Research on Stability Evaluation of Disaster Information Network by Multi Agent Theory

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ABSTRACT : The governmental institute The Headquarters for Earthquake Research Promotion announced that the percentage of the Nan-Kai trough earthquake occurrence in coastal sea area of Kochi Prefecture within 30 years is 40-50 percent, and it is even higher within 50 years, 80-90 percent reckoned from January 1st, 2008.

Since the information released by the governmental institute gives a great impact on the local citizens living near the epicenter of the earthquake, it is urgent for the local authorities in Kochi prefecture to take a countermeasure against the impending earthquake.

Immediate grasp on the demand from sufferers and devastated area and prompt action to take effective measures in the wake of any types of disaster are the main purpose of the research activities conducted by local authorities. To accomplish their purpose, it is essential for the local authorities to acquire the relevant information from sufferers and devastated sites and send the information promptly to the organizations in charge of taking practical actions. However, in the reality, the network system is basically built without being openly disclosed to the public. Due to the information path's closed nature, the system lacks the clarity for the local citizens to understand how and where to access when they need help in a time of disaster. Furthermore, as of 2009, the validity of disaster Information Network local authorities use remains unattested since there is no index for the evaluation.

In this research, existing disaster information network system is assessed its stability after verifying whether the newly contrived model can evaluate stability of the network. As a result, this research successfully proves that multi-agent theory has a potential for its practical use and the disaster information network is assessable by applying this theory.

KEYWORDS: Multi Agent Theory, Information transmission、Measure evaluation

1. Introduction

1. 1. Background

The governmental institute The Headquarters for Earthquake Research Promotion announced that the percentage of the Nan-Kai trough earthquake occurrence in coastal sea area of Kochi Prefecture within 30 years is 40-50 percent, and it is even higher within 50 years, 80-90 percent reckoned from January 1st, 2008.

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In the regional disaster prevention plan that Kochi City near the forecast epicenter of the Nankai ear thquake made, information necessary for a related organization's acting respectively to transmit information has been described. However, the process of the information transmission on disaster information is not clea r. Moreover, Kochi City is hanging out "The disaster information system of the collection and transmission i s maintained" as one of the basic policies in the regional disaster prevention plan. However, it cannot be pro ven that the disaster information network being decided now is the one to satisfy the user's demand. Theref ore, the maintenance situation of the system cannot be objectively proven.

1. 2. Objectives

In this research, it was proven to be able to actually evaluate the disaster information network by using the multi agent theory. First of all, investigate as a case study the local authorities in Kochi City. Next, make the disaster information network evaluation model. And, it is clarify to be able to evaluate the disaster information network by handling the made disaster information network evaluation model. The investigated actual disaster information network is evaluated according to the assembled disaster information network evaluation model.

2. Structure a appraisal model of disaster Information Network

In this chapter, account for multi-agent theory. And the model make based on the condition is discussed. The model make used "visual basic" of the programming language.

2. 1. Multi-agent theory

The multi agent theory is a theory concerning the group that consists of two or more subjects. The group that the subject that is called an agent composes is called a multi agent. As for the agent among the multi agents, communications are possible. Moreover, the agent has a similar rule. In addition, the agent has a purpose that is common or original. The action of the group that looks complex is clarified from the subject and the environment under this condition. In this research, an local authorities that is the group of the subject is assumed to be an agent. Two or more people behave in the organization and the activity of the organization is borne. Hereafter, it is called, "Organization agent". Next, sets of local authorities are treated as a multi agent. The information transmission is assumed to be a communications means.

2.2. Execution of investigation to local authorities

It is necessary to clarify the process of the information transmission on an local authorities to make t he disaster information network evaluation model. There is a possibility that the transmission process of dis aster information that a transmission process and a local authorities of disaster information actually done ar e providing is different. However, it is assumed that it consists of the omission and the addition in the proc ess based on the transmission process in which the transmission process actually done is provided. In a wor d, when it looks like the information transmission process for which the local government provided, the proc ess of the information transmission on the reality is predictable. Then, the process of the information tran smission on the local government was surveyed. The outline of the investigation actually executed was show n in Table-1.

Subject of investigation	Kochi City crisis-management room , Kochi City fire fighting bureau , Kochi City public health center , Independent disaster prevention organization in Hirata apartment of a housing complex
Content of investigation	Process of transmission of collection and disaster information on disaster information ,Tool of transmission of collection and disaster information on disaster information

Table-1 Content of subject of investigation and investigation

A basic idea in the information transmission on local authorities was shown by using the investigation result of execution < Table-2>. When the organization agent collects information, this table is a summary o f the process until outputting some. The multi-agent model is made based on this basic frame.

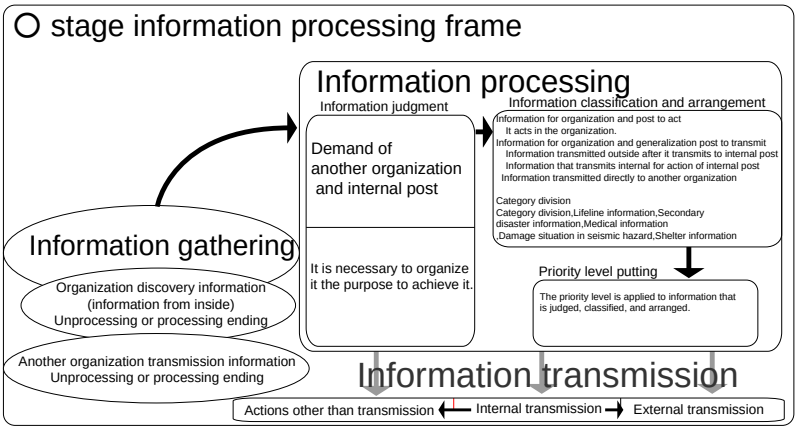

Table-2 Basic frame in processing of information on local authorities

2.3. Structure a appraisal model of disaster Information Network

The multi-agent model was shown in Figure-1. The multi-agent is not agent's mere set. This section explains about the multi agent among models. The reason to make the network of an local authorities a multi -agent is that a common purpose "Correspondence to the disaster event" exists. Moreover, it is the second reason that the regional disaster prevention plan exists as a common rule to an local authorities. There is common communications means of information transmission in the third reason. It is a reason why these three points make the network of an local authorities a multi agent. When the discoverer of the disaster event transmits information to the organization agent, the model begins trying. The information is "It wants someone to do something." And, the trial ends if the organization agent meets the disaster discoverer's demand.

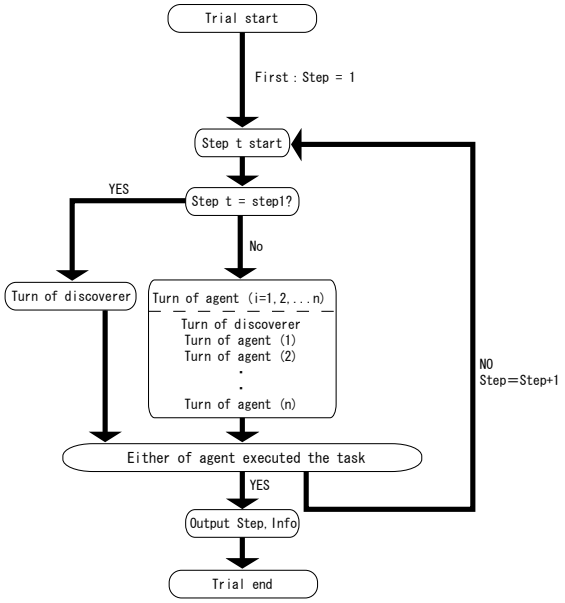

Fig.-1 the multi-agent model's flow

2.4. Structure a agent in the multi agent model

Figure 2 showed agent's specification. When agent's specification was made, time when an local authorities responded to the disaster was assumed to be a limited situation in which "Correspond to the crisis" became the purposes of most significant. It is assumed that the difference doesn't appear in the idea between agents of the organization in a word. However, the organization agent who corresponds to the demand of th

e information transmission and the disaster event discoverer in daily life exists. In a word, the judgment or ganization agent should change. Then, the parameter is set. The behavior of each organization agent change s depending on the parameter. The parameter value of the organization agent is the one having assumed it. Therefore, this model can do only a relative evaluation of the disaster information network. Next, if the tri al was done repeatedly, the organization agent assumed that studied. It was defined as the learning effect. It explains what influence the learning effect gives to the organization agent. Whether the organization age nt disregarded the rule after the trial ends is judged. And, the trial result is decided based on the elapsed ti me until the demand achieving and the demand of the disaster event discoverer. The judgment used expres sion 1 and 2.

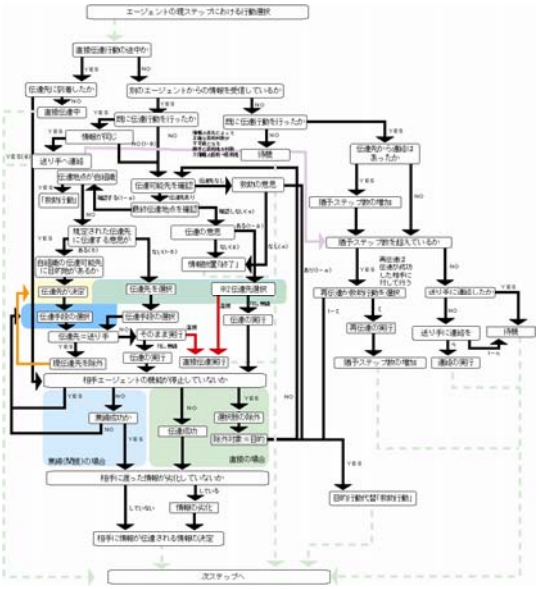

Fig.-2 Agent's specification

$$\alpha_{i+1} = \alpha_i - \left(\frac{0.005}{x(A_i)}\right) yz \qquad \ldots(1)$$

$$A_i = 0.5(Info_i) + 0.5(Step_i) \qquad \ldots(2)$$

α is a parameter that controls the action. i is a trial frequency. X (A) is a numerical value calculated from the evaluation of the trial result. y is a coefficient in which 0.5 or 1 is output based on the action. z is a coefficient in which 0.5 or 1 of each the parameters is output. A is a value in which the trial is evaluat ed. Info and Step are numerical values calculated from the information transmission evaluation that goes ou t of the trial result respectively and the evaluation of the end step. The part of "It wants someone to do so mething" of the demand of the discoverer corresponds to Info. The step when the trial ends corresponds to Step. When discoverer's demands are met and the trial ends promptly, A becomes a high numerical value. When the result of the numerical value that A is high came out, the organization agent assumed that relax ed guard. The value of A is converted into -0.55--0.1 before it is substituted for this expression (1). Moreover, it is assumed that A is a great result by 0.56 or more. When only the latter half part was filled and it too k time to the trial end, the demand set for it for A to lower, for the information transmission to become car eful, and to improve the possibility of the success oppositely.

2.5. Evaluable data within multi agent model

This model outputs the success or failure of the information transmission and the end time of the trial at each trial. The evaluation of the transmission network was tried by using this data.

3. Evaluate appraisal model of disaster Information Network

3.1. Evaluate appraisal model of disaster Information Network

It is necessary to see whether it can be proven to change the transmission success rate and the end time of the each disaster information network that the made valuation modeling outputs. The parameter value is groundless. However, if the condition of comparing it excludes the structure of the disaster information network, another is the same condition. In a word, it is thought that a separate disaster information network can be evaluated mutually. Therefore, it simulated it at identical terms after two kinds of disaster information networks had been set for the model evaluation.

3.2. Design the disaster Information Network for evaluating model

When the valuation modeling is evaluated, it is thought that it is important that the valuation modeling can recognize a structural difference of the disaster information network. A network and B network of Figure-2 are the one having designed to evaluate the valuation modeling. A structural difference of each disaster information network of A network and B network is whether information on a separate branch organization can be transmitted. In each disaster information network of A network and B network, another is the same condition. Therefore, only the difference of a theoretical network structure is appreciable.

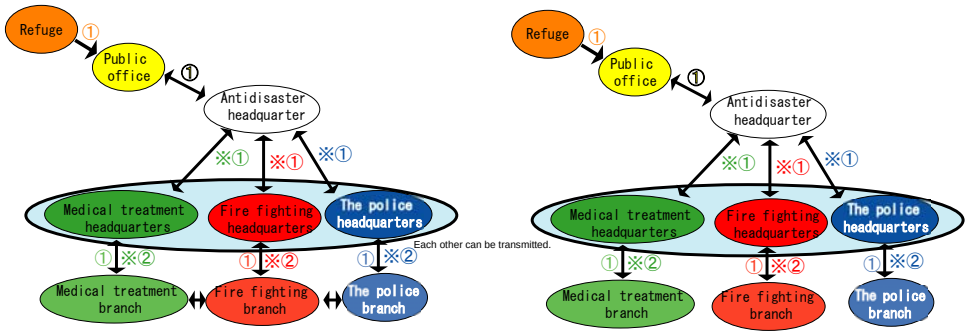

Fig.-3 Disaster information network for model evaluation (A and B from the left)

3.3. Method to evaluate model

Each A network and B networks are evaluated and the trial is evaluated with both parties of presence of the learning effect repeatedly 200 times. In addition, the same condition is repeated by five sets. The purpose of the presence of the learning effect is to see how the success probability of the network and the evaluation value of the step change by the learning effect.

3.4. Result and speculation of Simulation

The result table of A network and B network that had been evaluated by the valuation modeling was made. First of all, the transmission success probability (Table-3) was shown. Next, the evaluation value (Table-4) in all trials at the transmission time was shown. The evaluation value (Table-5) in the transmission time when transmission succeeded at the end was shown.

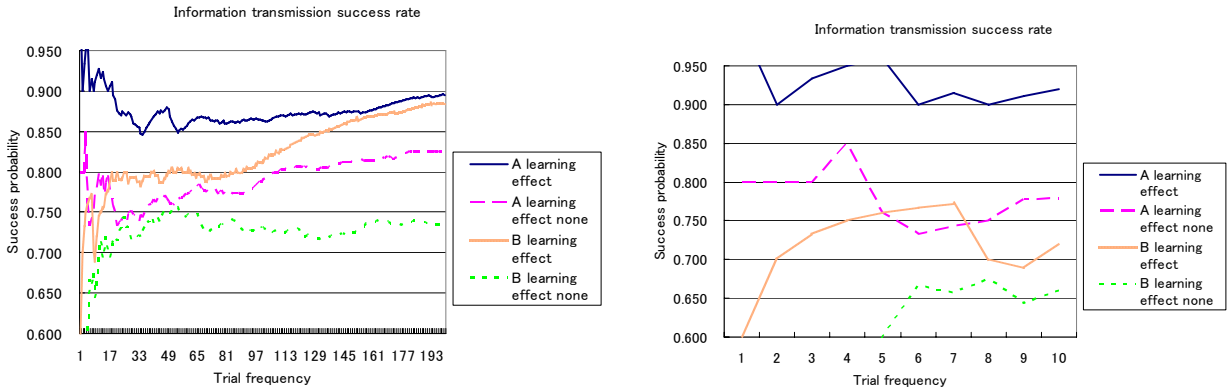

Table-3 Information transmission success probability of network A and network B

(The left side is 200 times of the trial. The right side is ten times of the trial.)

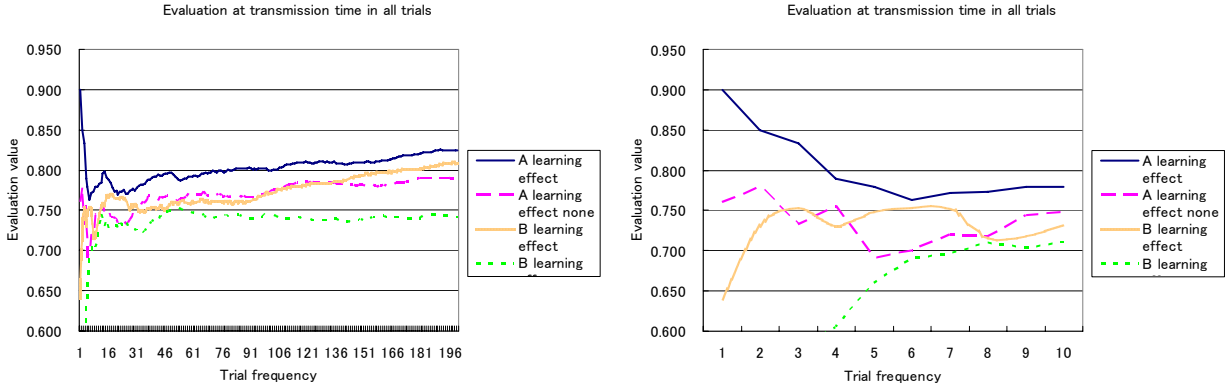

Table-4 Evaluation value in all trials at transmission time of network A and network B

(The left side is 200 times of the trial. The right side is ten times of the trial.)

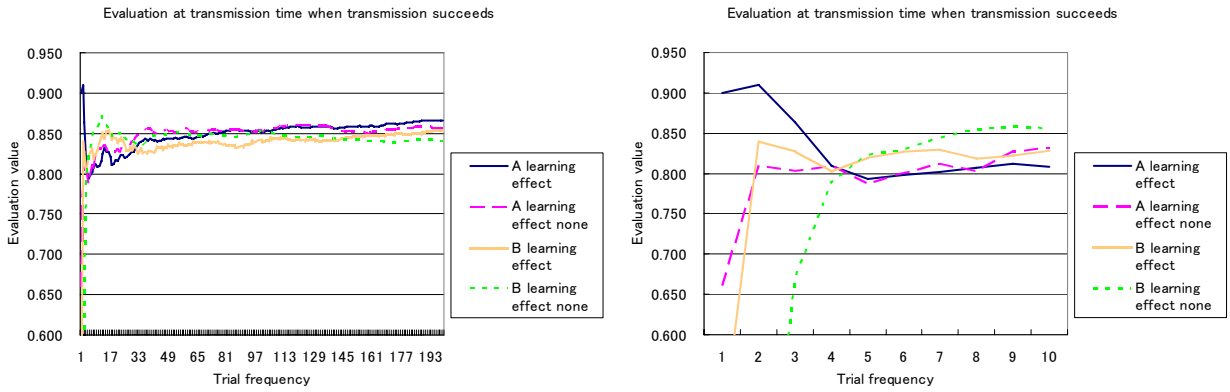

Table-5 Evaluation value at transmission time when network A and network B do information transmission success

(The left side is 200 times of the trial. The right side is ten times of the trial.)

The following two points were clarified by the evaluation of the valuation modeling.

The first is a point that the stability of the system is appreciable. As for A network, the transmission success probability evaluation value and the end step is higher than that of B network. Moreover, neither t he learning effect nor the trial frequencies are controlled as for the situation. As a result, the stability of the system was appreciable. The stability of the system is to be able to say, "Good structural networks are mor e dominant than bad structural networks regardless of the situation". However, there is an exception. It is t

he end step numerical value of the transmission success, and the numerical value of B network is higher th an the numerical value of A network. However, because transmission has succeeded only when the number of steps is little, B can be guessed to be an improvement the end step numerical value of the transmission success to this. Because the numerical value of A network in the mean value at the end time by ten times of the B network trial frequency exceeds the numerical value. In addition, the information transmission succ ess rate of the numerical value of A network is higher than the numerical value of B network. The value w hen the end time of the information transmission is in a word short is reflected in the evaluation value in t he transmission end time when the information transmission by ten times of the trial of B network succeed s.

The second is a point that it was able to be proven that the transmission success probability and the value at the end time improve even on a bad network by doing the trial repeatedly when there is a learning effect. The presence of the learning effect on B network is compared. Then, the network of the condition with the learning effect is a high evaluation value. If the trial frequency is piled up from this, it has been understood that the evaluation value of the transmission success rate and the end step improves by the learning effect. Moreover, A networks were compared by the learning effect present with a numeric difference of B network. A numeric difference decreased by the numerical value at the transmission success rate and the end time at time with the learning effect. It is thought that this has proven the limit of a numeric improvement by the learning effect. It is thought that the limit exists though the transmission success probability of the network and the evaluation value at the end time improve by the learning effect. The numerical value has already improved to the limit on A network. Therefore, it is thought that a numeric difference with B network decreased.

Therefore, it was able to be proven that the valuation modeling evaluated the difference of the network structure.

4. Evaluate actual disaster Information Network

It was proven the stability of the system was appreciable in the preceding chapter. Moreover, the nu merical value at the transmission success rate and the end time improves if the trial frequency is piled up i f there is a learning effect. In this chapter, a current disaster information network of Kochi City and the dis aster information network of the future were evaluated.

4.1. Evaluate actual disaster Information Network

The disaster information network in Kochi City is evaluated. The disaster information network in Koc hi City that would be forecast in present and the future was made Figure 4. The disaster information netw ork of the future is shape that a present disaster information network changes by making "Kochi City the s ynthesis and safe center". The network set this time is the simplified one, and actually has detailed local au thorities. However, it has aimed to see the information transmission between the organizations of another sy stem in research. Moreover, a small-scale local authority assumes belonging among agents of the organizatio n. Therefore, a lot of small scale or two or more existing local authorities' were simplified and shown.

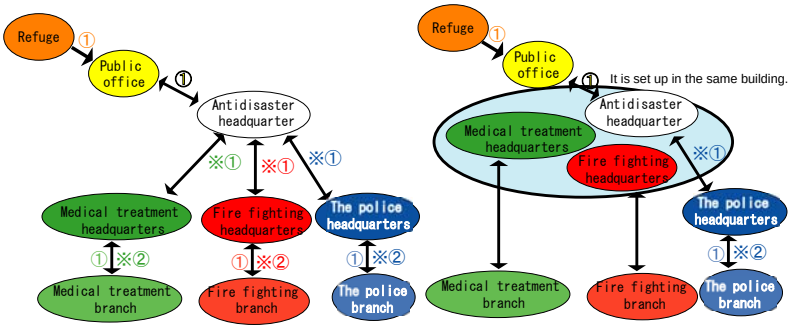

Fig.-4 Brief chart of actual disaster information network

(The left is present, and the right is the future)

4. 2. Result and speculation of Simulation

The evaluation used the technique similar to 3.3. It evaluated by the valuation modeling, and the table each disaster information network of a present disaster information network and the future results was made. First of all, the transmission success probability (Table-6) was shown. Next, the evaluation value (: Table-7) in all trials at the transmission time was shown. The evaluation value (Table-8) in the transmission time when transmission succeeded at the end was shown. A present disaster information network and the disaster information network of the future were evaluated respectively by the learning effect presence.

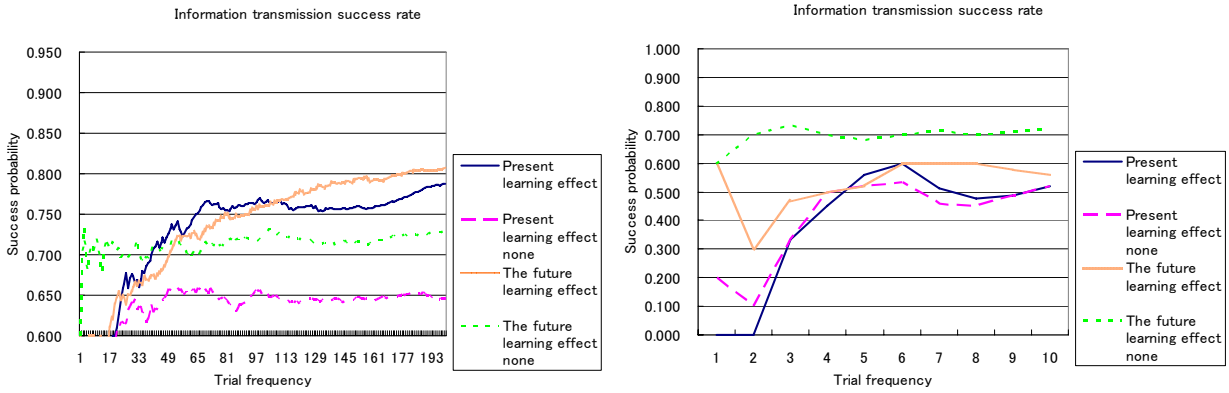

Table-6 Information transmission success probability of disaster information network
(The left side is 200 times of the trial. The right side is ten times of the trial.)

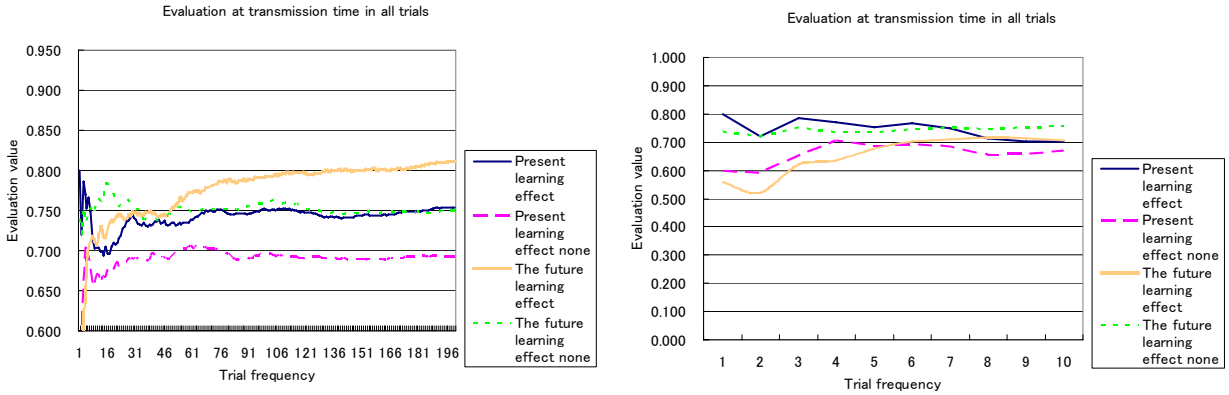

Table-7 Evaluation value in all trials at transmission time of disaster information network
(The left side is 200 times of the trial. The right side is ten times of the trial.)

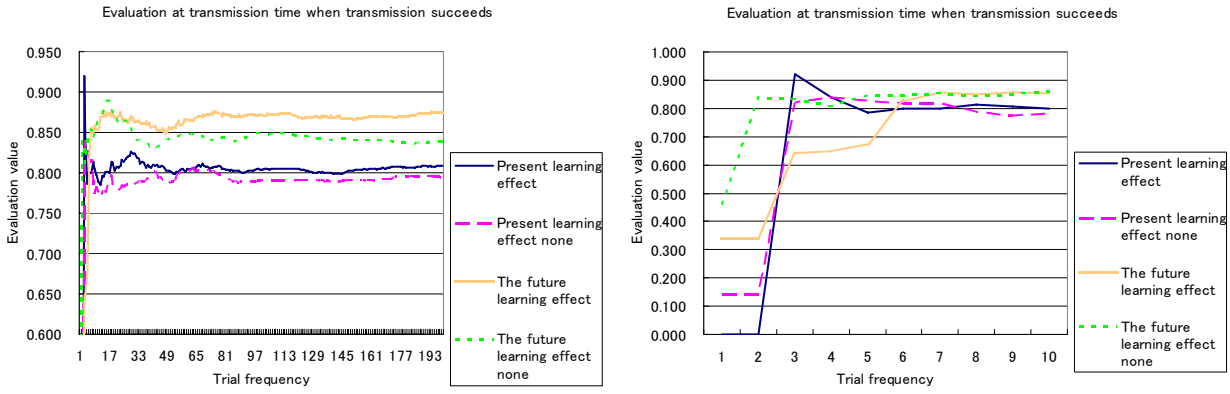

Table-8 Evaluation value at transmission time when disaster information network do information transmission success
(The left side is 200 times of the trial. The right side is ten times of the trial.)

It is necessary to verify whether consideration and the same thing in the preceding chapter can be said from the disaster information network simulation result of this chapter. The first is stability of the system. The second is that the success rates of the information transmission by the learning effect and the numerical value at the end time improve. First of all, the numerical value of the future disaster information network was higher than that of a present disaster information network in all numerical values without the condition relation. It can be said that the stability of the system was appreciable from this. Next, if the trial frequency was piled up, this simulation examined whether the numerical value improved. If this simulation result is seen, a numeric difference between the disaster information network of the reality and the future disaster information network is growing by the learning effect. However, the numerical value has improved by the learning effect when only a present disaster information network is seen. Therefore, the success rate of the information transmission and the numerical value at the end time improved by the learning effect and it was possible to prove.

5. Conclusion

It was able to be proven that it was the one that was able to be evaluated by comparing the disaster information networks mutually by using the valuation modeling made by using the multi agent theory by this research. And, the practical use possibility of the multi agent theory was shown. However, the model where only one event occurs by one trial is not realistic. In addition, it doesn't consider it in this valuation modeling though the lack number of men and equipment and dysfunctions etc. of the organization are thought in actual local authorities. In a word, it can be said that this research is the first stage of "Evaluation model make on the disaster information network with the multi agent theory". It has already worked on making the specification of a new model. The specification of the model will be completed in the future and it aims at a new model make.

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