Visualisation of Change in Employee Morale during Organizational Innovation

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Abstract— Employees' morale is known to depend upon the trust in their management and to have a significant effect on the possibility that organizational change or innovation will be successful. This study first formulates a total employees' morale associated with organizational reform and then develops a simulation model for visualising how employees' (psychological) state changes during organizational reform or innovation. Numerical examples are also presented to demonstrate the behaviour of the employees' states after the manager offers the plan with respect to the new organizational design.

Index Terms— Trust, Visualisation, Employee morale, Organizational innovation

I. INTRODUCTION

THE primary purpose of business organizations is to efficiently resolve the issues in their strategies and to achieve the objectives set by themselves/their stakeholders. Recently, many companies have no choice but to realign their organization design to fit ever-changing business environment. Several researchers have pointed out the following *Morale issues* associated with organizational reform ([1], [2]). The morale issue in the process of organizational reform is defined as the decreases in willingness to work, uncooperative attitudes, and low morale of both executive and non-executive employees, which is caused by the following factors: (a) resistance to the reform, (b) confusion caused by the change, and (c) conflict among employees. The morale issue, faced by the managers and corporate management, can become a serious problem that determines whether they can successfully achieve their organizational innovations or not. For this reason, the managers and executives have to play a key role in organizational reform as "designer" of their organizations with significant responsibilities [2].

Rousseau et al. [3] have explained a definition of (employees') *Trust* (in the management) as follows: in interpersonal relationships, when ensuring the intentions and behaviour of other people are appropriate comes with certain risks and when the achievement of interests of an individual may depend on another person, trust is essential in these case. Trust can be defined as "a psychological state comprising the intention to accept vulnerability based upon positive expectations of the intentions or behaviour of another" (Rousseau et al., 1998, p.395) [3]. Odaka[4] has described

that the morale consists of the trust in their manager as well as in their colleagues, but the trust in their manager and organization can be of particular importance to deal with the morale issues emerged with respect to the organizational innovation[1].

Reforming organization involves high risk essentially, in that not only will it have a significant effect on the entire organization, but it is also uncertain whether it will be successful or not. The existence of such risks leads to the employees' anxiety and confusion, which results in a serious morale issue with ease. The realization of organizational change therefore requires to secure the employees' morale so that they can work by collaborating with each other. Thus, organizational reform demands leadership as well, to "offer direction and then motivate others to believe and to follow" (Roberts, 2004, p. 284) [2]. The executive's leadership can be formed based on the trust of both managers and non-manager employees in their organization. Bellah et al.[5] also suggested that it is important to strengthen the relationship of trust in order to realise the organization design for high-technology companies, which can achieve the innovation and maximise the employees' creativities. The above discussions imply that the morale increases with the employees' trust in their manager and organization since the leadership for them increases with the trust, and then the morale becomes large as the leadership increases.

Inoue[6] has revealed that the relationship between the morale and major types for the organizational reform. Yamanaka[1] has proposed a model for estimating the value of the employee's trust in the management under the situation where nine kinds of organizing forms for reforming organization are introduced to the organizations. To the best of our knowledge, there are no previous studies that have explicitly clarified how employees' morale change during the organizational reform.

This study considers the case where each employee's (psychological) state with respect to the organizational reform consists of the following two factors: (1) degree of employees' consent to the proposal by their manager, which depends upon the trust in their management and (2) degree of their motivation to work, which is independent of the trust. We first formulate a total employees' morale to evaluate the difficulty of reforming the organization and then develop a simulation model for visualising the change in the employees' states during reforming of the organization design. Numerical examples are also presented to illustrate the behaviour of the

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employees when the frequency with which the manager gives her/his employees orders varies.

II. NOTATION AND ASSUMPTIONS

This study considers the following framework for simplicity:

- The organization has three levels: (1) a manager (or CEO), (2) executive employees (Executives), and (3) non-executive employees (Non-Executives).
- The manager (or CEO) gives her/his Executives orders associated with the organizational change, and then Executives instruct their subordinates (Non-executive) to do it.
- The employees are expected to obey the orders from their superiors (even if they do not agree with it in the back of their mind).

The main notation used in this paper listed below:

A	index set which consists of executive employees (Executives)
B	index set consisting of non-executive employees (Non-executives)
$\boldsymbol{u}_0$	vector of the manager's state ($\boldsymbol{u}_0 = (1,0)$)
$\boldsymbol{a}_i$	vector of state of Executive $i (\in A)$
$\boldsymbol{b}_i$	vector of state of Non-executive $i (\in B)$
V_i	morale of Employee i
θ_i	angle between vector $\boldsymbol{u}_0 = (1,0)$ and vector $\boldsymbol{a}_i$ (or $\boldsymbol{b}_i$), which expresses the degree to which Employee i gives her/his consent to the order $(0 \le \theta_i \le \pi)$
$\theta_{i,j}$	angle between the two vectors $(\theta_{i,j} = |\theta_i - \theta_j|, 0 \le \theta_{i,j} \le \pi)$
r_i	magnitude of each vector, which represents the degree of the motivation or willingness of Employee i to work $(0 \le r_i \le 1)$
φ_i	degree of trust of Employee i in the management
$p_i(\varphi_i)$	obedience of Employee i to the management, function of φ_i $(p_i'(\varphi_i) \ge 0,\ 0 < p_i(\varphi_i) < 1)$.
α_i	susceptibility of Employee i to mind or opinions of other employees in the same job position $(0 \le \alpha_i \le 1)$.
γ_i	rate of increase in the motivation of Employee i $(0 < \gamma_i < 1)$
η_i	rate of decrease in the motivation of Employee i $(0 < \eta_i < 1)$
X_i^1	categorical variable for gender of Employee i with 1 as male and 0 as female.
X_i^2	categorical variable for job position of Employee i with 1 as Executive and 0 as Non-executive.
N_C	the number of employees ($C = M, A, B$ as Manager, Executive, and Non-executive, respectively)

The assumptions in this study are as follows:

i) Each employee's trust, represented by φ_m ($m \in A \cup B$), in the management is expressed as a function of the (first and second principal component scores of) variable with respect to the type of organizational change as well as her/his gender (male or female) and job position in the company (executive or non-executive employee)[1].

ii) The state of each employee consists of the following two factors: (1) the degree of the consent, denoted by θ_m, of Employee m ($\in A \cup B$) to the proposal by their manager (which depends upon the trust in their management) and (2) the degree of willingness or motivation, denoted by r_m, of Employee m to work (independent of the trust). As for the manager, $(r_0, \theta_0) = (1,0)$, i.e., $\boldsymbol{u}_0 = (1,0)$.

iii) The morale of Employee $i \in A$ (or $k \in B$) can be measured by $\boldsymbol{a}_i \cdot \boldsymbol{u}_0$ (or $\boldsymbol{b}_k \cdot \boldsymbol{u}_0$) (inner product between two vectors).

iv) Each employee's motivation or willingness to work is reduced at the rate of η_m ($m \in A \cup B$) when the employee is forced to obey her/his superior's instructions. In contrast, it increases at rate γ_m when one employee decides her/himself whether or not to follow the instructions by being influenced by another employee in the same level of job position (Executive or Non-executive).

v) The degree of consent θ_i ($i \in A$) will approach zero in proportion to $p_i(\varphi_j)$ if Executive i receives the order from the manager. The angle θ_k ($k \in B$) will approach θ_i ($i \in A$) proportionally to $p_k(\varphi_k)$ if Non-executive k is ordered by Executive i.

vi) The degrees of consent of employees in the same job position are mutually influenced as follows: (a) For $\boldsymbol{a}_i \cdot \boldsymbol{a}_j > 0$ $(i, j \in A, i \ne j)$ (or $\boldsymbol{b}_k \cdot \boldsymbol{b}_l > 0$ ($k, l \in B), k \ne l$), $\theta_{i,j}$ (or $\theta_{k,l}$) decreases in proportion to each susceptibility to other people's mind or opinions. (b) For $\boldsymbol{a}_i \cdot \boldsymbol{a}_j \le 0$ (or $\boldsymbol{b}_k \cdot \boldsymbol{b}_l \le 0$), $\theta_{i,j}$ (or $\theta_{k,l}$) increases proportionally to the susceptibility.

III. MODEL

TABLE I
VALUES OF ρ_1 AND ρ_2 [1]

Type of organizational change	ρ_1	ρ_2
Hierarchical flattening	0.728	0.492
Strategic decentralization	0.895	-0.149
Operational decentralization	0.848	-0.270
Project-based organizational structures	0.786	-0.211
Downsizing	0.655	0.599
IT investment	0.796	-0.376
Communications and systems integration	0.762	-0.477
Strategic restructuring	0.866	0.110
Outsourcing	0.596	0.578

Yamanaka [1] has conducted a questionnaire survey to general employees and management personnel employed in different departments in a variety of organizations in Japan. As a part of the results, he revealed that each employee's Trust, denoted by φ_m ($m \in A \cup B$), in the management can be given by
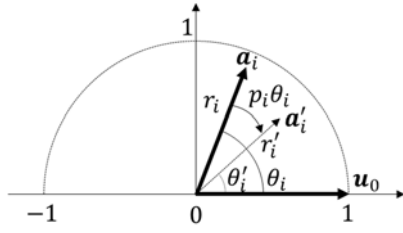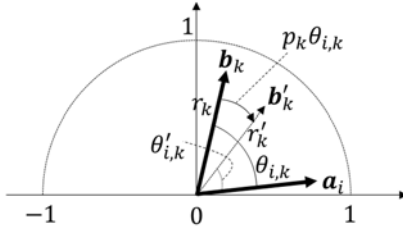
Fig. 1. Change of Executive's State (Obeying order)

Fig. 2. Change of Non-executive's State (Obeying order)

$$\varphi_m = 0.587\rho_1 - 0.452\rho_2$$

$$+0.479X_m^1 - 0.393X_m^2 + 14.085, \quad (1)$$

where ρ_1 and ρ_2 represent first and second principal component scores, respectively, which are obtained by applying a principal component analysis on the above data. Table I summarises the values of ρ_1 and ρ_2 correspond to each type of the reforming organization [1].

In this study, by Assumption iii), total morale of Executive $i \in A$ and Non-executive $k \in B$ are respectively given by

$$V_A = \sum_{i \in A} V_i = \sum_{i \in A} \boldsymbol{a}_i \cdot \boldsymbol{u}_0, \quad (2)$$
$$V_B = \sum_{k \in B} V_k = \sum_{k \in B} \boldsymbol{b}_k \cdot \boldsymbol{u}_0. \quad (3)$$

The change of the employee's state can be expressed as in the following two cases:

(1) In the case where the employee obeys the order
Let θ_i' and r_i' respectively denote the updated values of θ_i and r_i after the state of Employee i is changed.
If the employee follows the order from her/his superior, by Assumptions iv) and v), $\theta_i', r_i', \theta_k'$, and r_k' ($i \in A, k \in B$) can be given by
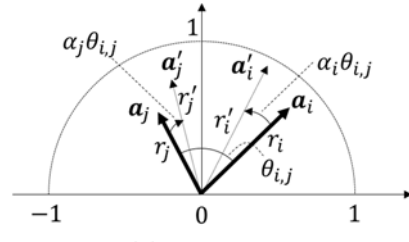
$$\theta_i' = [1 - p_i(\varphi_i)]\theta_i \ (i \in A), \quad (4)$$
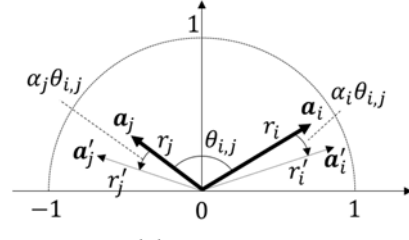$$r_i' = \eta_i r_i \ (0 < \eta_i < 1), \quad (5)$$
$$\theta_k' = \begin{cases} \dfrac{\theta_k - p_k(\varphi_i)\theta_{i,k}}{(i \in A, k \in B)}, & if \ \theta_i < \theta_k, \\ \theta_k + p_k(\varphi_i)\theta_{i,k}, & if \ \theta_i \geq \theta_k, \end{cases} \quad (6)$$
$$r_k' = \eta_k r_k (0 < \eta_k < 1), \quad (7)$$

where $\theta_{i,k} = |\theta_i - \theta_k|$. Figures 1 and 2 illustrate an example of the change of the employee's state in this case.

Fig. 3. Change of Employees' States (Determining themselves)

(2) In the case where one employee's decision is influenced by another employee
In this case, we characterise the change of the employee's state when one employee's state is changed by being influenced by the state of another employee in the same job position.
Assumptions iv) and vi) indicate that, for $i \in A$ and $j \in A \ (\theta_i \leq \theta_j, i \neq j)$, θ_i', θ_j', r_i', and r_j' can be expressed by

$$\theta_i' = \begin{cases} \theta_i + \alpha_i \theta_{i,j}, & if \ \theta_{i,j} < \pi/2, \\ \max[\theta_i - \alpha_i \theta_{i,j}, 0], & if \ \theta_{i,j} \geq \pi/2, \end{cases} \quad (8)$$
$$\theta_j' = \begin{cases} \theta_j - \alpha_j \theta_{i,j}, & if \ \theta_{i,j} < \pi/2, \\ \min[\theta_j + \alpha_j \theta_{i,j}, \pi], & if \ \theta_{i,j} \geq \pi/2, \end{cases} \quad (9)$$
$$r_i' = r_i + (1 - r_i)\gamma_i \ (0 < \gamma_i < 1), \quad (10)$$
$$r_j' = r_j + (1 - r_j)\gamma_j \ (0 < \gamma_j < 1). \quad (11)$$

Figure 3 shows an example of the change of a pair of Executives' states in this case.

Regarding the change of Non-executive's states, θ_k', r_k', θ_l', and r_l' for $k \in B$ and $l \in B \ (\theta_k \leq \theta_l, k \neq l)$, are also expressed by Equations from (8) to (11) by changing i and j to k and l, respectively.

IV. SIMULATION MODEL

This section develops a time-driven simulation model by using Artisoc 4.0 [7], which consists of three kinds of agents (agents of a manager, executive and non-executive employees) under a single space (field). In the time-driven simulation, a simulation time is advanced from t to Δt at each step so that we can confirm the state of every agent after each increment in time step Δt.
We first place a single Manager agent ($N_M = 1$) with $(r_0, \theta_0) = (1, 0)$ (i.e., with $\boldsymbol{u}_0 = (1, 0)$), N_A of the executive employee (Executive) agents with $(r_i, \theta_i) \ (0 \leq r_i \leq 1, 0 \leq \theta_i \leq \pi, i \in A)$, and N_B of the non-executive employee

(Employee) agents with (r_k, θ_k) $(0 \le r_k \le 1, 0 \le \theta_k \le \pi, k \in B)$, where the initial values of r_i, θ_i, r_k, and θ_k are randomly determined at time 0 (only at step 0). The vectors of the states of Executive and Non-executive agents can be expressed as $\boldsymbol{a}_i = (r_i \cos\theta_i, r_i \sin\theta_i)$ and $\boldsymbol{b}_k = (r_k \cos\theta_k, r_k \sin\theta_k)$, respectively.

At each step, each agent behaves in accordance with the following rules:

(a) *Behaviour of Manager agent*
The Manager agent randomly selects a single Executive agent with an interval of $\tau\Delta t$ ($\tau = 1, 2, 3, \cdots$).

(b) *Behaviour of Executive agent*
The state of the Executive agent selected by the Manager agent is varied in accordance with Equations (4) and (5). The selected Executive agent randomly chooses a single Non-executive agent.

(c) *Behaviour of Non-executive agent*
The state of the Non-executive chosen by the Executive agent is changed according to Equations (6) and (7).

As mentioned in Assumption vi), one agent (except for Manager agent) also decides her/his state her/himself by being influenced by another agent in the same level of job position. At each step, one Executive (or Non-executive) agent randomly picks out another Executive (or Non-executive) agent and the changes of the states of both the agents can be expressed as Equations from (8) to (11).

V. SIMULATION EXPERIMENT

This section focuses on the following situation: The obedience, denoted by $p_m(\varphi_m)$ ($m \in A \cup B$), of Employee m to the management can be expressed by a logistics function, i.e.,

$$p_m(\varphi_m) = a_m/[1 + e^{b_m(\varphi_m - c_m)}]. \qquad (12)$$

TABLE II
RESULT (EXECUTIVE)

τ	Steps	$\overline{V_A}$	$\overline{\theta_A}$ (degree)	$\overline{r_A}$
1	149.198	0.438	0.003	0.178
3	414.713	0.613	0.000	0.391
5	697.149	0.664	0.002	0.516

TABLE III
RESULT (NON-EXECUTIVE)

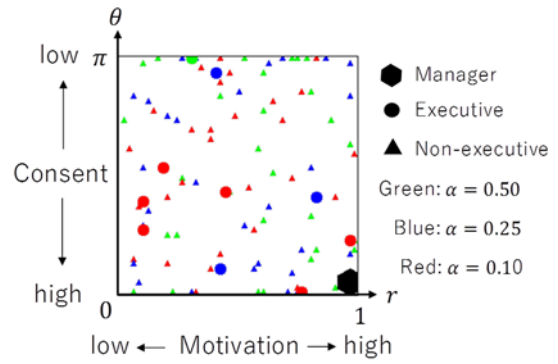| τ	Steps	$\overline{V_B}$	$\overline{\theta_B}$ (degree)	$\overline{r_B}$
1	149.198	0.178	22.078	0.669
3	414.713	0.391	22.230	0.855
5	697.149	0.516	22.318	0.908

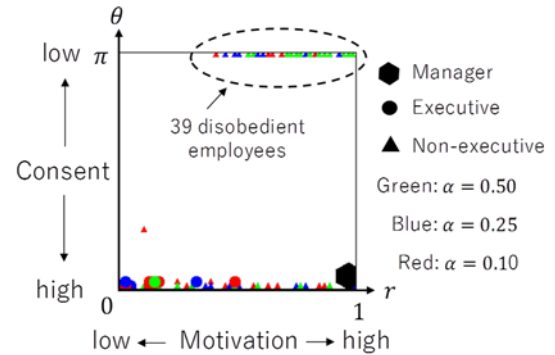Fig. 4. Initial states of employees on (r, θ) plane

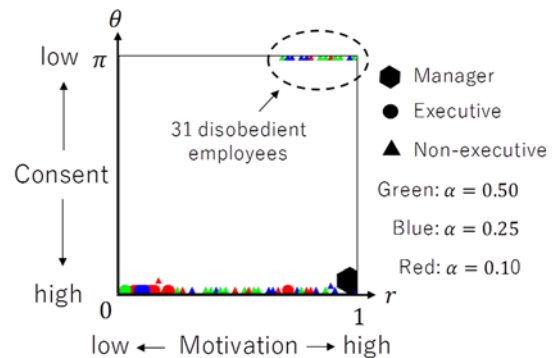Fig. 5. States of employees on (r, θ) plane at 30 steps

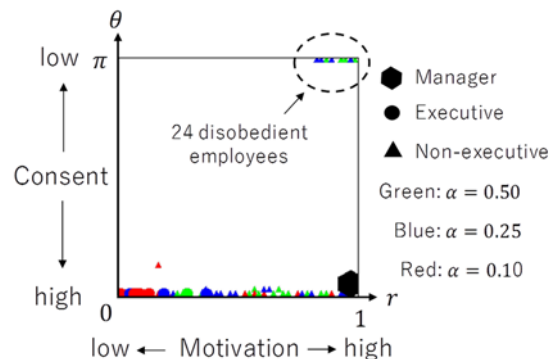Fig. 6. States of employees on (r, θ) plane at 60 steps

Fig. 7. States of employees on (r, θ) plane at 90 steps

The value of α_m in Equations (8) and (9) is randomly chosen out of 0.1, 0.25, and 0.5. This signifies that the employees are divided into three types of susceptibility to other people's mind or opinions. The other parameters are set

as follows:

$$(X_i^1, X_i^2, \gamma_i, \eta_i) = (0, 1, 0.01, 0.1) \ (i \in A), \quad (13)$$
$$(X_k^1, X_k^2, \gamma_k, \eta_k) = (0, 0, 0.01, 0.1) \ (k \in B), \quad (14)$$
$$(a_m, b_m, c_m) = (1.0, 0.9, 14.085) \ (m \in A \cup B), \quad (15)$$
$$(N_M, N_A, N_B) = (1, 10, 90). \quad (16)$$

We here introduce some additional notation in relation to the average values of the results obtained from the repeated simulation runs for simplicity:

$\overline{V_C}$ average of V_C/N_C $(C = A, B)$

$\overline{\theta_C}$ average of θ_C, where $\theta_C = \sum_{m \in C} \theta_m /N_C$.

$\overline{r_C}$ average of r_C, where $r_C = \sum_{m \in C} r_m /N_C$.

The simulation was repeated 100 times and each simulation was iterated until θ_B became less than or equal to $\pi/8$ radians (22.5 degrees) under the situation where the manager gives her/his employees instructions to reform the organization associated with "Communications and systems integration" in Table I.

Tables II and III summarise the results when τ varies from 1 to 5, where "Steps" in these tables represents the average number of steps until each simulation is terminated. The interval of time that the employees are ordered by their superior increases with τ, which signifies that the employees can have much time to think themselves whether or not to follow the orders when τ becomes large. Tables II and III show that the values of Steps, $\overline{V_C}$, (morale) and $\overline{r_C}$ (motivation) $(C = A, B)$ increase with τ. This indicates that the employees are less motivated to work as they are more frequently ordered by their superior, even though they appear to consent to the orders rapidly. In contrast, the manager can secure the employees' morale (in that the motivation to work becomes large) if she/he reduces the frequency of orders on reforming the organization, though it may take much time to realise the organizational change.

Figures from 4 to 7 depict the state of Employee m $(m \in A \cup B)$ on (r_m, θ_m) plane at 0, 30, 60, and 90 steps, respectively, under $\tau = 1$. Figures from 4 to 7 show that Non-executive agents are divided into two groups, obedient and disobedient employees, as the simulation time (step) is advanced. As for the group consisting of the disobedient employees, their motivation to work r_k $(k \in B)$, by and large, tends to approach 1 with steps (since they decides themselves to disobey the order), whereas the number of Non-executive agents in this group slightly reduces with increasing in steps. These figures also show that each Executive's motivation to work r_i $(i \in A)$, on the whole, becomes relatively smaller as step increases, though θ_i $(i \in A)$ approaches to 0 (all Executives almost completely consent to the order as shown in Table II). This is because the frequency with which each Executive agent receives the orders from the Management agent is greater than that of Non-executive agents in our model, which makes Executive agents less motivated.

VI. CONCLUSION

This study has formulated the employees' morale under the following circumstances: (a) There is a single manager (or CEO) and the employees can be divided into the executive and non-executive employees (Executives and Non-executives). (b) Each employee's morale consists of the degrees of the consent to her/his superior's instruction (which depends upon the trust in the management) and the motivation to work (independent of the trust). (c) The morale is expressed as the inner product of two vectors: one for the state of each employee, the other for the state of the manager.

We have then developed a simulation model for demonstrating the change of the employees' morale after they are offered the organizational change or innovation. Simulation experiments illustrated the behaviour of the employees' states when the interval of time that the manager gives them the orders varied. The results indicated that the employees' morale is reduced as the time interval of the instructions decreases, whereas they seem to consent to the order from the management quickly. This implies that the manager should provide them enough time to think themselves whether or not to follow the instructions in order to secure the employees' morale.

However, this study assumed that the change rates of the employees' motivation to work and of those their consent to the instruction are deterministic and constant in the case where they determines themselves whether or not to follow the instructions. We need to clarify how one employee's mind and motivation change and how they are influenced by those of another employee independently of the trust in the management or organization more precisely. These factors will be considered in an extended paper in the future.

REFERENCES

[1] N. Yamanaka, Organizational Design in Modern Firms and the Role of Corporate Management: Relationships of Organizational Change with Trust and Creative Capacity Journal of Japanese Management, vol.2, no.2, pp.12- 22, 2018,
[2] J. Roberts, *The Modern Firm: Organizational Design for Performance and Growth*,Oxford University Press, Oct. 2007.
[3] D. M. Rousseau, S. B. Sitkin, R. S. Burt and C. Camerer, "Not So Different After All: Cross-discipline View of Trust", Acadamy of Management Review, vol. 23, no. 3, pp. 393-404, 1998.
[4] K. Odaka, *Lectures on Industrial Sociology*(in Japanese), Iwanami Shoten, 1981.
[5] R. Bellah et al., *The Good Society*, Vintage, 1992.
[6] T. Inoue, "Selection and Concentration and Corporate Organization - Four Types of Reorganization Patterns" (in Japanese), In *Selection and Concentration: An Empirical Analysis of Electronics and Information Technology Firms in Japan*, T. Tsuru, Japanese Electrical Electronic & Information Union (Eds.). Yuhikaku, pp. 53-104, 2004.
[7] S. Yamakage, *Modeling and Expanding Artificial Societies*, Shosekikobo Hayama Publishing, 2009.