

## A Study on Logical Formalization of HOHFELD's Fundamental Legal Conceptions

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### 1. Introduction

This paper aims at a new review of HOHFELD's fundamental legal conceptions [1,2] from the logical point of view and a logical formalization of their jural relations by predicate logic to examine their applicability to legal reasoning by intelligent computer system. Legal logic, which analyzes legal system and legal reasoning by application of logic, is one of the important scientific trends of jurisprudence. It can make clear logical structure of conceptions and their relations in the legal world. On the other hand, it needs no hard emphasis to say that the conceptions of rights and duties are core conceptions of legal relations in legal system. HOHFELD systematized fundamental legal conceptions, such as right and duty, strictly for the first time with dispute of jural relations in England and America as a turning point. In order to build up a legal reasoning computer system, it is therefore important to examine precisely the applicability and limitation of the HOHFELD's legal conceptions for it. This can be done by legal logic at first.

What kind of logic is to be applied to formalize legal conceptions? Modern Logic, which was established by FREGE [3], seems to be an indispensable

tool to formalize the HOHFELD's legal conceptions logically. In general, up to now, there was an essential confrontation [4] in the measure adopted when we formalize legal conceptions logically. ALLEN & SAXON [5] have proposed to formalize the HOHFELD's legal conceptions used in Deontic Logic, Predicate Logic and Action Logic with time relationship. But Philosophical Logic, which is Deontic Logic and so on, is not always appropriate in logical proof as a background. Thus it is difficult now to put our hopes in applications of Philosophical Logic for intelligent computer system. But the field of norm is applicable to the classical Mathematical Logic without difficulty [4]. In view of the above, this paper adopts the YOSHINO MODEL [6], the formalization of legal norm sentences by means of two-valued Mathematical Logic, especially Predicate Logic, to formulate the HOHFELD's legal conceptions logically. Further, this paper examines the possibility and limitation of legal conceptions which HOHFELD systematized and their formalization.

## 2. HOHFELD's fundamental legal conceptions

This section outlines HOHFELD's eight fundamental legal conceptions as applied in judicial reasoning, which are arranged by him in certain schema, namely, jural opposites and jural correlatives as cited below.

### HOHFELD's fundamental legal conceptions

Jural Opposites	[	right	privilege	power	immunity
		no-right	duty	disability	liability
Jural Correlatives	[	right	privilege	power	immunity
		duty	no-right	liability	disability

In general, legal relations are used with reference to X and Y. The term

opposite means X's legal situation negated from X's position, that is, no pair of two conceptions which are opposite exist together as to the same subject and person. The term correlative means X's legal situation viewed from Y's position, that is, pair of two conceptions which are correlative must exist together as to the same subject.

### **RIGHT and DUTY**

RIGHT, as defined above, is the opposite of NO-RIGHT, and the correlative of DUTY. RIGHT denotes absence of NO-RIGHT with respect to the same subject and the same person, and its correlative must denote DUTY with respect to the relation of Y to X. RIGHT is an affirmative claim for the other person.

### **PRIVILEGE and NO-RIGHT**

PRIVILEGE is the opposite of DUTY, and the correlative of NO-RIGHT. PRIVILEGE denotes absence of DUTY with respect to the same person, and its correlative must denote absence of RIGHT with respect to the relation of Y to X. PRIVILEGE is a liberty from RIGHT or claim of the other person. In a legal relationship, liberty is equivalent to privilege.

### **POWER and LIABILITY**

POWER is the opposite of DISABILITY, and the correlative of LIABILITY. POWER denotes absence of DISABILITY with respect to the same person, and its correlative must denote LIABILITY with respect to the relation of Y to X. POWER is an affirmative control of the given legal relations for the other person. The analogue of LIABILITY is subjection or responsibility.

### **IMMUNITY and DISABILITY**

IMMUNITY is the opposite of LIABILITY, and the correlative of DISABILITY. IMMUNITY denotes absence of LIABILITY with respect to the same person, and its correlative must denote DISABILITY with respect to

the relation of Y to X. IMMUNITY is a liberty from POWER or control of the other person.

Further, CORBIN [7] indicates legal terms and the HOHFELD's legal conceptions in the following grouping.

### **CORBIN's grouping of terms**

May .....	permission .....	privilege---	no-right
Must (may not).....	compulsion .....	right---	duty
Can .....	danger or possibility (of new relations)	power---	liability
Cannot .....	safety (from new relation) .....	immunity--	disability

This grouping is useful for logical formalization of concrete legal norm sentences. But in the field of public law or conventions recently it is usual to use term "shall" or "should" as the term of compulsion, so we suggest to add these terms. Further the grouping of terms is ought to decide comprehensively by not only above anomalous finites but also by other elements, such as context.

### **3. NeoHohfeldian Logic by ALLEN & SAXON**

NeoHohfeldian Logic (System H), which was tried by ALLEN & SAXON [5], is an extension of the combination of Deontic Logic, Predicate Logic and Action Logic with time relationships. They have defined a formalization of the HOHFELD's conceptions as following (we show below only the essence of their definitions of the conceptional relations).

**[DEFINITION]**

$RI(w(t2),x,y,t1) = \text{df } OD24(w(t2),x,y,t1)$

(“Person-y has a RIGHT at time-t1 that person-x do act-w at time-t2” is equal to by definition “IT IS OBLIGATORY at time-t1 THAT act-w be DONE BY person-x at time-t2 FOR person-y”.)

$DU(w(t2),x,y,t1) = \text{df } RI(w(t2),y,x,t1)$

(“Person-y has a DUTY at time-t1 to person-x to do act-w at time-t2” is equal to by definition “Person-x has a RIGHT at time-t1 that person-y do act-w at time-t2”)

$NO(w(t2),x,y,t1) = \text{df } NRI(w(t2),x,y,t1)$

(“Person-y has a NORIGHT at time-t1 that person-x do act-w time-t2” is equal to by definition “IT IS NOT SO THAT person-y has a RIGHT at time-t1 that person-x do act-w at time-t2”.)

$PR(w(t2),x,y,t1) = \text{df } NRI(Nw(t2),y,x,t1)$

(“Person-y has a PRIVILEGE at time-t1 with respect to person-x to do act-w at time-t2” is equal to by definition “IT IS NOT SO THAT person-x has a RIGHT at time-t1 that person-y do act-not-w at time-t2”.)

Thus DUTY, NORIGHT and PRIVILEGE are defined in terms of RIGHT. Similarly, LIABILITY, DISABILITY and IMMUNITY are defined in terms of POWER. ALLEN & SAXON have proved their relations as NeoHohfeldian RIGHT-set and POWER-set. However it seems that their formalization raises a few questions that are discussed below.

At first, NeoHohfeldian Logic adopts a kind of Deontic Logic as imperfect system which uses the particular operators. Therefore their logical formulus are not wff(well-formed formulus) and inference rules are not valid on logical deduction. Secondly, it seems that the left hand side act-w of logical formula

is different from the right hand side act-w on formalization of correlative relations.

#### **4. A logical formalization of HOHFELD's fundamental legal conceptions**

In this section, applying the logical formalization model of legal norm sentences developed by YOSHINO, we formalize logically HOHFELD's fundamental legal conceptions faithfully and make clear logical structure. The YOSHINO MODEL [6], which makes possible to apply mathematical logic to legal norm sentences directly, is the best available tool for this research. Deduction of logical formula which formalized within mathematical logic has proved completeness on the condition, so that the YOSHINO MODEL is suitable not only to analyzing logical structure of legal norm sentences but also to carrying out legal deductions. Now, based on the YOSHINO MODEL, we attempt to formalize logically the HOHFELD's legal conceptions as below.

#### **NOTATIONS:**

$Na(p1) = p1$  is a norm-subject: (the term subject means not only subject in grammar but also indirective object in grammar, such as opponent of RIGHT-DUTY relation, which is to be considered as a subject in relations)

$Ha1(h1) = h1$  is a norm-object of a specific behavior

$Co(h2, h1) = h2$  is "correlative" to  $h1$

$Ri(p1, p2, h1) = p1$  has a RIGHT to  $p2$  concerning  $h1$

$Du(p1, p2, h1) = p1$  has a DUTY to  $p2$  concerning  $h1$

$Pr(p1, p2, h1) = p1$  has a PRIVILEGE to  $p2$  concerning  $h1$

$NR(p1, p2, h1) = p1$  has a NO-RIGHT to  $p2$  concerning  $h1$

$Po(p1, p2, h1) = p1$  has a POWER to  $p2$  concerning  $h1$

$Li(p1,p2,h1) = p1$  has a LIABILITY to  $p2$  concerning  $h1$

$Im(p1,p2,h1) = p1$  has a IMMUNITY to  $p2$  concerning  $h1$

$Di(p1,p2,h1) = p1$  has a DISABILITY to  $p2$  concerning  $h1$

### **JURAL OPPOSITES---X's legal situation negated from X's position**

[1] $\forall p1\forall p2\forall h1(Na(p1) \cdot Na(p2) \cdot Ha1(h1) \rightarrow (NR(p1,p2,h1) \leftrightarrow \sim Ri(p1,p2,h1)))$

(for all  $p1$  and all  $p2$  and all  $h1$ , IF  $p1$  is a norm-subject AND  $p2$  is a norm-subject AND  $h1$  is a norm-object of a specific behavior, THEN that  $p1$  has a NO-RIGHT to  $p2$  concerning  $h1$  is equivalent by definition that  $p1$  has not a RIGHT to  $p2$  concerning  $h1$ )

[2] $\forall p1\forall p2\forall h1(Na(p1) \cdot Na(p2) \cdot Ha1(h1) \rightarrow (Du(p1,p2,h1) \leftrightarrow \sim Pr(p1,p2,h1)))$

(for all  $p1$  and all  $p2$  and all  $h1$ , IF  $p1$  is a norm-subject AND  $p2$  is a norm-subject AND  $h1$  is a norm-object of a specific behavior, THEN that  $p1$  has a DUTY to  $p2$  concerning  $h1$  is equivalent by definition that  $p1$  has not a PRIVILEGE to  $p2$  concerning  $h1$ )

[3] $\forall p1\forall p2\forall h1(Na(p1) \cdot Na(p2) \cdot Ha1(h1) \rightarrow (Di(p1,p2,h1) \leftrightarrow \sim Po(p1,p2,h1)))$

(for all  $p1$  and all  $p2$  and all  $h1$ , IF  $p1$  is a norm-subject AND  $p2$  is a norm-subject AND  $h1$  is a norm-object of a specific behavior, THEN that  $p1$  has a DISABILITY to  $p2$  concerning  $h1$  is equivalent by definition that  $p1$  has not POWER to  $p2$  concerning  $h1$ )

[4] $\forall p1\forall p2\forall h1(Na(p1) \cdot Na(p2) \cdot Ha1(h1) \rightarrow (Li(p1,p2,h1) \leftrightarrow \sim Im(p1,p2,h1)))$

(for all  $p1$  and all  $p2$  and all  $h1$ , IF  $p1$  is a norm-subject AND  $p2$  is a norm-subject AND  $h1$  is a norm-object of a specific behavior, THEN that  $p1$  has a LIABILITY to  $p2$  concerning  $h1$  is equivalent by definition that  $p1$  has not a IMMUNITY to  $p2$  concerning  $h1$ )

**JURAL CORRELATIVES---X's legal situation viewed from Y's position**

[5] $\forall p1\forall p2\forall h1\forall h2(Na(p1) \cdot Na(p2) \cdot Ha1(h1) \cdot Co(h2,h1) \rightarrow (Du(p1,p2,h1) \leftrightarrow Ri(p2,p1, h2)))$

(for all p1 and all p2 and all h1 and all h2, IF p1 is a norm-subject AND p2 is a norm-subject AND h1 is a norm-object of a specific behavior AND h2 is "correlative" to h1, THEN that p1 has a DUTY to p2 concerning h1 is equivalent by definition that p2 has a RIGHT to p1 concerning h2)

[6] $\forall p1\forall p2\forall h1\forall h2(Na(p1) \cdot Na(p2) \cdot Ha1(h1) \cdot Co(h2,h1) \rightarrow (NR(p1,p2,h1) \leftrightarrow Pr(p2,p1, h2)))$

(for all p1 and all p2 and all h1 and all h2, IF p1 is a norm-subject AND p2 is a norm-subject AND h1 is a norm-object of a specific behavior AND h2 is "correlative" to h1, THEN that p1 has a NO-RIGHT to p2 concerning h1 is equivalent by definition that p2 has a PRIVILEGE to p1 concerning h2)

[7] $\forall p1\forall p2\forall h1\forall h2(Na(p1) \cdot Na(p2) \cdot Ha1(h1) \cdot Co(h2,h1) \rightarrow (Li(p1,p2,h1) \leftrightarrow Po(p2,p1, h2)))$

(for all p1 and all p2 and all h1 and all h2, IF p1 is a norm-subject AND p2 is a norm-subject AND h1 is a norm-object of a specific behavior AND h2 is "correlative" to h1, THEN that p1 has a LIABILITY to p2 concerning h1 is equivalent by definition that p2 has a POWER to p1 concerning h2)

[8] $\forall p1\forall p2\forall h1\forall h2(Na(p1) \cdot Na(p2) \cdot Ha1(h1) \cdot Co(h2,h1) \rightarrow (D1(p1,p2,h1) \leftrightarrow Im(p2,p1, h2)))$

(for all p1 and all p2 and all h1 and all h2, IF p1 is a norm-subject AND p2 is a norm-subject AND h1 is a norm-object of a specific behavior AND h2 is "correlative" to h1, THEN that p1 has a DISABILITY to p2 concerning h1 is equivalent by definition that p2 has a IMMUNITY to p1 concerning h2)



Transforming [1][6], we have the following [1']·[1'']·[6']·[6''].

$$[1'] \forall p1 \forall p2 \forall h1 (\sim Na(p1) \vee \sim Na(p2) \vee \sim Ha1(h1) \vee \sim NR(p1, p2, h1) \vee \sim Ri(p1, p2, h1))$$

$$[1''] \forall p1 \forall p2 \forall h1 (\sim Na(p1) \vee \sim Na(p2) \vee \sim Ha1(h1) \vee Ri(p1, p2, h1) \vee \sim NR(p1, p2, h1))$$

$$[6'] \forall p1 \forall p2 \forall h1 \forall h2 (\sim Na(p1) \vee \sim Na(p2) \vee \sim Ha1(h1) \vee \sim Co(h2, h1) \vee \sim NR(p1, p2, h1) \vee \sim Pr(p2, p1, h2))$$

$$[6''] \forall p1 \forall p2 \forall h1 \forall h2 (\sim Na(p1) \vee \sim Na(p2) \vee \sim Ha1(h1) \vee \sim Co(h2, h1) \vee \sim Pr(p2, p1, h2) \vee \sim NR(p1, p2, h1))$$

Then [1']·[6''] indicate

$$\begin{aligned} & [9] \forall p1 \forall p2 \forall h1 \forall h2 (\sim Na(p1) \vee \sim Na(p2) \vee \sim Ha1(h1) \vee \sim Co(h2, h1) \vee \sim Pr(p2, p1, h2) \vee \\ & \sim Ri(p1, p2, h1)) \\ & = \forall p1 \forall p2 \forall h1 \forall h2 (Na(p1) \cdot Na(p2) \cdot Ha1(h1) \cdot Co(h2, h1) \rightarrow (Pr(p2, p1, h2) \rightarrow \sim Ri(p1, p2, \\ & h1))). \end{aligned}$$

Similarly, [1'']·[6'] indicate

$$\begin{aligned} & [10] \forall p1 \forall p2 \forall h1 \forall h2 (\sim Na(p1) \vee \sim Na(p2) \vee \sim Ha1(h1) \vee \sim Co(h2, h1) \vee Ri(p1, p2, h1) \vee \sim Pr \\ & (p2, p1, h2)) \\ & = \forall p1 \forall p2 \forall h1 \forall h2 (Na(p1) \cdot Na(p2) \cdot Ha1(h1) \cdot Co(h2, h1) \rightarrow \sim (Ri(p1, p2, h1) \rightarrow Pr(p2, p1, \\ & h2))). \end{aligned}$$

In these legal reduction, we have the following.

$$[11] \forall p1 \forall p2 \forall h1 \forall h2 (Na(p1) \cdot Na(p2) \cdot Ha1(h1) \cdot Co(h2, h1) \rightarrow \sim (Ri(p1, p2, h1) \rightarrow Pr(p2, p1, h2)))$$

From [1], [5] and [11], we find out that DUTY, NO-RIGHT and PRIVILEGE are formalized by use of RIGHT. However, it is possible to formalize RIGHT, NO-RIGHT and PRIVILEGE by DUTY as well. As ALLEN & SAXON have proved, DUTY, NO-RIGHT and PRIVILEGE are RIGHT-set. In other words, each definition of conceptions can be deduced logically from definition of RIGHT only. In the same way, we find out that LIABILITY, DISABILITY and IMMUNITY are formalized by use of POWER. As

ALLEN & SAXON have proved, LIABILITY, DISABILITY and IMMUNITY are POWER-set. In other words, each definition of conceptions can be deduced logically from the definition of POWER only. Next, we present case studies in private and public law for the purpose of showing the possibility of applying these formulation.

### CASE STUDY 1: “UNITED NATIONS CONVENTION ON CONTRACTS FOR THE INTERNATIONAL SALE OF GOODS”

**Article 30 <extract>**; The seller must deliver the goods as required by the contract and this Convention.

Logical formula is as following.

[12]  $\forall x \forall y \forall h1 (\text{Seller}(x) \cdot \text{Buyer}(y) \cdot \text{Deliver}(h1) \rightarrow \text{Du}(x, y, h1))$

$\text{Seller}(x)$  = x is a seller.

$\text{Buyer}(y)$  = y is a buyer.

$\text{Deliver}(h1)$  = h1 is to deliver the goods as required by the contract and this Convention.

Transforming [12], we have the following.

[12']  $\forall x \forall y \forall h1 (\sim \text{Seller}(x) \vee \sim \text{Buyer}(y) \vee \sim \text{Deliver}(h1) \vee \text{Du}(x, y, h1))$

From  $\forall x \forall y \forall h1 ((\text{Seller}(x) \cdot \text{Buyer}(y) \cdot \text{Deliver}(h1) \rightarrow \text{Na}(x) \cdot \text{Na}(y) \cdot \text{Ha1}(h1)))$ , we can change [2] into [13].

[13]  $\forall x \forall y \forall h1 ((\text{Seller}(x) \cdot \text{Buyer}(y) \cdot \text{Deliver}(h1) \rightarrow (\text{Du}(x, y, h1) \leftrightarrow \text{Pr}(x, y, h1)))$

From [13], we have the following [13'] · [13"].

[13']  $\forall x \forall y \forall h1 (\sim \text{Seller}(x) \vee \sim \text{Buyer}(y) \vee \sim \text{Deliver}(h1) \vee \sim \text{Du}(x, y, h1) \vee \sim \text{Pr}(x, y, h1))$

[13"]  $\forall x \forall y \forall h1 (\sim \text{Seller}(x) \vee \sim \text{Buyer}(y) \vee \sim \text{Deliver}(h1) \vee \text{Pr}(x, y, h1) \vee \text{Du}(x, y, h1))$

[12'] and [13'] indicate

[14]  $\forall x \forall y \forall h1 (\sim \text{Seller}(x) \vee \sim \text{Buyer}(y) \vee \sim \text{Deliver}(h1) \vee \sim \text{Pr}(x, y, h1))$

=  $\forall x \forall y \forall h1 (\text{Seller}(x) \cdot \text{Buyer}(y) \cdot \text{Deliver}(h1) \rightarrow \sim \text{Pr}(x, y, h1))$

(for all x and all y and all h1, IF x is the seller AND y is the buyer AND h1 is to deliver the goods as required by the contract and this Convention, THEN x has not a PRIVILEGE to y concerning h1).

As its legal effect means “a seller has not a liberty from claim of a buyer concerning delivery of the goods as required by the contract and this Convention”, this change of logical formulism fits the actual legal situation on contract.

From  $\forall x \forall y \forall h1 ((\text{Seller}(x) \cdot \text{Buyer}(y) \cdot \text{Deliver}(h1) \rightarrow \text{Na}(x) \cdot \text{Na}(y) \cdot \text{Ha1}(h1))$ , we can change [5] into [15].

[15]  $\forall x \forall y \forall h1 \forall h2 ((\text{Seller}(x) \cdot \text{Buyer}(y) \cdot \text{Deliver}(h1) \cdot \text{Co}(h2, h1) \rightarrow (\text{Du}(x, y, h1) \leftrightarrow \text{Ri}(x, y, h2)))$

From [15], we have the following [15']·[15"].

[15']  $\forall x \forall y \forall h1 \forall h2 (\sim \text{Seller}(x) \vee \sim \text{Buyer}(y) \vee \sim \text{Deliver}(h1) \vee \sim \text{Co}(h2, h1) \vee \sim \text{Du}(x, y, h1) \vee \text{Ri}(y, x, h2))$

[15"]  $\forall x \forall y \forall h1 \forall h2 (\sim \text{Seller}(x) \vee \sim \text{Buyer}(y) \vee \sim \text{Deliver}(h1) \vee \sim \text{Co}(h2, h1) \vee \sim \text{Ri}(y, x, h2) \vee \text{Du}(x, y, h1))$

[12'] and [15'] indicate

[16]  $\forall x \forall y \forall h1 \forall h2 (\sim \text{Seller}(x) \vee \sim \text{Buyer}(y) \vee \sim \text{Deliver}(h1) \vee \sim \text{Co}(h2, h1) \vee \text{Ri}(y, x, h2))$   
 $= \forall x \forall y \forall h1 \forall h2 (\text{Seller}(x) \cdot \text{Buyer}(y) \cdot \text{Deliver}(h1) \cdot \text{Co}(h2, h1) \rightarrow \text{Ri}(y, x, h2))$

(for all x and all y and all h1 and all h2, IF x is the seller AND y is the buyer AND h1 is to deliver the goods as required by the contract and this Convention AND h2 is “correlative” to h1, THEN y has a RIGHT to x concerning h2).

As its legal effect means “a buyer has a right of receiving (= to be delivered) the goods as required by the contract and this Convention from a seller”, this legal interpretation is valid for the concept on contract. In the same way, we examine the other articles on this Convention (the concept of parameter is extended).

**Article 33 <extract>:** The seller must deliver the goods if a date is fixed  
by or determinable from the contract on that date.

(for all x and all y and all h1 and all t, IF x is a seller AND y is a buyer AND  
h1 is to deliver the goods AND t is the date fixed by or determinable from the  
contract on that date, THEN x has a DUTY relate to y concerning h1 at t)

{PRIVILEGE : a seller has not a liberty from claim of a buyer concerning  
delivery of the goods at the date fixed by or determinable from the contract on  
that date}

{RIGHT : a buyer has a right of receiving (=to be delivered) the goods from a  
seller at the date fixed by or determinable from the contract on that date}

**Article 34 <extract>:** If the seller is bound to hand over documents  
relating to the goods, he must hand them over at the time and place and in the  
form required by the contract.

(for all x and all y and all h1 and all m, IF x is a seller AND y is a buyer AND  
h1 is to hand over documents relating to the goods AND m is the time and  
place in the form required by the contract, THEN x has a DUTY relate to y  
concerning h1 following m)

{PRIVILEGE : a seller has not a liberty from claim of a buyer concerning  
delivery of the goods at the time and place and in the form required by the con-  
tract}

{RIGHT : a buyer has a right of receiving (=to be delivered) the goods from a  
seller at the time and place and in the form required by the contract}

In above cases, logical formulæ changed by RIGHT are suitable to actual  
legal application, although logical formulæ changed by PRIVILEGE have a lit-  
tle difficulty in adaptability of legal facts. But these meaning is able to under-  
stand in the light of legal matters.

## CASE STUDY 2 : “INTERNATIONAL REGULATIONS FOR PREVENTING COLLISIONS AT SEA, 1972”

**Rule 18 <extract>**; A power-driven vessel underway shall keep out of the way of a vessel not under command.

Logical formula is as following.

$$[17] \forall x \forall y \forall h1 (Pd(x) \cdot Nc(y) \cdot \text{Keep-out}(h1) \rightarrow Du(x, y, h1))$$

$Pd(x)$  = x is a power-driven vessel underway.

$Nc(y)$  = y is a vessel not under command.

$\text{Keep-out}(h1)$  = h1 is to keep out of the way of.

In the same way of case study 1, we get the following [18] and [19].

$$[18] \forall x \forall y \forall h1 (\sim Pd(x) \vee \sim Nc(y) \vee \sim \text{Keep-out}(h1) \vee \sim Pr(x, y, h1))$$

$$= \forall x \forall y \forall h1 (Pd(x) \cdot Nc(y) \cdot \text{Keep-out}(h1) \rightarrow \sim Pr(x, y, h1))$$

(for all x and all y and all h1, IF x is a power-driven vessel underway AND y is a vessel not under command AND h1 is to keep-out of the way of, THEN x has not a PRIVILEGE to y concerning h1)

As its legal effect means “a power-driven vessel underway has not a liberty from claim for a vessel not under command concerning keeping-out of the way of it”, this change of logical formulæ fits the actual legal navigation custom.

$$[19] \forall x \forall y \forall h1 \forall h2 (\sim Pd(x) \vee \sim Nc(y) \vee \sim \text{Keep-out}(h1) \vee \sim Co(h2, h1) \vee Ri(y, x, h2))$$

$$= \forall x \forall y \forall h1 \forall h2 (Pd(x) \cdot Nc(y) \cdot \text{Keep-out}(h1) \cdot Co(h2, h1) \rightarrow Ri(y, x, h2))$$

(for all x and all y and all h1 and all h2, IF x is a power-driven vessel underway AND y is a vessel not under command AND h1 is to keep-out of the way of, THEN y has a RIGHT to x concerning h2)

As its legal effect means “a vessel not under command has right as a stand-on vessel (= get the other vessel to keep-out of the way)”, this legal interpretation is valid for the way of navigation at sea.

Thus we can find out new legal relation (opposite and correlative relations)

from one original legal relation. Similarly, other legal conceptions can also be explained. From the above discussion, we find out that the HOHFELD's legal conceptions are deduced by legal reasoning and used logical definitions of RIGHT and POWER. Moreover, this process of legal reasoning is perfect on deduction. Thus jural relations, which are considered eight legal conceptions, are a result of legal deduction by two core conceptions at the view of legal logic. It is possible to deduce automatically by an intellectual computer using artificial language like PROLOG or LISP, because these logical formulas are formalized within predicate logic. But this formalization has some problems concerning negation and correlative symbol. Negative symbol in this paper is the negation in propositional logic. However this formalization may be a kind of approximation. Further, correlative operator may be caused by Japanese expression in grammar.

## 5. Conclusion

In this paper, we have examined the possibility and limitation of HOHFELD's model as well as its logical formalization for the systematization of law in the service of legal reasoning by an intelligent computer system. This paper has a characteristic that the HOHFELD's legal conceptions is formalized logically by the YOSHINO MODEL based on predicate logic with completeness. This legal deduction clarifies that the HOHFELD's legal conceptions are redefined in terms of RIGHT and POWER logically. Thus it is of great significance to analyze legal norm sentences based on formalization logically. In general, each article of laws and regulations stipulates only a legal relation from a viewpoint (e.g. in case of article using term "DUTY", there are legal relations of other legal conceptions). Therefore legal relations being not stipulated are deduced on HOHFELD's legal conceptions in practical

applications. In this sense, legal logical formalization of HOHFELD's legal conceptions is an analysis of significance on legal logic. Moreover it is useful not only to make clear logical structure of legal norm sentences but also to apply for computer which has an infinite possibility.

Further, the HOHFELD's legal conceptions that are formalized in this paper was tried with simple case studies concerning private and public law. But properly speaking, its validity should be evaluated by more cases compared with actual legal practices. This investigation is essential to a computerization of legal deduction, a kind of legal expert system. The logical formalization in this paper may present the basis of this empirical research, in other word, a scientific approach of legal deduction. With full optimism, we wait to meeting other applications in the near future.

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