980] 1 WLR 1129, [1980] 2 All ER 29, [1980] 2 Lloyds Rep 1 England and Wales, the House of Lords held that when a shipowner terminates a shipbuilding contract, it is not an ordinary contract for the sale of goods in respect of the shipbuilder's claim for payment of the unpaid purchase price. The House of Lords also emphasized that while the design phase constitutes a service contract, in terms of the completion of the shipbuilding, it is not correct to treat the ship as a mere commodity and include it in the category of a contract of sale. Ultimately, The House of Lords held that the true economic value is transferred when the ship is finally delivered to the shipowner as a 'ship in a state of completion' following successful commissioning, and therefore the shipbuilder is entitled to payment of the outstanding shipbuilding payments even if the shipbuilding contract is terminated. As a result, it can be interpreted that shipbuilding contracts under English law are basically treated as goods by applying the UK Sale of Goods Act 1979, but recognize differences in shipbuilding processes based on special provisions. This is because shipbuilding is different from general contracts for the sale of goods in that it takes a relatively long time to build, and the process of customized design, production, assembly, commissioning, and delivery is carried out sequentially according to the needs of

the shipowner. In addition, shipbuilding contracts under English law are characterized by the long duration of the construction period, the equity of risk allocation between the contracting parties, and the project nature similar to a general construction project. Under Korean law, a shipbuilding contract is generally concluded as a contract between a shipowner and a shipbuilder, but it is recognized as a product supply contract if it includes not only the obligation to complete the shipbuilding but also the obligation to supply various rebar, wires, and machinery[22].

In this regard, the Korean Supreme Court's position on the legal nature of shipbuilding contracts is based on the Supreme Court's ruling of October 13, 2006, 2004 Da 21862[23], which states that "if the goods to be manufactured and supplied under the contract are fungible products, the rules on sale and purchase apply, but if the goods are non-fungible products to satisfy the demand of a specific order, the supply and manufacture of such goods become the main object of the contract and have the nature of a sub-contracting." The legal nature of the contract for the supply of accessories is determined to be a sub-contracting contract. In the end, under Korean law, a shipbuilding contract is recognized as a hybrid of a contract for the supply of goods and a contract for the construction of a ship, considering that the shipbuilder builds and delivers a specific ship in accordance with the shipowner's construction instructions.

2.2 Legal Status and Core Theory of Smart Contracts Legal

A Nick Szabo defines a smart contract as "a computerized transaction protocol that executes the terms of a contract[24]." In order to apply blockchain-based smart contracts to shipbuilding contracts, it is necessary to clarify the terms and conditions between the contracting parties and the definition of the contracting parties, the same as in shipbuilding contracts based on traditional contract theory. However, in order to examine the legal significance of emerging technologies such as blockchain-based smart contracts and the extent to which they will affect the application of traditional contract law theory and jurisprudence, it is necessary to theoretically discuss the legal status of blockchain-based smart contracts from two perspectives.

First, it is the view that "computer-coded contracts" are strictly included in the category of "contract" because blockchain-based smart contracts are subject to formalized regulations and are based on principles that are clear from the perspective of contract interpretation[25]. This is because each clause contained in Blockchain-based Smart Contracts can be interpreted as a 'codified contract' in which the principles of absoluteness, freedom of contract, and negligence, which guarantee ownership through the performance of the contract according to the principles of reliance and promissory estoppel, are converted into computer code. In 2019, the UK Jurisdiction Taskforce ("UKJT") published a legal statement on the status of crypto assets and smart contracts, providing the legal binding and stability needed for the commercialization of smart contracts in the services industry. On this basis, the Ministry of Justice emphasized that crypto-assets have all the legal status of property and should be treated as 'property' under English law, and, in particular, recognized that smart contracts satisfy the formal requirements of a contract under English law because they can be recorded in computerized, compatible code. Blockchain-based Smart Contracts can therefore be identified, interpreted, and enforced in accordance with legal principles, and both novel legal issues and factual scenarios, as well as existing legal principles, may apply to cryptographic assets and Smart Contracts. And ultimately, even for signature requirements on documents, they recognize that, in principle, such requirements can be met through the use of private cryptographic keys or smart contracts written into the source code. The UK Ministry of Justice, through the Law Commission, has an ongoing project to analyze the current law relating to crypto assets and smart contracts and to solicit opinions on what changes should be made, making the UK a leader in the global standardization of the legal framework for digital assets[26].

Similar to the UK's position, Korea acknowledges that blockchain-based smart contracts, regardless of their negotiated/expansive interpretation, are partly distinct from the concept of traditional contracts, but are still covered by the provisions of civil law regarding legal acts such as the purpose of the act, the subject of the act, the formation of the contract, the effect and performance of the contract, the issue of withdrawal of consent, and various contractual expressions of intent[27].

Second, there is a view that blockchain-based smart contracts are not contracts at all, but rather technology services, as they are a transformation of a piece of "code or computer program," given the nature of the contract, how it works, etc. From the perspective of technical services, Blockchain-based Smart Contracts are concentrated on the 'automatic execution' of contracts, so the fulfillment and completion of contracts are limited to the level of a process or a set

of rules for solving problems by a computer as a 'program' or 'code'[28]. To put this into perspective on the legal status of blockchain-based smart contracts, Sir Geoffrey Vos, a High Court judge who participated in the UK Jurisdictional Task Force ("UKJT"), defines a coded program as one that runs automatically without the intervention of the parties by programming the terms of a contract into a computer-readable form called "code"[29]. And in Korea, the Seoul High Court's ruling on September 23, 2020 (2020na2016462) supports the argument that encryption, Distributed Ledger Technology (DLT), and consensus mechanisms are systems in which unit element technologies are connected and automated, so that the parties to the contract do not need to rely on the law to perform or enforce the performance of contractual obligations, but are automatically executed based on the trust of the transaction. After all, despite the fact that blockchain-based smart contracts are programmed with "code" that allows contracting parties with equal legal knowledge and experience to understand and anticipate all possible consequences of their agreed-upon actions, there is a view that they still have the legal status of mere tools and do not serve as decisions that can alter the legal relations of individuals or entities in the sense of traditional contract law[30].

2.3 Theory of Smart Contract based on block chain 2.0

Blockchain is a distributed ledger technology in which information is stored and maintained by a network of parties without a centralized administrator. These technologies can be utilized to reduce costs and time in areas such as finance, trade, logistics, copyright, utilities, healthcare, real estate, and more in fields on land[31]. The application of blockchain-based smart contracts to shipbuilding contracts enables the creation of a network in which key transaction participants such as shipbuilders, shipowners, ship financiers, charterers, marine insurers, and classification societies can jointly store and manage information about the progress and outcome of the shipbuilding process without a centralized administrator, based on a distributed ledger with proven technical feasibility. Because blockchain 2.0 technology is based on the principle of "trustless execution" with no centralized administrator, it offers the advantages of transparent cost management, streamlined procedures, strict adherence to delivery quality, and no costs associated with technical security in commerce such as shipbuilding contracts, which are typical of B2B contracts[32]. For example, if block chain 2.0 technology is applied to the position of a shipbuilder who receives shipbuilding payments in a mile stone manner, as shown in Figure 2 below, the payment of shipbuilding payments for each key event, including steel cutting, keel laying, launching, yard trial, sea trial, and delivery, and the transaction information of related stakeholders can be interconnected in one block to ensure objectivity in the event of a dispute that delays delivery due to a problem in the middle of the process. Since the information stored in these linked blocks is managed jointly by each block and the shipbuilders, ship financiers, ship owners, shipbuilding insurers, charterers, classification societies, etc. participating in the block in the form of a linked list, it is relatively safe from the risk of cyber hacking and can be managed so that the project schedule is not delayed due to the wrong judgment of one party. Since the information stored in these linked blocks is jointly managed by each block and the shipbuilders, ship financiers, shipowners, ship insurers, charterers, classification societies, etc. participating in the block in the form of a linked list, it is relatively safe from the risk of cyber hacking and can be managed so that the project schedule is not delayed due to the misjudgment of any party. In particular, based on the four principles of smart contracts - Observability, Verifiability, Privacy, and Enforceability[33] - the shipowner will be able to store objectively completed information according to the shipbuilding stage as an agreed result value, not as a simple input value, so that information about the shipbuilding process is prevented from being falsified or altered during the process, ultimately protecting information between key stakeholders, and the shipowner's payment and rejection of shipbuilding payments will be bound based on the shipbuilder's strict shipbuilding quality control.

At the same time, the form of Blockchain-based Smart Contracts will be either permissioned, with appropriate arrangements to limit access to contract information, or privately held blockchains with sole control of ledger views and records. However, in order to conclude a contract that includes smart contract terms in a shipbuilding contract, unlike other forms of smart contracts, it is necessary to obtain approval from a third party, such as a Class for ship inspection. This is because the elimination of brokers, which is the purpose of blockchain-based smart contracts, can be realized by replacing the escrow account in shipbuilding contracts with blockchain-based smart contracts, but specialized personnel are still needed to check the stage inspection for shipbuilding. And as shown in Figure 3, Blockchain-based Smart Contracts are transacted for ready-made funds and ownership

when certain conditions are met, and product or service responsibility is required as a counterparty. In the case of shipbuilding contracts, the conditions of the transaction cannot be met by simply exchanging digital information, so it is necessary to verify the technical and physical completion through on-site verification. Considering this situation, the blockchain-based smart contract in the shipbuilding contract should not be divided into four or five stages according to the change of milestones, but should be divided into more detailed stages, and cross-verification should be performed through a third party with specialized technology and experience, and if the cross-verification sets a criterion that meets a certain level or higher, the transaction for continuous ready-made funds and ownership should proceed.

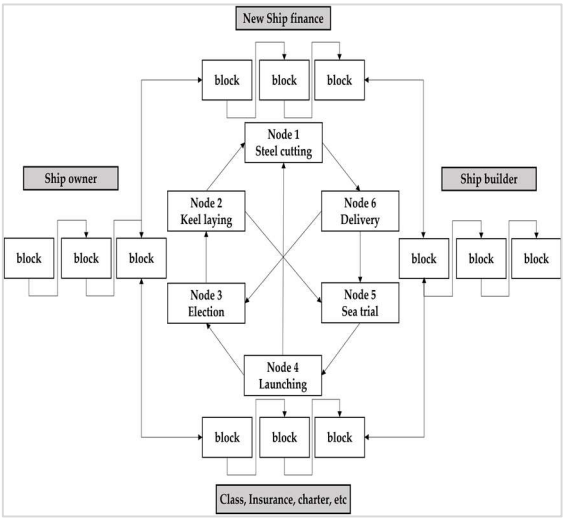
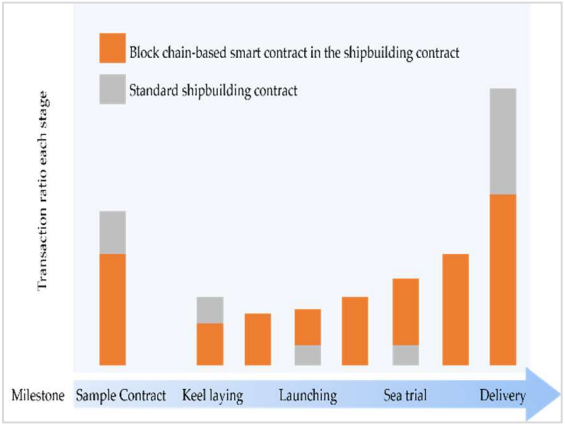


Figure 2. Application of distributed ledger technology to shipbuilding contracts

Figure 3. Comparison of transaction process each stage in Blockchain-based smart contract in the shipbuilding contract



2.4 Method for application and Architecture design in shipbuilding contract based on smart contract

When applying smart contracts to shipbuilding contracts, the automation of contract terms may extend to various legal issues beyond the scope of the code, such as system failure. Therefore, it is necessary for this study to compare and distinguish the legal status of smart contracts based on the theories, principles, and precedents of traditional contract law set forth in the common law of the United Kingdom and the civil law of Korea, as shown in Figure 4 below. And in view of preparing for the era of Transformation of Digital Technology, this study aims to derive from the research questions that the shipbuilding contract is different from the archetypal model of contract law in the United Kingdom and Korea due to the unjustified sharing of information between the shipowner and the shipbuilder, the asymmetry of supply and demand, and the difference in bargaining power between the parties. And as shown in Figure 5, this study assumes that the legal relationship caused by the contract is a complex continuous contract based on a shipbuilding contract block that verifies the transaction by node and binds it into a shipbuilding contract block, and based on the relationship contract theory[34] that the relationship between various parties participating in the contract has a great influence on the contract, we tried to analyze the legal status, object, scope of responsibility, and mechanism of smart contracts in relation to technological changes based on the multi-case analysis method.

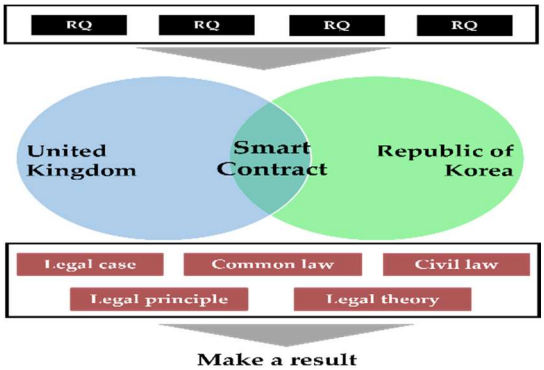


Figure 4. Research methodology as a comparative tool

3. LEGAL ISSUES FOR SMART CONTRACT RUNNING ON A BLOCKCHAIN 2.0

Due to the current shipping market, shipowners and shipbuilders are preferring financially favorable contractual arrangements and are managing risks through refund guarantees and escrow accounts to protect their respective ownership of the vessel during construction and their receivables for shipbuilding costs[35]. Therefore, when it comes to shipbuilding, shipbuilders and shipowners want to minimize the possibility of legal disputes related to the quality of the ship's completion, payment, and compliance with the schedule of the shipbuilding process from different perspectives, so it is necessary to approach the expected problems and solutions assuming the application of blockchain-based smart contracts to shipbuilding contracts as the most efficient future means to achieve common goals in completing such projects. In Chapter 3, we categorize the legal issues derived from the Needs Analysis method in Chapter 1 and try to find ways to improve them through legal interpretation based on the comparative tool of UK and Korean laws and precedents as shown in Figure 4.

3.1 Issue for Recognizing the legal status of shipbuilding contracts with blockchain-based smart contracts

A First, from a formal point of view, smart contracts apply blockchain 2.0 technology to execute the terms of the contract through a computer program that ensures automatic execution of the contract, so the first thing to discuss is the limitation that offers and acceptances are not materialized in the strict sense. The key to these restrictions is that smart contracts are governed by general contract law, which is based on the principlde that "contracts must be honored"[11]. After all, a shipbuilding contract with a blockchain-based smart contract is predicated on trust between the contracting parties, and there are of course differences in the impact of trust on the contract depending on the nature or content of the contract. The application of differences in the scope and terms of the contract between the shipowner and shipbuilder under a shipbuilding contract may depend on whether this is an area of the contract where smart contracts can be applied[7].

Second, from a content perspective, as the introduction of autonomous ships, smart logistics, and smart ports increases the demand for acceptance of the Relational Theory of Contract to reflect technological changes caused by the digital transformation, blockchain-based smart contracts are bound to be expanded and applied to the shipbuilding, shipping, and port sectors, and changes in existing laws and precedents should be considered at the same time[4]. In particular, shipbuilding contracts with smart contracts utilize blockchain 2.0 technology to reduce contractual disputes by predetermining payments and counter payments in a coded program, instead of traditionally exchanging stamped documents between the shipowner, shipbuilder, and classification society, so that a computer determines whether the conditions are met with objective, quantitative values and finally approves them. A shipbuilding contract with a blockchain-based smart contract is conditional on the quantification or objectification of the shipbuilding process between the shipowner and the shipbuilder, and as a typical international transaction, it is appropriate to apply a smart contract because the most important purpose and result of the contract is the delivery of the ship on the agreed date rather than the trust of the parties. This mechanism ensures that a traditional shipbuilding contract based on a two-way document delivery system between the shipowner and the shipbuilder and a future shipbuilding contract based on automatic exchange of coded programs are mutually equivalent in terms of legal effect.

According to English law, which is most often applied as the governing law for shipbuilding contracts, in order for a contract to be valid, there must be: first, the parties' agreement on the terms of the contract; second, the parties' intention to form a contract; third, the parties' capacity to act; and fourth, the consideration of the contract[12]. Therefore, a shipbuilding contract with a blockchain-based smart contract can be recognized as a normal contract strictly concluded through an agreement between the contracting parties, reflecting the intention to fulfill the specific conditions existing in the expression of the offer based on the coded program through the exchange of contracts[13]. Therefore, the convergence of these expressions is equivalent to the conditions for the formation of a contract referred to in Articles 527 to 532 of the Civil Code of Korea[36], and in particular, the legitimate expectations of the parties, i.e. their interests in the consummation of the contract, are protected when the contract is legally valid based on objective criteria and the obvious rule. Therefore, even when connected to the essential legal status and theory of smart contracts mentioned in Chapter 3, it is judged that smart contracts still have a traditional legal status because there is an agreement process of offer and acceptance like a traditional contract, and

the contract is completed by delivering the ship only when certain coded conditions are met.

3.2 Issue for Legal Risk Management in the Contract Formation Phase

In a shipbuilding contract with a smart contract based on blockchain 2.0, the offer and acceptance are programmed into a computer 'code' in the process of establishing the contract. In other words, the shipbuilder's acceptance of the shipowner's offer is completed simultaneously with the shipowner's acceptance of the shipbuilder's offer, thus eliminating the possibility of a dispute based on a breach of contract.

Nevertheless, as a shipbuilding contract with a smart contract based on blockchain 2.0 must be completed through the agreement of the shipowner and the shipbuilder, whether the objectified and quantified value of the millstone for each key event exists through the agreement of the mutual communication may become a key legal risk in the contract formation stage[9]. A shipbuilding contract with a smart contract based on blockchain 2.0 may have an error in the process of creating the smart contract code by the programmer, so if the core transaction parties, the shipowner and the shipbuilder, enter into a contract without recognizing it, it is a serious problem that the contract cannot be invalidated later, so a minimum safety device to solve the problem should be included as a condition[10]. For example, it is necessary to insert a kill button system that can immediately stop the transaction if the program code related to smart contracts based on blockchain 2.0 detects risks such as fraud or hacking by the other party and the need to stop or cancel the transaction arises[14]. In addition, if a ship contract with a smart contract based on blockchain 2.0 is operated against the will of both contracting parties, or if there are problems such as system design errors or incomplete fulfillment of the contract, it is redundant for the contracting parties to check the algorithm code, so it is necessary to consider transferring the risk through ship insurance rather than attributing the responsibility to the algorithm developer in this regard.

For example, in the process of programming standardized and documented shipbuilding contracts such as SAJ form, AWES form, MARAD form, and Newbuildcon into 'code' with customized conditions for each ship type, it may happen that the true intention of the legal representative of the contracting party and the intention of the software coding engineer are different, and the contract is built with different codes, and the risk of technical errors, bugs, cyber hacking, etc. may occur during the implementation process. Therefore, the contracting parties must prepare for the risk of legal disputes by notarizing the Certified True Copy between the program coding and the paper contract to publicly prove the existence of certain facts and legal relationships[8]. Nevertheless, in order to insure such risks in shipbuilding contracts with smart contracts based on blockchain 2.0, Hochster v De la Tour [1853] 118 E.R. 922 and Heyman v Darwins Ltd. [1942] A.C. 356, the doctrine of anticipatory breach of contract under the English Contract Act and the 'Termination' clause under the Korean Civil Act, which encompasses rescission and termination, can be inserted as a condition to allow either party to express its intention to repudiate during the course of the contract after the shipbuilding contract has been concluded[19]. Therefore, if the other party accepts, the other party should immediately be released from any future obligations and terminate the contract, and additionally claim damages for breach of contract.

3.3 Issue for Legal Risk Management in the Post-Contract Maintenance Phase

In general, shipbuilding contracts are paid by the top heavy method with a high proportion of advance payment, the milestone method with four to five installments for each stage of the process, and the heavy tail method with a high proportion of the balance at the delivery stage after the ship is built[18]. If the shipowner's payment to the contractor for the completion of the object under the shipbuilding contract is not properly fulfilled, the shipbuilder may attempt to recover the debt through court proceedings or arbitration to eliminate the risk of various legal disputes arising during the post-construction maintenance phase[37]. However, in the case of shipbuilding contracts with smart contracts based on blockchain 2.0, in terms of contractual effectiveness, which is the automation of performance, contractual claims are automatically fulfilled when quantified results for each major event based on the agreement between the contracting parties are met, so in theory there is no problem with payment, and even claims for extension of the shipbuilding period due to changes in the contract, calculation of the grace period, and settlement of damages for breach of contract can be automatically settled[17]. After all, due to the algorithmic nature of smart contracts, they are automatically executed according to predetermined rules, and in ship building, the issue of liability becomes very important if a transaction is made against the will of the other party. This is a question of attribution of responsibility in smart contracts, but also a question

of risk allocation. For example, assuming the construction of an LNG ship or LNG fueled ship which takes about 39 months from order to delivery, if a shipbuilding contract is signed with a smart contract based on blockchain 2.0, the validity and execution of the contract between the shipbuilder and the shipowner are automated, forming a stable contract system, and the risk of contract default is reduced because the contract is designed to be automatically executed at the same time as the contract is validated[16]. However, if the automation is contingent on the completion of contractual terms, there is a risk of legal disputes over a party's default and collateral liability after delivery. The implications of the cases of Chilean Nitrate Sales Corp. v Marine Transportation Co. [1982] 1 Lloyd's Rep. 570 and SK Shipping (S) PTE Ltd. v Petroexport Ltd [2009] EWHC 2974 (Comm) are that, in order to objectively determine whether a party has expressed an intention to repudiate, when applying a shipbuilding contract with a smart contract based on Blockchain 2.0, the debtor must completely refuse to perform its contractual obligations and express a clear opposite intention. However, there are limitations to making clear, unambiguous, and definitive statements through programming with 'code'. Shipbuilding contracts with smart contracts can systematically enable automatic enforcement of the law for the realization of rights, minimizing uncertainty about the interpretation of contracts by stakeholders such as shipowners and shipbuilders during the whole contract process and reducing the risk of contract breakage, thereby securing the reliability and transparency of contract processing and securing overall contract stability[15]. Nevertheless, in order to resolve these contractual issues, it is necessary to list the cases of repudiation in the automatic performance conditions of the contractual obligation so that a certain behavior is externally manifested, and to set aside a separate down payment to fulfill the contract but settle damages in the form of a loss reserve.

3.4 Post-delivery legal risk management issues

Shipyards have a product liability obligation to ensure that the vessel built under the contract is of satisfactory quality. For example, under sections 12 and 14 of the Sale and Supply of Goods Act 1979 and 1994 in the United Kingdom, respectively, shipyards are liable for express and implied warranties. However, for defects or damages that occur after the shipbuilder has properly delivered the ship, the shipowner must manage the legal risk to the extent that causation is recognized[38]. In addition, according to Article 7, Paragraph 1 of the Product Liability Act of Korea, the right to claim damages under the Product Liability Act is time-barred if the victim or his/her legal representative does not exercise the right for three years from the date of discovery of the damages and the person responsible for the damages, and the right to claim damages must be recognized within 10 years from the date of delivery to the consumer[39]. As confirmed in Wilson v Beko [2019] EWHC 3362 (QB), English law, s.2(1) of the Consumer Protection Act 1987 (CPA), requires that a longstop limitation clause be limited to 10 years. In general, the shipbuilder is responsible for the product liability for defective materials, bad workmanship, faulty erection, etc. during the warranty period after delivery of the ship, and is not responsible for defects occurring after the end of the warranty period. In practice, shipbuilders are minimizing their post-warranty liability by limiting the limitation period clause in shipbuilding contracts to 10 years and limiting their liability to direct and indirect damages caused by defects[40].

Therefore, it is necessary for shipbuilders to prepare deposit money in the form of bad debt provision for the period and utilize it to settle various expenses because the warranty period for damages caused by discrepancies with the automation conditions implemented in advance is usually about one year after the delivery of the ship[41]. It is also worth noting that "property damage caused solely by a product" includes not only property damage caused by the product itself, but also damage caused by business loss due to a defect in the product, so such damage is not covered by the Product Liability Act. In particular, it would be unfair to hold a shipbuilder liable for errors that cannot be predicted with current technology outside of the conditions contained in the smart contract.

4. DISCUSSION

Through the analysis of the exploring results reviewed in Chapter 3, the authors presented the architecture in terms of conceptual aspects related to the completion of the contract as shown in Figure 5, and proposed an improvement by illustrating that the algorithm according to the flowchart can be applied to the smart contract so that the payment proceeds with the verification completed in the manner of the multi-signature wallet participating in the oracle on the off-chain as shown in Figure 6. As shown in Table 3, the study identified a rationale for defining blockchain-based smart contracts in shipbuilding contracts as "the embedding of contractual provisions agreed upon by the contracting parties into hardware or software by

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programming written contractual provisions into computer 'code' to be automatically enforced in the event of a breach of contract or control of assets."

In addition, it has been confirmed that blockchain-based smart contracts in shipbuilding contracts have the advantage of realizing institutional transparency and legal stability at the same time, as they can be interpreted and resolved as legal contracts in the traditional sense while embracing the Transformation of Digital Technology method of relational contract theory.

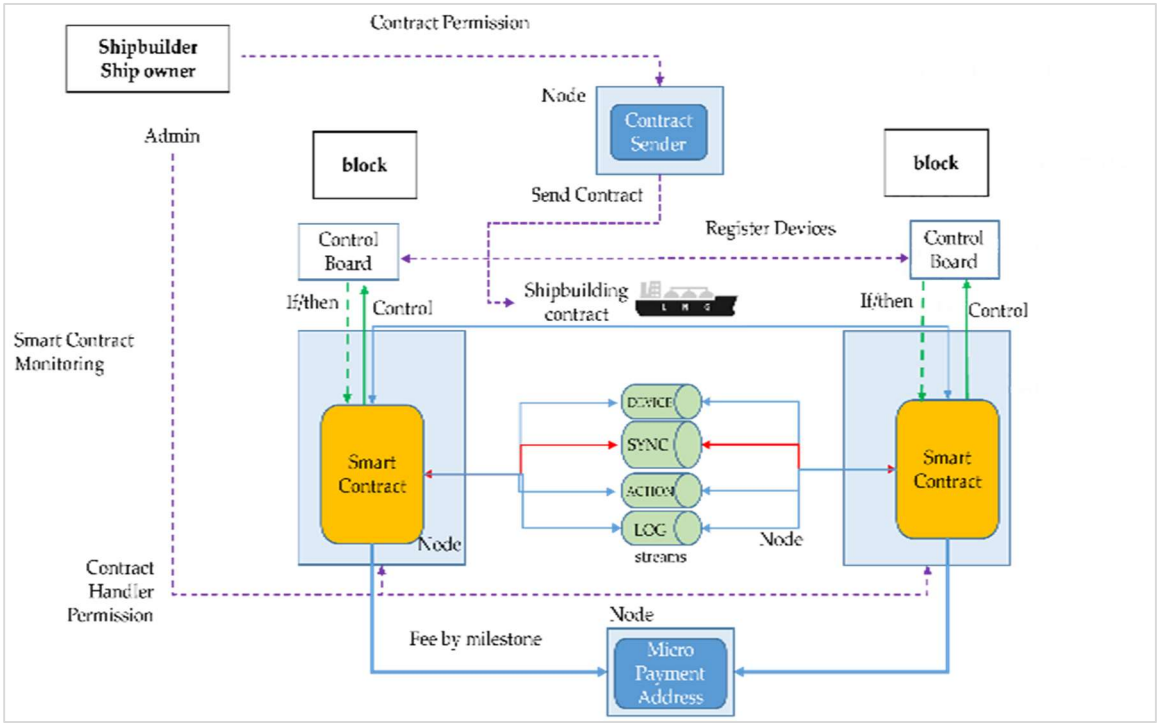

Figure 5. Architecture For Blockchain-Based Smart Contract In The Shipbuilding Contract

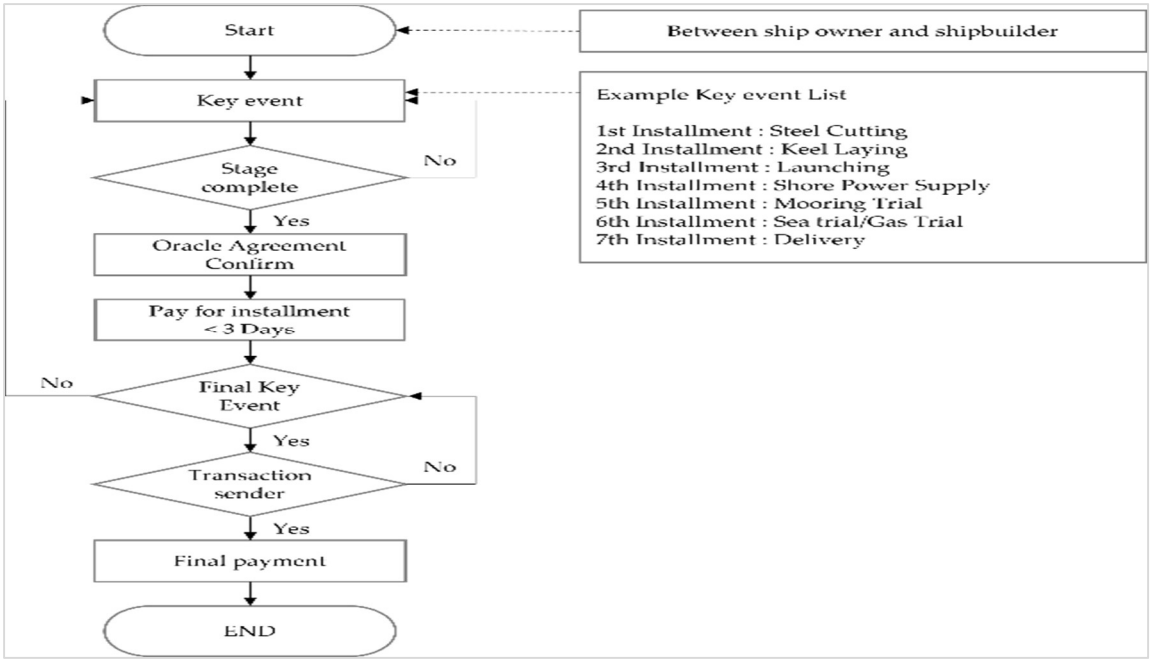

Figure 6. Algorithm Applying Pseudo Code As Payment Condition For Blockchain-Based Smart Contract In The Shipbuilding Contract

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In order to improve the blockchain-based smart contract in the shipbuilding contract to reflect the basic principles of contract law, we suggest the following key contribution directions.

First, if blockchain-based smart contracts are commercialized for shipbuilding contracts, the scope of related services will be expanded to pre- and post-operational business processing covering related contract contents such as fund transfers between stakeholders such as shipbuilders and shipowners, and business-to-business (B2B) [1] ***** contracts based on automatic execution of smart contracts between trading parties will develop into a safe and transparent system, contributing to more diverse ship financing. In particular, in shipbuilding contracts, blockchain-based smart contracts are very stable because they are designed to suspend the provision of counter payments that must be maintained because they are bilateral contracts with a bond relationship between the shipowner and the shipbuilder, and high shipbuilding quality can be maintained by suspending the counter payment of the contracting party against the contracting party that violates the payment.

Secondly, shipowners can protect their intellectual property rights and contribute to limiting piracy by clearly distinguishing ownership of intellectual property rights in relation to data generated from 'pre-construction', 'under-construction' and 'completed ships' between the shipbuilder, shipowner and ship financier. In particular, the contractual terms between the shipowner and the ship financier and the shipbuilder and the shipowner can be programmed directly, as needed, by viewing the linked list on the blockchain as a mass node, exchanging all assets transparently, and recognizing the final delivered vessel as an asset and how it is operated or traded as appropriate.

Third, with blockchain-based smart contracts, even if the two key parties to a shipbuilding contract, the shipbuilder and the shipowner, do not know each other, the automation of contract execution will allow them to trust each other without the need for traditional procedures such as money-back guarantees and escrow account opening. In particular, if the blockchain-based smart contract in the shipbuilding contract is activated, it is possible to prevent unnecessary expenses incurred by using an escrow account. Eventually, algorithms and self-executing logical calculation programs that generate predefined outputs when certain digitized inputs are met will be extended to shipbuilding contracts as blockchain-based smart contracts, providing objective and transparent assurance to

Table 3. Algorithm code

```
address ship_builder
address ship_owner
address oracle
array payment_plan
bool finish
int total_installment
int next_payment_deadline
int current_stage
int payment_finish_stage

FUNCTION initialize(installment_, payment_plan_) {
   IF sum of payment_plan_ is 100
      payment_plan = payment_plan_

   total_installment = installment_
   finish = false
   payment_finish_stage = 0
   current_stage = 0
}

FUNCTION builder_agreement() {
            ship_builder = transaction sender
}

FUNCTION owner_agreement() {
            ship_owner = transaction sender
}

FUNCTION oracle_agreement() {
   oracle = transaction sender
}


FUNCTION stage_complete(stage) {
   IF finish is true

return
   CHECK transaction sender is oracle
   next_payment_deadline = current time + 3 day
   current_stage = stage
}

FUNCTION payment(stage) {
   IF finish is true
      return
   CHECK transaction sender is buyer
   IF current_stage is stage
      IF next_payment_deadline >= current time
         next_payment_deadline = 0xFFFFFFFFFFFFFFFF

SEND (total_installment * payment_plan[stage]) / 100 to
ship_builder
      ELSE
         finish = true
         return
   ELSE return
}

FUNCTION set_finish() {
   CHECK transaction sender is oracle or ship_builder
   IF next_payment_deadline <= current time
      finish = true
}
```

shipowners, shipbuilders and other stakeholders of the completion, execution and performance of the contract. As the trust at the heart of a blockchain-based smart contract in the shipbuilding contract compensates for the lack of individual trust in the other party, it can provide new opportunities for the shipbuilding market to enter into contractual relationships with previously unknown shipowners without the need for intermediary brokers. Nevertheless, the core of blockchain-based smart contracts in shipbuilding contracts is to develop appropriate measures according to technological changes, along with the theory of legal interpretation based on relational contract theory, to overcome the limitations that require further supplementation and completion as a contract with legal status. This is because the purpose of the law is to provide legal stability and predictability, and various risks may arise in the process of implementing technical standardization ahead of the rapidly changing technology in the shipbuilding and shipping industry. Therefore, in order to ensure that contractual obligations are fulfilled and legally binding in the rapidly changing shipbuilding and shipping industry, and that basic contractual rights, obligations or conditions are remembered and automatically enforced, I propose that BIMCO(The Baltic And International Maritime Conference) and IMO(International Maritime Organization) form a Working Group to develop a blockchain-based smart contract standard for shipbuilding contracts in consultation with key stakeholders such as shipowners, shipyards, classification societies, insurers and ship financiers, with a future focus on ISO/TC 307 (Blockchain and distributed ledger technologies).

5. CONCLUSION

This paper suggests the concept of smart contracts based on blockchain 2.0 technology in shipbuilding contracts, where frequent disputes arise. Since this contract is algorithmized into a blockchain by the two parties agreeing in advance, it can be operated by being protected from conflict or disputes between the two parties during the contract. With the expectation that blockchain-based smart contracts can be applied to shipbuilding contracts, this study starts from the essential research question of the legal status of contracts and analyses the laws, precedents, legal theories, and principles of the UK and Korea based on the multi-case comparative theory, focusing on the main legal issues, and summarizes them as follows. First, we blockchain-based smart contracts for shipbuilding payment is a concept that applies blockchain technology to existing document clauses to maximize safety by proving identity according to an agreed algorithm between the shipowner and shipbuilder. Second, the Blockchain-based smart contract in the shipbuilding contract is a coded program for automatically implementing key events agreed upon in the shipbuilding process. Therefore, it is a type of substantial contract that exists in the expression of an offer and a type of transaction that reflects the intention to fulfill certain conditions and can be recognized as a normal contract strictly concluded by the exchange of consideration through the agreement of the other party's consent to fulfill the conditions. Third, since the blockchain-based smart contract in the shipbuilding is based on the automatic execution of the contract entered in advance as a code, there is less room for defects in the process of establishing the contract to expand into legal issues, but in the event of contractual defects, the contracting parties must prepare for the risk of legal disputes by notarizing the Certified True Copy between the program coding and the paper contract to publicly prove the existence of specific facts and legal relations. Fourth, to resolve contractual issues, it is necessary to enumerate the cases of automatically executed conditional refusal to perform as a condition of the program. Fifth, the scope of application of smart contracts should be limited to objects that can be codified (codifiability), and the nature and content of the contract should be quantifiable. Therefore, it is unreasonable to hold the shipbuilder responsible for errors that are not predictable with the current technology, so it is necessary to limit the longstop limitation clause in the shipbuilding contract to 10 years about the warranty period after the ship is built, and to limit the scope so that the shipbuilder is not liable for direct or indirect damages caused by defects so that the shipbuilder's liability after the warranty period is minimized. Although this study has the limitation of applying the algorithm only to the payment terms of shipbuilding contracts and cannot be applied to the entire contract terms, it is meaningful in that it examines the legal issues that can be expected from a legal perspective. Based on this, this study will prepare for the possibility that transactions through smart contracts will be activated in a short time and contribute as a basis for uniform regulations on related matters. And in the future, ISO/TC 307 will take center stage, and BIMCO and IMO will consult with major organizations such as shipping, shipbuilding, classification, and insurers to ensure that the fulfillment of contractual obligations in the

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rapidly changing shipbuilding and shipping industry can be legally binding, so I would like to expand the research necessary to develop The standard for Blockchain-based smart contract in the shipbuilding contract.

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