

Logical Structure of Contract Law System – For Constructing a Knowledge Base of the United Nations Convention on Contracts for the International Sale of Goods –

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In order to construct a deductive legal knowledge base, it is necessary first to clarify the structure of the law as a deductive system from which a legal judgement can be justified as a conclusion of logical deduction together with relevant facts. As the legal state of affairs changes according to the time progress of an event, a clarified logical model of law is necessary to enable us to deduce changes among legal relationships over time from the beginning to the end of a case. This study presents such a model based on Logical Jurisprudence, in which the relationship between legal sentences and the legal meta sentences regulating the validity of legal sentences plays a definitive role. The model is applied to the United Nations Convention on Contracts for the International Sale of Goods (CISG) to develop a deductive knowledge base. The deductive structure of the contract law is clarified so that appropriate answers are deduced to questions about legal state of affairs at any time point as a results of the application of CISG provisions to a concrete case.

Keywords: Contract, CISG, Expert system, AI, Legal knowledge, Logical structure

1. Introduction

In the “Legal Expert” Project, we have developed a knowledge base of the United Nations Convention on Contracts for the International Sale of Goods (CISG). For a legal knowledge base of the CISG, it has been necessary for us first to clarify the logical structure of the contract law system as a whole because, to show (justify) a legal judgement as a conclusion of logical deduction from a legal system of the CISG, together with a given fact by means of a legal expert system, we must make a deductive knowledge base of the CISG and, for such construction, we must to have a clear logical model of the contract law system to which the CISG belongs and upon which it is based, thus making it possible to justify the judgement as a result of logical deduction.

The legal state of affairs, which refers to the status of legal relations, changes according to time progress of an

event. We therefore must clarify such a logical model of law that enables us to deduce changes of legal relation according to time, regardless of any time point in given events from the beginning to the end: for example, before or after the contract conclusion; before or after fulfillment or non-fulfillment of an obligation on contract; before or after remedies for breach of contract; before or after cancellation of a contract; before or after fulfillment or non-fulfillment of restitution, and so on. The present work contributes to this clarification.

The systematization of law, i.e., to present the law as a deductive system, has long been a central theme of legal theories, but remains illusive.¹ Modern mathematical logic and the construction of a knowledge base system of law gives us the opportunity to systematize this properly, succinctly and explicitly and demonstrate that the proposed systematization is correct.

I believe we have already clarified the logical structure of the contract law system in the above sense and have developed a knowledge base that demonstrates it appropriately. Our aim is to present the essence of that clarification of the logical structure of contract law system by focusing on the United Nations Convention on Contracts for the International Sale of Goods (CISG).

The study is based on Logical Jurisprudence. This paper demonstrates the basic structure of law from the point of Logical Jurisprudence. In accordance with such a framework, this study clarifies and demonstrates the structure of contract law as a deductive system from which a legal decision may be justified as a logical deduction when the CISG is applied to a concrete case. This report considers the relationship between legal sentences and legal meta sentences that provide the validity of legal sentences as the starting point for legal knowledge analysis and modeling. From this point, a deductive model of the contract law system is presented and applied to the CISG. The legitimacy of the model is demonstrated in an example of the CISG application to a concrete case.

¹ The systematization of law has been endeavored especially in continental law countries. Scholars of modern natural law, such as H. Grotius, S. F. v. Pufendorf, and B. de. Spinoza have tried to present the natural law system as a deductive system such as geometry. Legal scholars of general theory of law in Germany, such as F. R. Bierling and K. Bergbohm, have tried to explicate positive law as a deductive system. From a strictly logical point of view, however, they did not succeed in presenting a legal system as deductive. Cf. Ref.9).

2. Logical Jurisprudence

Logical Jurisprudence ("ronri hogaku" "Logishe Rechtslehre") is a legal theoretically developed form of a discipline in Jurisprudence that we call "legal logic" or "Juristische Logik."

Logical Jurisprudence tries to constitute the world of legal discourse in terms of smallest unit of primitives. It starts from three primitives: "sentence," "validity" of sentence, and "inference rule." Logical Jurisprudence attempts to explain or model the law using these three notions.

Logical Jurisprudence does not support in the existence of "legal norms as a meaning," which has traditionally been admitted or presupposed in legal studies and praxis. Logical Jurisprudence presupposes the notion "**sentence**." Sentences exist, as a form of written or spoken sign, cognizable or perceptible and therefore communicable. In our opinion, legal norms as a meaning belong to the world of images. It is what is imagined when legal sentences are thought of. To communicate images to other persons, they must be put them into sentential form perceptible by others. Logical Jurisprudence considers sentences in the field of law as the direct and sound object of legal recognition. The second basic conception in Logical Jurisprudence is "**validity**" of a legal sentence. The validity of a legal sentence is viewed by Logical Jurisprudence as a "truth in the logical sense." That a legal sentence is valid means that the sentence is true in the world of legal discourse, i.e., legally true. Logical Jurisprudence represents this legal truth by means of a predicate (e.g., "is_valid(sentence1, goal1, time1)," which could be read as follows: "a sentence1 is valid for a goal1 at time1." The representation of the validity concept by a predicate is characteristic of the knowledge representation of Logical Jurisprudence that corresponds to the natural language representation of knowledge in the real legal world.

The third basic concept in Logical Jurisprudence is the "**inference rule**." The logical correct reasoning is based on inference rules. The main inference rule is *Modus Ponens* which is represented in the following schema where A and B express propositions:

$$(A \rightarrow B), A \Rightarrow B$$

This formula is read: If 'if A then B' is true and A is true, then follows: B is true. *Modus Ponens* is the basic reasoning schema legal justification, as discussed later.

In Logical Jurisprudence, legal reasoning is a process of the development of legal sentences. In other words, legal sentences are developed in the process of legal reasoning.

Logical Jurisprudence divides legal reasoning into reasoning of justification and reasoning of discovery. **Reasoning of legal justification** is reasoning through which a judgement is justified from already justified legal knowledge. Logical deduction is type of reasoning in legal justification. The logical structure of this reasoning is *Modus Ponens*. judgement may not be deduced from statutes and facts alone, but may be shown to be deduced from the whole

body of legal knowledge, including statutes, facts, and additional legal sentences to the former as implicit legal common sense or as a result of the reasoning of legal discovery. Logical Jurisprudence makes this implicit or discovered knowledge clear and identifies it to make it explicit. Following are such additional legal sentences: principles of law that unify statutory legal sentences; common sense about legal terms, especially hierarchical relations between legal concepts; and the proposition of interpretation of statutes that are produced by the reasoning of legal discovery. Logical Jurisprudence analyzes legal knowledge in detail, recognizes and demonstrates the implicit knowledge of legal experts, and legal sentences created by the reasoning of legal discovery, such that the reasoning of legal justification is formed as logical deduction.

Reasoning of legal discovery is reasoning through which judgements themselves or additional legal sentences are discovered or created. This reasoning is based on logical deduction because discovered legal sentences are to be set so that the whole reasoning process including these additional sentences can be presented as a logical deduction on the one hand and the reasoning of discovery is to be performed through a falsification inference on the other. Falsification has the logical structure of *Modus Tollens*:

$$(A \Rightarrow B), \neg B \Rightarrow \neg A$$

This formula is read as follows. If 'if one sets a hypothesis A (together with theorems accepted already) then B follows' and it is proven that B is not true, then it follows that hypothesis A is not true. (The legal hypothesis cannot be proven as just but only falsified as unjust.)

The reasoning of legal discovery, however, requires something more than deduction. To get hypothesis A in the schema above, abductive or inductive reasoning are needed. Reasoning to get a hypothetical fact sentence is abduction and reasoning to generate a rule is induction. Logical Jurisprudence analyzes the legal reasoning process in two directions: (1) concretization (putting in concrete terms) and (2) systematization. This is also true for legal reasoning of discovery. The study of legal interpretation or analogy is important to concretization. In systematization, it is important to make legal principle sentences clear which will enable as to bring mere collections of legal sentences into a system, on the one hand, and to analyze how legal principle sentences are to be found as hypotheses, on the other.

The structure of legal reasoning in the application of law, where both reasoning of justification and discovery interact to a concrete case is shown in Fig.1.

The study of legal discovery reasoning is important to the theory of legal reasoning, both in concretization (Cf. Ref.15)) and systematization.⁷⁾ Few engineers, however, study legal knowledge systematization itself, i.e., showing laws as a deductive system. This is: because engineers assume that a theory of science has a deductive system, they are not interested in finding the deductive structure of law and, furthermore, legal knowledge is too specialized and complicated for engineers to deduce the structure. To construct a legal expert system, however, the deductive struc-

2 The difference between conventional and legal sentences and how these differ is discussed in section 5.2.1.

3 We proved the quasi-deductive structure of such legal (theoretical) systems in modern mathematical logic and clarified the logical structure of reasoning of legal discovery as an falsification inference to reasoning of justice through which one gets more just legal rules, applying K. Popper's Theory of Falsification.⁹⁾ We applied this result to analyze the logical structure of legal decision, where judges get a certain legal decision reasoning, as falsification inference of *Modus Tollens*.¹⁰⁾

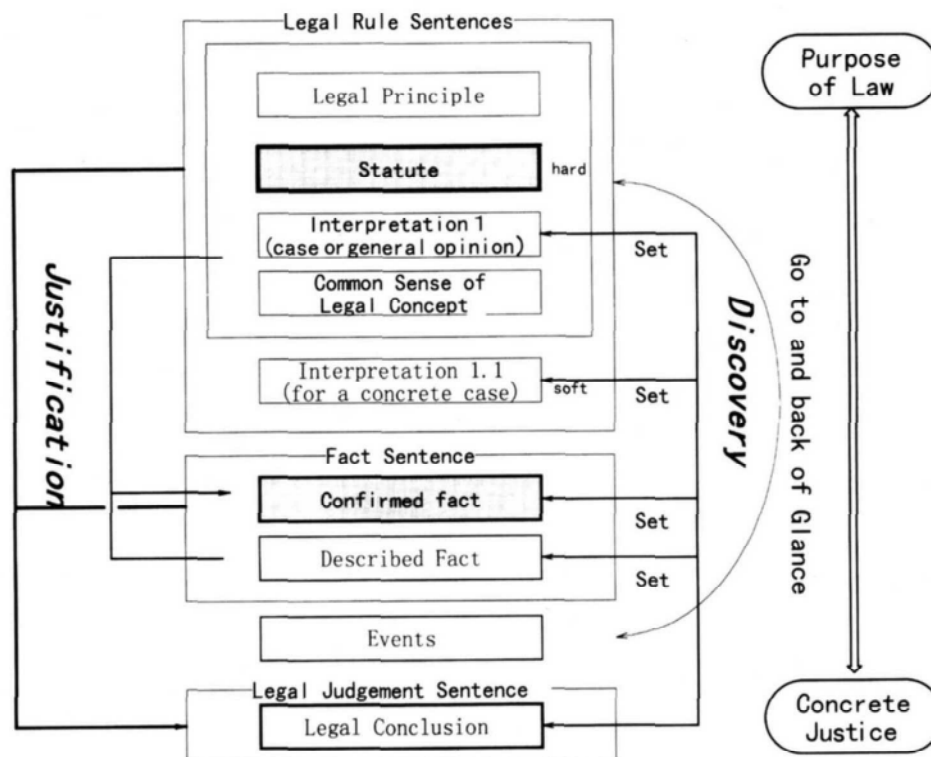


Fig. 1. Legal Reasoning Structure.

ture of law must be clarified to make a deductive knowledge base. It has long been desired in legal studies to clarify the deductive system of law and to systematize legal knowledge.⁴ We focus on how to systematize the law of contracts as a logical deductive system,⁴ leaving the reasoning of legal discovery in CISG to another time.⁵

3. Basic Concepts and Structures of Legal Sentences

Sentences in the legal field, referred to here as **legal sentences**, are starting points. We introduce basic legal sentence concepts, according to which legal sentences are classified so that laws can be systematized as a deductive system of legal sentences.

First, it is important to distinguish between legal rule and fact sentences. Legal sentences consist of two types: **Legal rule sentences** have the following syntactic form: " $\forall X\{a(X) \leftarrow b(X)\}$." This formula is read: "For all X, X is a, if X is b." In legal sentences, the consequence of the sentence, which is the formula at left in the implication, is called a "legal consequence" and the antecedent, which is the formula at right, is called a "legal requirement." **Legal fact sentences** have the following syntactic form: " $b(x1)$," read: " $x1$ is b." Note that the difference between legal rule and fact sentences is, in Logical Jurisprudence, purely syntactic, as mentioned above.

Second, legal sentences are to be further classified in

terms of elementary and complex legal sentences. An **elementary legal sentence** is the smallest unit of legal sentences. Statutes or contracts are composed of elementary legal sentences, e.g., "one must drive a car under 100 km /hour on a highway" or "A may require B to pay the price of \$10000." A **complex legal sentence** is a group of legal sentences, e.g., "the United Nations Convention on Contracts for the International Sale of Goods," or "a contract for sale of a farming machine between A and B on October 8, 1997." Code and parts or sections or an article of a statute is a complex legal sentence. In most cases, the fact that a certain legal sentence belongs to a complex legal sentence is represented by the place and space where they are printed. The relationship is represented in Logical Jurisprudence by a sentence describing the united relationship of grouped sentences. The concept of a complex legal sentence enables us to treat the validity of legal sentences at once. Namely, if one has described the validity of a complex legal sentence, then all legal sentences that belong to it have been regulated. The advantage of the complex legal sentence is that it contributes to producing economical description.

It is also important for the deductive systematization of legal knowledge to distinguish between legal *object sentences* and legal *meta sentences*. A **legal object sentence** describes the object itself. In the legal domain, the object is an "obligation." Legal object sentences prescribe the obligations of a person. The sentence "one must drive a car under 100 km /hour on a highway" or "B must pay A the price of \$10,000" is a legal object sentence. A **legal meta sentence** prescribes legal sentences. More precisely, it de-

⁴ Interesting books on law and legal reasoning modeling have been published.^{2,5,6)} Our study developed independently of them. Our approach is different from Kralingen's approach, for example, in that it is not conceptual or frame-based, but purely logical, especially in that we analyze and reconstruct the law intensively in "legal sentences," "their validity," and "logical deduction."

⁵ We have already done this to a certain extent, i.e., Ref.15).

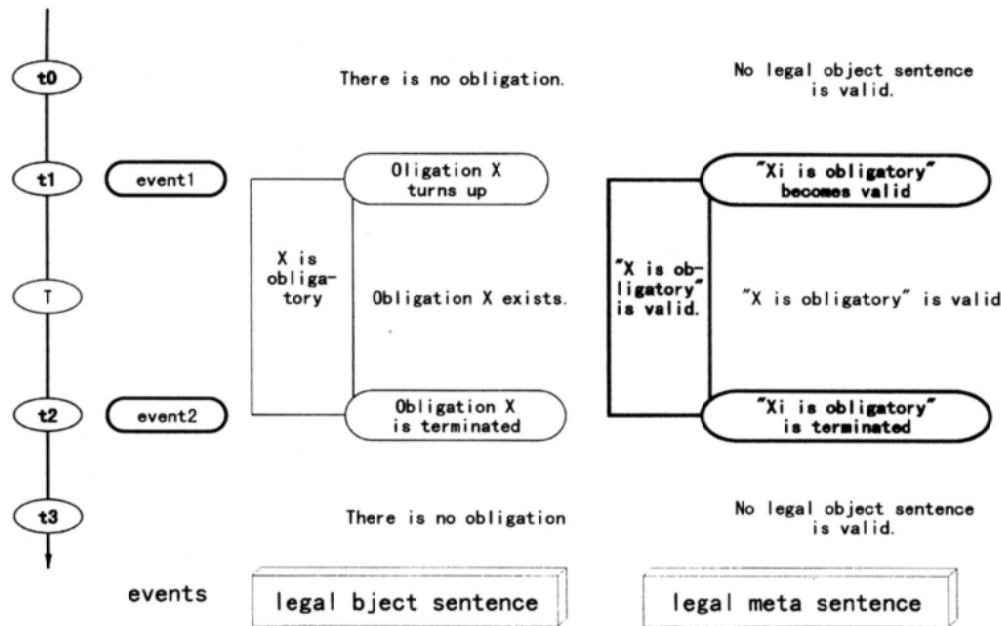


Fig. 2. Existence of Obligation and Validity of a Legal Sentence.

scribes the validity of a legal sentence. Some legal meta sentences describe the validity of legal meta sentences. An example of a legal meta sentence is: "A law is enforced 20 days after the day of its promulgation" (Article 1 of the law governing the application of laws (HOUREI)) or "(1) This Convention applies to contracts of the sale of goods between parties whose places of business are in different states: (a) when states are contracting states; or ... " (Article 1 of the CISG).

Law ultimately prescribes the obligation of persons. In other words, people's conduct is ultimately regulated by obligations given them by law. What legal obligations exist depend on the legal sentences that describe obligations, or more precisely, on the validity of legal object sentences. The validity of legal object sentences is prescribed by legal meta sentences. In Logical Jurisprudence, the existence of A's obligation to do Z means that "A has an obligation to do Z" or "It is obligatory for A to do Z" is valid. The relation of the existence of an obligation and the validity of a legal object sentence describing the obligation are shown in Fig.2.

The validity of legal meta sentences that prescribe legal object sentences is prescribed by other legal meta sentences. A legal meta sentence that prescribes the validity of a legal meta sentence is called a higher or upper level legal meta sentence. The validity of each legal meta sentence is prescribed by a higher level of legal meta sentences. The highest, final level of legal meta sentence is called a "basic" or "fundamental" legal sentence. The validity of the final, highest legal meta sentence is set as fact.⁶

In legal sentences describing rights, note that they are not legal object sentences, which describe obligations. They do not belong to an object level of legal language but to a meta level. Logical Jurisprudence takes sentences that describe rights as a legal meta rule sentence, which make it possible to set forth a new legal object rule. This is discussed later.

4. Case and Solution

This section describe an example of CISG and questions on the example, and introduces legal solutions to questions so that the deductive knowledge structure of contract law by which solutions may be deduced are clarified.

[Case7h]

- (1) On April 3, 1997 A, a farming machine maker in New York sent a letter to the branch office in Hamburg of B, a Japanese trading company. The letter indicated that A was to sell B a set of farming machines for \$50,000, and that A was to deliver the machine to B by May 10 and that B was to pay the price to A by May 20.
- (2) On April 8, the letter reached B, the branch office in Hamburg.
- (3) On April 9, B made a telephone call to A. "The offer is accepted." Then, B said to A, "I would like to withdraw my offer."
- (4) On May 1, A finally handed the farming machine over to a Japanese container ship at the port of New York.
- (5) On May 31, the machine was delivered to the branch office in Hamburg.
- (6) On June 5, B examined the machine.
- (7) On May 10, B paid the price of \$50,000 to A.
- (8) On August 10, the machine proved to out of order because of a faulty connection gear. B immediately notified A specifying the nature of the problem.
- (9) On September 1, B asked A to repair the problem within one month. A did not repair it until October 1.
- (10) On October 10, B declared the contract void.
- (11) On December 10, A recovered damages and B restituted the machine delivered by A.
- (12) On December 20, A estitute the price paid by B.

⁶ Ref.4), p.109, proposed the concept of "basic norm." Note that my basic legal rule sentence does not always coincide with Kelsen's concept. They differ in that Kelsen starts on legal norms as a meaning, while I start on legal rule sentences; Kelsen's basic norm is conceived of as a norm that gives the ground of the validity of constitution or convention as a given positive law, while my theory presents both such a basic legal rule sentence and fundamental rules always applied where the validity of a legal sentence is to be decided. This has become the case of our logical analysis of legal systems and legal reasoning.

The following questions are set as examples:

[Question]

At each of the points in time below, what is the legal relation between A and B?

- 1: April 5
- 2: April 15
- 3: May 5
- 4: August 15
- 5: September 15
- 6: October 5
- 7: November 15
- 8: December 15
- 9: December 25

The following CISG articles apply:

Article 15

- (1) An offer becomes effective when it reaches the offeree.
- (2) An offer, even if it is irrevocable, may be withdrawn if the withdrawal reaches the offeree before or at the same time as the offer.

Article 16

- (1) Until a contract is concluded an offer may be revoked if the revocation reaches the offeree before he has dispatched an acceptance.

Article 18

- (2) An acceptance of an offer becomes effective at the moment the indication of assent reaches the offeror.

Article 23

A contract is concluded at the moment an acceptance of an offer becomes effective in accordance with the provisions of this Convention.

Article 31

If the seller is not bound to deliver the goods at any other particular place, his obligation to deliver consists:

- (a) if the contract of sale involves carriage of the goods - in handing the goods over to the first carrier for transmission to the buyer;

Article 38

- (1) The buyer must examine the goods, or cause them to be examined, within as short a period as is practicable in the circumstances.

Article 39

- (1) The buyer loses the right to rely on a lack of conformity of the goods if he does not give notice to the seller specifying the nature of the lack of conformity within a reasonable time after he has discovered it or ought to have discovered it.

Article 45

- (1) If the seller fails to perform any of his obligations under the contract or this Convention, the buyer may:
 - (a) exercise the rights provided in articles 46 to 52;
 - (b) claim damages as provided in articles 74 to 77.
- (2) The buyer is not deprived of any right he may have to claim damages by exercising his right to other remedies.

Article 46

- (1) The buyer may require performance by the seller of his obligations unless the buyer has resorted to a remedy which is inconsistent with this requirement.
- (2) If the goods do not conform with the contract, the buyer may require delivery of substitute goods only if the lack of conformity constitutes a fundamental breach of contract and a request for substitute goods is made either in conjunction with notice given under article 39 or within a reasonable time thereafter.
- (3) If the goods do not conform with the contract, the buyer may require the seller to remedy the lack of conformity by repair, unless this is unreasonable having regard to all the circumstances. A request for repair must be made either in conjunction with notice given under article 39 or within a reasonable time thereafter.

Article 47

- (1) The buyer may fix an additional period of reasonable length for performance by the seller of obligations.

Article 49

- (1) The buyer may declare the contract avoided:
 - (a) if the failure by the seller to perform any of his obligations under the contract or this Convention amounts to a fundamental breach of contract; or
 - (b) in case of non-delivery, if the seller does not deliver the goods within the additional period of time fixed by the buyer in accordance with paragraph (1) of article 47 or declares that he will not deliver within the period so fixed.

[Solution]

- 1) On April 5, there is no legal relation between seller A and buyer B.
- 2) On April 15, A has a duty to deliver the farming machine to B by May 10 and B has a duty to pay the price of \$50,000 to A by May 20, while B has the right to require A to deliver goods to B and A has the right to require B to pay the price to A by May 10.
- 3) On May 5, B has a duty to pay the price of \$50,000 to A by May 20, while A has the right to require B to pay the price to A by May 10.
- 4) On August 15, A has the duty to recover the damage, while B has the right to claim A for damage and B has the right to require A to repair the machine.
- 5) On September 15, A has the duty to recover the damage and a duty to repair the machine, while B has the right to claim damage from A and B has the right to require that A repair the machine, restricted to exercise.
- 6) On October 5, A has the duty to recover the damage and to repair the machine, while B has the right to claim damage from A, B has the right to require A to repair the machine and B has the right to declare the contract void.
- 7) On November 15, A has the duty to recover the damage and the duty to restate the price paid by B, and B has the duty to restate the machine delivered by A, while B has the right to claim damage for A and the right to require A to restate the price, and A has the right to require B to restate the machine.
- 8) On December 15, A has the duty to restate the price paid by B, while B has the right to require A to restate the price.

obligation to deliver a farming machine to B" or "It is obligatory for A to deliver a farming machine to B" is valid. If the parties have an obligation to deliver a farming machine to B based on a contract, it is so because the sentences in the contract describing the obligation (that is, legal object sentences) are valid as proved. The contract law is a set of legal meta rule sentences that regulates the validity of the legal object sentences of the contract. Below, We show what legal meta rule sentences work to prove the validity of legal object sentences related to contracts and how they do so.

5.1. Legal Rule Sentences Deciding that Legal Sentences are Valid.

The following fundamental legal meta rule sentence is valid for confirming that legal sentences are valid:⁷

(mrl) "A legal sentence S is valid at the time T if and only if S becomes valid at time T1 before T, and S is not terminated until T."

This legal rule sentence cannot be found as a statutory text in the CISG or other regulations. This is a fundamental legal meta rule sentence implicitly taken for granted by the CISG and all other regulations. Without this rule, no statutory legal sentence works when it comes to application. This rule is the most fundamental among legal meta rules enabling us to put mere collection of legal sentences into a legal system. This rule applies to every case where the validity of legal sentences is considered.

In deciding, for example, whether legal sentence "A has an obligation to deliver the machine to B on April 15" is valid, we apply this rule and examine its two specified requirements: "'A has an obligation to deliver the machine to B' becomes valid before April 15" and "'A has an obligation to deliver the machine to B' is not terminated until April 15." If both requirements are satisfied, then the legal object sentence is valid in April 15. Therefore, A's obligation to deliver the machine exists in the prevailing usage of legal language; if not, it is not valid, and therefore the obligation does not exist.

How are legal sentences to be systematized under this fundamental legal meta rule sentence? All other legal meta rule sentences are systematized as subrules of this sentence, as rules to decide whether the two different requirements of this fundamental meta rule sentence, i.e. "the legal sentence becomes valid" and "the legal sentence is not terminated," are satisfied.⁸

Now, we shall clarify the structure of legal knowledge deciding these two factors, i.e. "the legal sentence becomes valid" and "the legal sentence is not terminated" focusing on the validity of legal object sentences to make the logical structure of legal knowledge regulating changes of legal obligation clear. Here, note the following: "The legal sentence is not terminated" means "it is not the case that the legal sentence is terminated." In the real legal world, there is no rule that decides directly "a legal sentence is not terminated," but there exist many legal rule sentences that

decide "a legal sentence is terminated." The negation of the sentence "a legal sentence is terminated" is conceived of as proven in fact if the later sentence fails to be proven.

5.2. Logical Structure of Contract Law Deciding Accrual of Obligation

Legal obligations accrue because legal object rule sentences become valid, as mentioned above.

5.2.1. Accrual of validity of elementary legal sentences with accrual of contract validity

The accrual of validity of a complex legal sentence follows the accrual of validity of elementary legal sentences belonging to it. The following legal meta rule sentence is presupposed:

*(r01) become_valid(ES,G,T) ←
element_complex_sentence(ES,CS) &
become_valid(CS,G,T)*

This rule is read: A legal sentence ES becomes valid for goal G at time T, if ES is an element sentence of complex sentence CS and CS becomes valid for G at T.

Consider, for example, the change in the legal relation on April 9 in Fig.3. As the contract as a complex legal sentence has become valid, the following two obligation sentences (legal object sentences) as elementary legal sentences of the contract, become valid: "A has an obligation to deliver the machine to B" and "B has an obligation to pay the price A by May 20." The main part of contract law is legal meta rule sentences regulating changes of validity of the contract itself as a complex legal sentence, i.e., the accrual and termination of its validity.

Figure 4 is a logical flowchart of the legal rule sentence that decides the accrual of validity of contract. 3AA1BA in Fig.4⁹ means that the contract is concluded. The "conclusion" of the contract means that it is formed as a legal sentences named contract. Legal sentences differ from conventional sentences because legal sentences satisfy the requirements of legal meta rules prescribing the formation of the relevant legal sentences such as contracts, judgements, statutes, constitutions, and conventions.

Part 2 of CISG regulates in detail the conclusion of contracts from Articles 14 through 24. To bring them into a unified system, however, we need a legal rule sentence such as that in Fig.5.

This rule is related to Article 23, but is not the same. The article does not refer to the effectiveness of an offer directly. For Articles 14 through 17 to be systematized, the first requirement must be met. This legal rule sentence therefore [2A] (Fig.5) is a legal principle of contract law.¹⁰ (This rule would be valid for CISG and also for other contract laws.) Articles 14 through 17 and 24 in part 2 are to systematized as a subrule of the first requirement [2AA] of this legal rule sentence. Articles 18 through 22 and 24 in part 2 are systematized as a subrule of the second requirement [2AB].

⁷ The validity of this fundamental legal meta rule is a fact, or is presupposed always valid. In our knowledge base, a sentence that describes this *mrl* is valid is set as a legal fact sentence.

⁸ Thus, all legal meta rules in this sense contribute to regulating the validity of legal sentences.

⁹ For knowledge representation of law by logical flowcharts, refer to Refs.16) and 17).

¹⁰ This legal requirement is defined and the inference process of the discovery formalized in Ref.7).

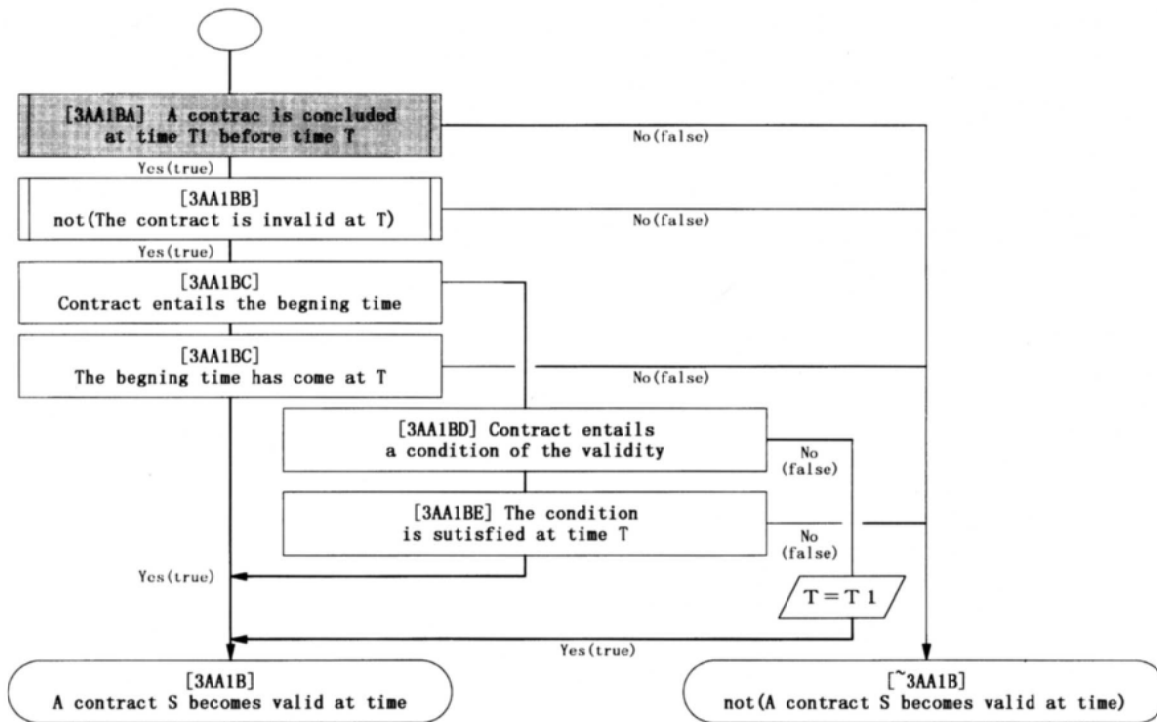


Fig. 4. 3AA1B A contract becomes valid.

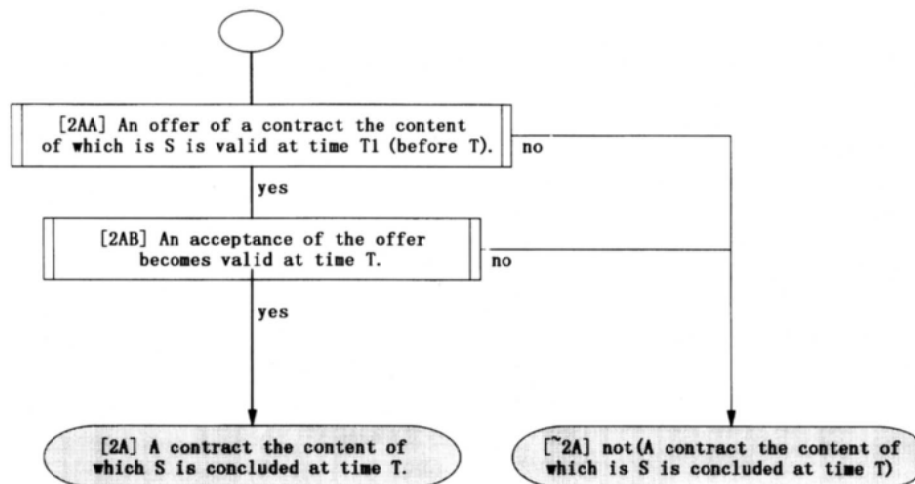


Fig. 5. [2A] Contract is concluded.

5.2.2. Accrual of validity of a legal sentence by exercising rights

In some cases, the accrual of validity of the elementary legal sentence by itself, not as a result of the accrual of contract validity, is regulated. An obligation accrues, for example, along with exercise of the relevant right. In Figure 3, the legal sentence "B has an obligation to repair the machine for A" becomes valid because A exercised the right to require the repair of the machine on September 1.

Logical Jurisprudence does not consider sentences describing rights as a legal object sentence as in the prevailing opinion in legal theories, but as a legal meta rule sentence, as described above. That a person has a right to require another person to do Z, for example, means, in our opinion, that the person may arrive at a legal object sentence concluding that the other person is obligated to do Z.

The legal meta rule sentence below must be valid.

(3AA2) "A legal sentence '*X has an obligation to do Z*' becomes valid at time *T*, if a legal sentence '*Y has a right to require X to do Z*' is valid at time *T*, and *Y* exercises the right to require *X* to do *Z* at time *T*."

The accrual of seller A's concrete obligation to repair the machine on September 1. For example, in Fig.3, for the present case is deduced by the application of this rule. The proof is as follows: The second requirement of the rule "*Y exercises the right to require X to do Z at time T*" is satisfied by buyer B's exercise of the right to require seller A to remedy the problem by repair on September 1. The instantiated first requirement, "*Buyer B has a right to require seller A to remedy the lack of conformity by repair on September 1*" is valid," is proved by applying the fundamental meta rule *mr1*. The instantiated first condition of the latter

rule “‘Buyer B has a right to require seller A to remedy the lack of conformity by repair’ becomes valid on August 10” is proved by applying the following legal rule sentence representing Article 46 of CISG:

(rCISG46): “The buyer has a right to require the seller to remedy the lack of conformity by repair” becomes valid, if the goods do not conform to the contract.

The requirement of rule *rCISG46* is satisfied by fact (8) on August 10. The instantiated second requirement of the applied *mr1* “‘B has a right to repair the machine’ is not terminated until September 1” is proven because the proof of “‘B has a right to repair the machine’ is terminated until September 1” is false.

The deductive system of legal knowledge to deduce an accrual of the validity of an legal object sentence by exercising a right of claim is explicated in an example of the claim to repair goods delivered. Legal meta rule sentence 3AA2 applies to many other cases such as accruals of the seller’s duty to perform obligations (Article 46(1)), to deliver substitute goods (46(2)), and so on.

Many statutory legal rule sentences regulate the accrual of validity an legal object directly. In such a case, one need apply the relevant statutory legal rule sentences, not 3AA2.

5.3. Logical structure of contract law deciding termination of obligations

The termination of obligations means that the validity of legal object sentences describing obligations is terminated. There are two ways to terminate the validity of elementary legal object sentences: the termination of their validity along with the termination of the complex legal sentence and the termination of their validity by themselves.

5.3.1. Termination of elementary legal sentence validity and contract termination

The validity of elementary legal sentences is terminated if the complex legal sentence to which they belong is terminated. The validity elementary sentences of a contract are terminated if the validity of the contract as a complex legal sentence is terminated.

Complex legal sentences lose their validity on the day when a fixed term expires, when the termination condition is met or when contract avoidance becomes effective. Regulations concerned with these factors can be integrated as a legal rule sentence, which makes concrete the second requirement of the fundamental legal meta rule sentence *mr1* as its subrule sentence.

In Fig.3, two legal object rule sentences, “A has an obligation to B that the machine delivered conform to the contract” and “A has an obligation to B to repair the machine” is terminated on October 1, because the validity of the contract as a complex legal sentence was terminated owing to B’s exercise of the right to declare the contract avoided when B has the right, i.e. ‘B has the right to declare the contract avoided’ is valid. The right to declare the contract void resulted from the fact that the seller had not fulfill an obligation to repair the machine within the additional period of time (one month) fixed by the buyer.¹¹

5.3.2. Termination of validity elementary legal object sentences with fulfillment of obligation

In some cases, the validity of one article of a contract is terminated independently of the validity of the whole contract. The following legal meta rule sentence is valid:

(mr4b) “The validity of elementary legal object sentences is terminated when the obligation is fulfilled.”

Because of the delivery by A on May 1, for example, the validity of the legal object sentence “A has an obligation to deliver the machine to B” is terminated May 1, and because of payment by B on May 20, the validity of legal sentence “B has an obligation to pay the price by May 20” is terminated May 20. These terminations of obligations are deduced by applying the above legal meta rule sentence *mr4b*.

6. Conclusion

This research confirmed the structure of contract law by taking up CISG as an example and focusing on the systematization of law from the view of Logical Jurisprudence. By using three standards of legal sentences -- that is, legal fact sentences and legal rule sentences, complex legal sentences and elementary legal sentences, and legal object sentences and legal meta sentences -- we explicated the basic structure of legal knowledge enabling us to systematize contract law. Applying the frame to cases (case 7h here), we formalized the change of legal relation as a change of the validity of legal sentences that describe obligations. On formalization, we found the fundamental legal meta rule sentence under which every other legal meta rules are systematized. We thus clarified the logical structure of a contract law system that deductively proves the change of legal relations along with the progress of events in a concrete example.

The results of this study have been introduced to the knowledge base of the CISG. We have developed a knowledge base system by which solutions about legal states of affairs can be deduced at any time as a result of applying the CISG to a given international trade case.

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¹¹ This reasoning is made through the analogical application of article 49 (1)(b), discussed elsewhere.

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