

# Proposal and Evaluation of Contribution Value Model for Creation Support System

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**Abstract**— Participants in the creation projects of new products and services start a discussion by formulating the concept or posing a question. It is important for them to exhibit creativity and propose diverse ideas. In order to support the creation, supporting the connectivity of information and motivation improvement is important. It is expected that if the participants feel they are meaningfully contributing to the project, they will become more motivated. In this study, we propose an evaluation model that visualizes the degree of contribution of each participant as a contribution value when the project reaches points that require creativity. Through this model, one's own ideas and opinions can be visualized as a chronological contribution value throughout the course of a discussion. The evaluation results demonstrate that the visualization of the course of a discussion motivates the participants to contribute to others and to the project.

**Keywords**— *Creation Support; Collaboration; Contribution Value; Motivation Improvement; Evaluation*

## I. INTRODUCTION

Participants in the creation projects of new products and services start a discussion by formulating the concept or posing a question. A new development method known as design thinking [1] is increasingly being used in this context. In contrast to existing projects with established processes, an important point for new service creation projects is the generation of diverse ideas by the participants. In order to support the creation, supporting the connectivity of each information and motivation improvement is important. [2]

Previous systems have provided support mainly in the form of methods that help to create diverse ideas. However, as yet there is no method to evaluate how much the generated ideas contribute to a project. If it is not possible to identify how much an individual's content contributes, there is little motivation for individuals to propose better ideas in the future. Moreover, the evaluation of idea content has been limited to the direct evaluation of agreements or disagreements, or to the total registration numbers. In this paper, we pay attention to motivation improvement and propose a model to visualize the contributive value of content to a project during a new discussion and examine how this model allows the evaluation of content. The proposed model does not merely evaluate the value of individual content separately; rather, it assesses

content as a process factor from the problem to the solution and evaluates the content that led to results.

Thus, in order to evaluate content accurately, we focus on the transition of the value of content following the passing of time and on the flow of the discussion composed of connections between content. When individual content is accurately evaluated, we can precisely evaluate its contribution level in the discussion. This will enable the participants to visualize their ideas and opinions as a chronological contribution value along with the transition of the discussion. We predict that this will enhance the participants' motivation and guide their actions toward the success of the project.

## II. CURRENT STATE AND PROBLEMS OF CONTRIBUTION LEVEL EVALUATION IN DISCUSSIONS

### A. Related studies

For the visualization of discussions, there is a structuralization method that makes it easier to understand after the passing of time. The Issue Based Information System (IBIS) was developed by Werner Kunz and Horst W. J. Rittel [3] to visualize discussions during a complex development process. Following this, gIBIS [4] was developed in order to visualize the flow of these discussions. This system uses nodes and links on a graph for the visualization. This allows for a smooth comprehension of the structure of a discussion, making it easier to join it in the middle.

There has been some prior research on the evaluation of the content of one's comments and on a practical case regarding the contribution to a discussion. Quirky [5] has a platform that enables users to propose new products in an open environment and forms a community for co-creating these products with the users, leading to the eventual launch of the products. Its most unique feature is a system called Influence, which measures the contribution levels of an individual on the product that is being developed. Compensation that corresponds to one's influence is paid from the funds derived from the sales profit of the product. The contribution levels of the person who proposed the idea, those who voted on it, the designer, and the one who proposed the product name are all taken into account.

There has also been work that aims to activate a discussion and improve its quality through utilizing a discussion incentive

function of the participants in large-scale discussions such as an online town meeting [6]. Here, the discussion is represented as a tree structure. It awards activity points according to the content of one's comments in the discussion, which becomes an incentive to be active, and it also awards feedback points, which becomes an incentive to encourage constructive comments. Post, reply, and agreement functions are included in the activity points. The feedback points consist of reply points gained by replying to a comment and agree points based on how an agreement with one's comment proportionally spreads. Giving incentives to the discussion participants will ideally activate more fruitful discussion.

There is also a method of collaborative learning that utilizes the system of discussion activation using online chats and its effects [7]. It monitors the discussion progress and quantifies and displays the role of a learner as an "influence level of positive comment". The idea is to draw useful comments from participants to trigger an active discussion. The intentions of comments are classified and defined before the discussion and a rule for calculating the influence level of positive comments is established. This enables the character of a participant and his/her role in the discussion to be extracted.

#### *B. Awareness of contribution level in discussions*

The discussion methods above can be roughly divided into the evaluation of the content itself and the evaluation of propagation to previously registered content. The evaluation of the content itself involves evaluating the already added scores and its registration number. The evaluation of the effect on the registered content involves agreements and disagreements, transmission of such evaluations, and quotation of the content. Both of these serve as methods in which people directly evaluate the registered content themselves.

However, the typical discussion situation is not limited to a direct evaluation of the content by people. For example, there are evaluations of the actions of a person, of the feelings shown through actions such as praising or thanking another participant, and of the role of the facilitator in triggering the progress of the discussion. As an example of evaluating the actions toward others, there is one case in which offering help to another person in trouble led to that person achieving a result. In such a case, the supportive action toward another should be considered. Moreover, content that supports a good idea when it is proposed should also be considered. There have been cases where a person who received praise or gratitude started to actively participate in the discussion afterward. This is because the human desire for recognition was satisfied. Finally, expansion and conclusion of the discussion and activation of a stagnant discussion are also key items to be evaluated because they encourage the progression of the discussion.

The items discussed above are parts that cannot be assessed through a method in which people directly evaluate the content by themselves. As such, an expanded evaluation, in addition to the evaluation of the content itself, is necessary. The evaluation of the expanded part is also a part that has been left to others to evaluate intuitively. When a discussion concludes within a short period of time, or when there is only a small number of participants, it is possible to grasp the registered content of

each participant; however, when the discussion is prolonged, or when there are many participants, it becomes difficult to grasp an overall view of the discussion. This is because one only remembers the content from the preceding moment and tends to forget more as time passes. Moreover, it is necessary to successively grasp the relationship between content, or to identify how content may change the behavior of people. Since the evaluation of these expanded parts exceeds the scope of human recognition, they cannot be evaluated without using ICT to gain an overall view of the discussion.

We are currently facing three issues here. First, an evaluation of the effects of actions such as supporting others has not been conducted. Second, an evaluation of the changes in behavior triggered by actions such as showing gratitude to others or praising them has not been conducted. Third, an evaluation of discussion progress has not been conducted.

### III. PROPOSAL OF A CONTRIBUTION VALUE EVALUATION MODEL FOR CONTENTS

We put forth that the comprehensive evaluation of content can be achieved by expanding the direct evaluation of content, thus solving the three problems above. As discussed in Chapter 2, earlier content evaluations were mainly direct evaluations of the content by people. For example, the direct evaluation to contents by people is agreements and disagreements. The evaluation of the parts that were expanded on this occasion as a new evaluation involves the evaluation of actions toward others and content that helps the discussion progress. For such an evaluation, it is necessary to monitor both achievements and results, which requires comprehension of the content as a process rather than looking at individual bits.

Both the direct evaluation of content and the evaluation of the expanded parts are organized from the perspective of their respective necessary factors. The necessary factors for the direct evaluation of the content consist of the "people", which serve as the subject of the evaluation, as well as the "time" factors. On the other hand the necessary factors for the expanded parts consist of the "system", which serve as the subject of the evaluation, as well as the "time" factors. It is necessary to verify the results of the registered content after the passage of time. In other words, it is necessary for the system to first analyze the state of the discussion using the registration time of the content as well as the connection state. For example, registered content must be identified as either an action toward others or an action toward the discussion. It is then necessary to verify whether this has led to the expected result after some time. Then, the previously registered content must be evaluated in light of the result.

We integrated the common elements among the abovementioned factors and constructing a comprehensive evaluation and then produced a matrix consisting of the evaluation subject and the time axis. The contribution value evaluation model, as shown in Table 1, was then obtained. Details of the item of the matrix are shown in the next chapter.

TABLE 1. Contribution value evaluation classification.

		Evaluation subject		
		Evaluation by others		Evaluation by System
Time	When node is registered	1) Self-evaluation	2) Evaluation of others	5) Situation evaluation
		Self-evaluation or already added	Evaluation of others.	Evaluation through time factor and connection status.
	Over time	3) Sequential evaluation		6) Contribution evaluation
Reflexive evaluation through connection to the host node.		Recognized as the contribution to the project and to others.		
At solution	4) Process evaluation			
	Evaluation of the node done backward from the solution to the problem.			

#### IV. CONCRETE REALIZATION METHOD

##### A. Visualization of discussion

Regarding the visualization method, ideas, opinions, and information are recorded in “nodes”, as shown in Fig.1. A connection with the problem or previously registered “nodes” is established by means of “links”, as discussed in detail in the next subsection.

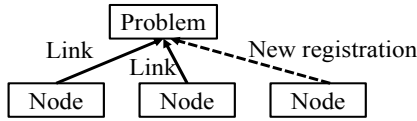


FIGURE 1. Connection of nodes and links.

##### B. Evaluation of contribution value

With the objective of solving the three issues, we evaluated the contribution value using the evaluation model in Table 1. Contribution value is defined from the overall score of the node derived from each of the nodes. The following is a detailed explanation of the six evaluation points we used, along with their algorithms

###### 1) Self-evaluation:

Self-evaluation is the evaluation of a node by oneself or an already added score when registering the node. However, as it is likely for discrepancy caused by individual judgments to occur, this paper allocated points to each class of node, as listed in Table 2. First, the node is classified into one of five factors “Intellect”, “Emotion”, “Action”, “Problem”, or “Solution”. Points are allocated in accordance with the classification of each node.

###### 2) Evaluation by others

Evaluation by others is when an evaluation is given to an already registered host node. For example, the expression of agreement or disagreement with an idea or an opinion, through direct evaluation giving points to a good idea or demonstrating how a host node was influential, is expressed through the link information that connects a node with other nodes. As shown in Table 2, a propagation coefficient is added to links as the influence level to the host node. This propagation coefficient is changed according to whether it is merely a connection to the host, one’s own idea and opinion registering the influence of the host node, or a direct evaluation toward the host node. For example, in the case of influence classification shown in Table 2, one’s own opinion and idea were considered to have been

created under the influence of the host node, and thus 50% of one’s point is given to the host. In this system, the total of one’s self-evaluation and the evaluation from others is set as the “overall score of node”. An overview of the evaluation method is shown in Fig. 2.

TABLE 2. Classification of nodes and links.

Node		
Large classification	Content	Point
Problem	Setting problem(Identify between AND problem and OR problem)	4
Solution	The solution to the problem	4

Large classification	Medium classification	Small classification	Point
Intellect	Knowledge	Information, analysis, question, opinion	2
	Idea	Inspiration, realization, proposal, ingenuity	4
	Judgment	Evaluation, agreement, disagreement	1
Emotion	Needs	Clients' needs, external environment	1
	Wish	Longing, ideal form, vision	2
Action	Will	Encouragement, gratitude	1
	Network	Introduction, visit	1
	Plan	Planning, prototype, milestone	1

Link		
Large classification	Small classification	Propagation coefficient
Evaluation	Connection to the node that gave an evaluation to the host node	0.8
Influence	Influence, integration, separation	0.5
Result	Result of the support, outcome	0.5
Replacement	Replacement, generalization, specification	0.8
Connection	Connection, explanation	0.2

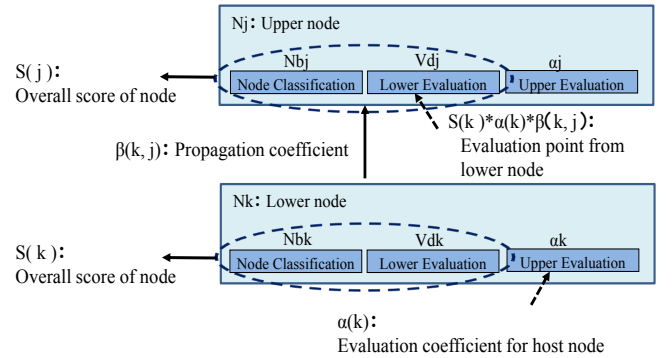


FIGURE 2. Evaluation method using nodes and links.

Next, we explain how the system gives an evaluation from others to the already registered host node. The actual calculation is done through the algorithm below. (1) The overall score of a node is only one line if it is on the evaluation of the host node. However, if the node is connected through several lines, it is calculated reflexively. In the case shown in Fig. 2, the overall score of node  $S(j)$  of node  $N(j)$  is calculated as

$$S(j) = Nb(j) + \sum_k S(k) * \alpha(k) * \beta(k, j) \quad (1)$$

$Nb(j)$ : Node classification point of node  $N(j)$

$\alpha(k)$ : Evaluation coefficient of host node  $N(j)$

The evaluation coefficient is either added through the node classification of  $N(k)$ .

$\beta(k, j)$ : Propagation coefficient from node  $N(k)$  to node  $N(j)$

###### 3) Sequential evaluation

Sequential evaluation is an evaluation that considers the passing of time and the connection status of the nodes. This is

done because it is not possible to determine the true value of a node with only the evaluation at the point of its registration. It is necessary to add the factor of passing time to the overall score of the node, which includes the influence of evaluation by others in the self-evaluation. For example, when many opinions over an idea node are given, the branches of the true diagram expand. Similar to how new ideas are added to an original idea as a result of people seeing the idea, a discussion deepens as a result of many opinions being exchanged over the initial idea. In such a case, a function to reflexively calculate the points using the function to propagate toward the host node is installed. The algorithm for this is shown in Fig. 2. The discussion on a good idea deepens, and the evaluation toward the node that initially proposed the idea improves. In contrast, if the discussion does not progress, the evaluation of the node does not change from the point of its registration.

#### 4) Process evaluation

Process evaluation goes backward from the solution to the problem at the point when the solution of the problem was determined and extracts the nodes in that process to evaluate. In reality, the overall score of all nodes aside from the nodes in the process is decreased. Through this, the nodes that contributed to the problem solving and the nodes that did not are differentiated. Process evaluation is possible only when the problem is solved; it is not possible to conduct it at the point of node registration or during the problem solving. Process evaluation enables the evaluation of the process toward problem solving. For example, it allows re-recognition of an opinion that changed the way of thinking or an opinion that no one initially valued but that turned out to be important.

#### 5) Situation evaluation

Situation evaluation is an evaluation through the connection situation of nodes. For example, in order to evaluate a node with an intention to organize several nodes and conclude the discussion or, conversely, a node with an intention to expand the discussion, it is necessary to classify the node. Moreover, whether the discussion is stagnating or being active can be judged by the registration situation of the nodes up to that point. The activity ratio of each problem is determined by comparing the average of the interval between node registrations of the project as a whole and the interval between node registrations of the given problem. For this, although the performance of the node cannot be verified at the point of its registration, it is necessary to record it as the node that triggered a change. Table 3 shows how these cases are identified.

TABLE 3. Distinction of situation evaluation and contribution evaluation.

Classification	Situation evaluation distinction	Contribution evaluation distinction
Convergence	Registration of multiple nodes through convergence link.	Exceeds the project node registration average after convergence (activation of discussion).
Divergence	Registration of connection to multiple nodes through an divergence link.	Reaches the solution via the path after the divergence.
Breaking silence	Registration of a node after going below the project node registration average.	Exceeds the project node registration average after node registration (activation of discussion).
Support/Introduction	Classify and identify support to others as node.	The result is given as feedback through the link.
Praising/Gratitude	Classify and identify support to others as node.	Exceeds the project node registration average after the node registration (activation of discussion).

#### 6) Contribution evaluation

As shown in Table 3, contribution evaluation verifies the result, over time, of nodes whose performance could not be verified at the point of their registration by situation evaluation. For example, when a registration of someone broke the stagnation of a discussion and triggered its activation, it was not clear that this was going to be the case at the point of the node registration. Only after time could it be verified how effective that node was. Similarly, only after some time could we verify whether it was really effective in terms of supporting someone. This shows that those with a high node point are not necessarily the only ones with value (i.e., supporting the discussion), and that others should also be evaluated. Through this, identification of the characteristics of each person, such as those who break silence, those who support and introduce, those who are good at summarizing the discussion, and those who are good at expanding the discussion, is enabled.

## V. EVALUATION

### A. Evaluation method

Table 4 lists the various conditions of virtual data used in the evaluation. The node and the link without contents were produced as shown in Table 5, taking into consideration the flow of the discussion. A role was given to each participant in order to construct the discussion. Regarding the node registration time, it is conducted with the timeframe that, though virtual, takes into consideration the stagnation and activation of the discussion. However, the registration time is not shown in Table 5. Fig. 3 shows an example of the structural graph that we evaluated this time. This evaluation uses pre-prepared virtual data, but the algorithm would function even when data from a real discussion is used, and thus the function is verified. However, proposed parameter and coefficient are a temporary values it, and should consider it of deciding the best value while experimenting.

TABLE 4. Evaluation data.

Item	Content	Details
Node and Link	Produced 100 nodes.	Node/Link classification is based on Tabel 2.
Member	5 participants. Each takes action suitable to his/her character.	A: Sub leader-like character. B: Leader-like character who leads the discussion. C: Supports the discussion and others. D: Does not speak up often, but has good ideas. E: Only evaluations such as agreement or disagreement.
Node registration time	Time that takes into consideration the flow of the discussion.	Not a real node registration time but a prepared one; does not display the registration time.
Evaluation method	Contribution value evaluation classification.	1) Self-evaluation 2) Evaluation by others 3) Sequential evaluation 4) Process evaluation 5) Situation evaluation 6) Contribution Evaluation

TABLE 5. Registration situation of a node.

Category	Member	A	B	C	D	E	Total
		Problem	1	2	0	0	
Intellect	Knowledge	5	8	6	5	1	25
	Idea	4	4	2	2	0	12
	Judgment	9	8	13	8	16	54
Emotion	Praising/Gratitude	1	1	0	0	0	2
Action	Support	0	0	1	0	0	1
	Solution	2	1	0	0	0	3
Total		22	24	22	15	17	100

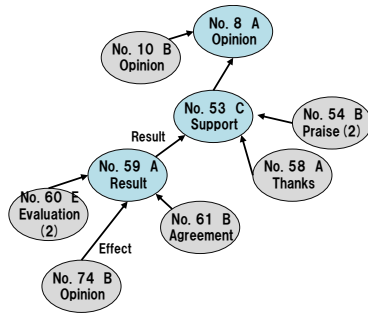


FIGURE 3. Structural graph.

### B. Evaluation results

The quantitative evaluation of the three issues was examined through the six evaluations listed in Table 1.

#### 1) Self-evaluation

Self-evaluation is the evaluation of a node by oneself or an already added scores when registering the node. In this paper, regarding the self-evaluation, we determined that the preset node classification point was reflected on the evaluation point of the node.

#### 2) Evaluation by others

We examined whether the evaluation points were added to the host in the propagation coefficient that was set when evaluating an already registered host node and found that they were, in each of the following cases:

- When only adding simple agreements and evaluation points.
- When an opinion or an idea was registered under the influence of the host node.
- When it is only a simple connection.

#### 3) Sequential evaluation

The transition of the overall score of node no. 6, which is an idea node, is shown in the graph in Fig. 4. The overall score of node no. 6 increased over time from the point of registration, following evaluation from others and the progress of the discussion. Its point initially increased as it was evaluated to be a good idea from the early stage, and over time, the discussion progressed along the line of this idea, and with the addition of reflexive evaluation, after the final solution, the overall score of the node increased.

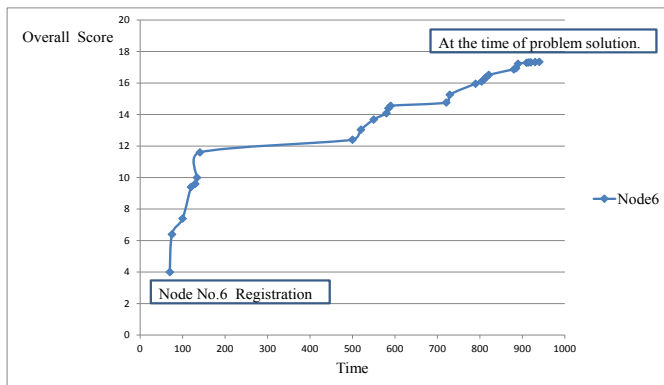


FIGURE 4. Change in the overall score of node No.6.

#### 4) Process evaluation

Table 6 shows an effect of process evaluation. Though the total number of registered nodes was 100, only 19 were related to the solution. Regarding these 19, Table 6 shows that the point ratio, after the process evaluation of participating members A to E, changed in accordance with the number of nodes related to the solution. The point ratio of E, who participated in the project only through agreements and disagreements, was 3.1 points lower, while that of A was 3.4 points higher. Although D did not speak up often, his/her point ratio was higher than that of C. From these values, we can see that D contributed to the project and that A and B contributed to solving the problems.

TABLE 6. Effect of process evaluation.

Member	A	B	C	D	E	Total
Overall score	87.8	103.5	55.5	55.6	18.0	320.4
Point ratio (%)	27.4	32.3	17.3	17.4	5.6	100.0
Process evaluation node number	22	24	22	15	17	100
Node number after process evaluation	7	6	2	4	0	19
Score after process evaluation	66.0	67.3	33.1	42.2	5.4	214.0
Point ratio after process evaluation (%)	30.8	31.5	15.5	19.7	2.5	100.0

#### 5) Situation evaluation and 6) Contribution evaluation

As an example of situation evaluation, we selected a node that broke the silence. First, it is necessary to recognize that the discussion is stagnating. The calculation of the activity ratio of each problem is used as the recognition method.

As shown in Fig. 5, it is clear that before the registration of node no. 36, which is an idea node, the node registration of problem X was stagnating. Initially, at the point of the registration of node no. 36, it was situation evaluated as a node with the potential to activate the discussion. Following the registration of node no. 36, many other nodes started to register, and it is clear that the multiple registration of nodes was conducted for problem X in a shorter interval than the average node registration interval of the project as a whole. From this, we can infer that the idea of node no. 36 is what activated the discussion.

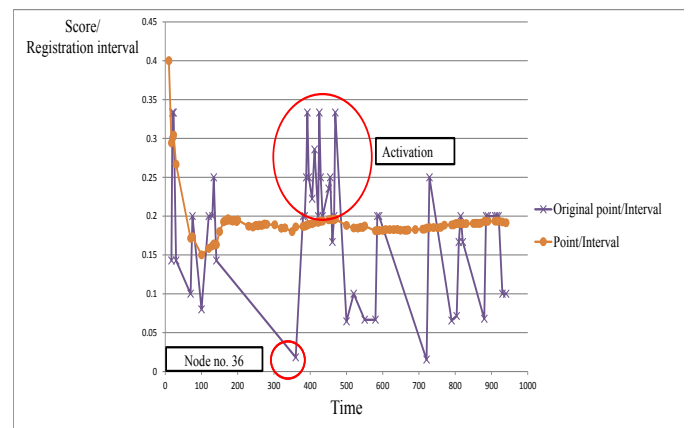


FIGURE 5. Activation of argument.

Fig. 3 also shows the evaluation of supports from others, which is the other evaluation. Node no. 53 is the node where C

supported A. First, at the point of registration of node no. 53, the situation evaluated it as a support node. Sometime after the registration of node no. 53, A reported the result in node no. 59. From this, we can see that A achieved a result with the support from node no. 53 registered by C. In addition to the increased overall score of node no. 53, a contribution evaluation was conducted on node no. 53 of C, as it was judged to have contributed to A.

As shown in Fig. 6, node no. 80 is a convergence node related to the solution node no. 96 and this node should be evaluated as contribution value. It is possible to visualize the contribution value of each person to the project.

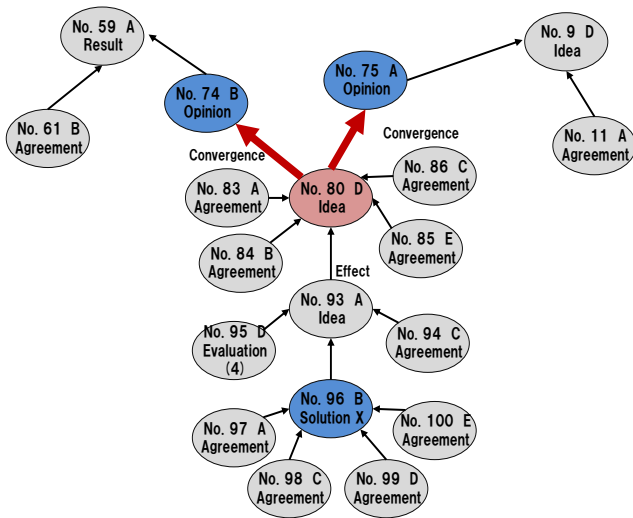


FIGURE 6. Effect of the convergence node.

## VI. DISCUSSION

As stated earlier, we identified three key issues in the evaluation of discussion. In response to these problems, we examined an evaluation method for solving them and proposed an evaluation model as a contribution evaluation that integrates the subjectivity of evaluation and the perspective of time. Algorithms for the evaluation were also established. We consider this to be a key guide for evaluating a discussion or a project. Next we performed an evaluation of the evaluation model through a simulation using virtual data. Results showed that the qualitative evaluation of this system is able to conduct a wide-ranging evaluation covering areas that other systems do not. We also found that it is possible to evaluate the character of the participants, such as a person who expands or concludes the discussion, breaks silence, or supports others. From these results, the contribution value of the participants to the project was visualized.

We conclude that it is possible to apply the evaluation method of the contribution value in a discussion to the

previously examined creation support system. One of the functions of the creation support system is the bridging information and motivation, improvement by enabling the visualization of the contribution level to the project, which is subsequently used to increase motivation. Moreover, it allows for the introduction or recommendation of a suitable person by using the contribution evaluation, thus bridging information. In addition, as it manages the nodes of the overall project, it allows analysis from various perspectives: by individual, by node, by problem, and by project. It is also possible to discover the characteristics of participating members by aggregating the contribution value evaluation.

## VII. CONCLUSION

The proposed evaluation method is a key addition to the field of human motivation. In order to promote the creation of new values, it is necessary to gather the wisdom of many people and translate their insights into action. In order for an individual to think for him or herself and adapt his or her actions, it is first necessary to have a clear understanding of one's role and situation. We believe that this contribution value is effective for the reformation of one's action.

We are developing this system, and we plan to confirm whether same processing result can be obtained in the near future. We will also encourage individual inspiration and the bridging of information in order to implement this system as an integrated creation support system.

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