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Effective Temperature Hypothesis and Thermometer**

by

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**LUKEWARM FEELING IN JAPANESE FIRMS:  
EFFECTIVE TEMPERATURE HYPOTHESIS AND THERMOMETER**

by

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**Abstract**

In Japanese firms, the word "nurumayu" is used on the analogy of a lukewarm bath, and this word expresses lukewarm atmosphere in which employees easily accept the present situation and spend a carefree time. This paper proposes the effective temperature hypothesis and develops an effective temperature "thermometer" which can be used to explain the lukewarm feeling ratio and the boiled frog phenomenon. Our hypothesis is supported by eight surveys of 6,259 white-collar workers of 60 Japanese companies from 1987 to 1994.

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## INTRODUCTION

This paper is focused on "nurumayu" (in Japanese) feeling in Japanese firms, which is supposed to be caused by not preferable organizational conditions, probably by diseased conditions of the firms. The word "nurumayu" is used on the analogy of a lukewarm bath. Average Japanese enjoy a hot bath, and a lukewarm bath is not hot enough and is at lower temperature than desired. Intuitively it would appear that the meaning typically accorded the term lukewarm comes very close to what we mean by "nurumayu."

In the Japanese firms, this word expresses lukewarm atmosphere in the organization and is usually used in the case that the members easily accept the present situation and spend a carefree time. In common parlance, employees in Japanese firms refer to a "nurumayu" constitution with reference to their work situation in which they face with a difficult problem of building up an active and vigorous constitution. This problem is treated as the problem of *organizational activation* in the field of the Japanese style organization development (Takahashi, 1992; Kawai, 1992).

For the time being, we assume that "nurumayu" feeling is a typical signal of non-activated state of the organization. But, is it true? Under what conditions are lukewarm feelings aroused? We study the conditions to cause lukewarm feeling among the employees in Japanese firms. And then we study the relationship between such a feeling and the activated state of the organization, which is initially defined by Takahashi (1992) through applying the results of mathematical organization design theories (Takahashi, 1986; 1987; 1988).

In 1987, we made the first survey of 580 white-collar workers of eleven Japanese companies in order to get fact findings of the "nurumayu" phenomenon. As a result of this survey, we propose the effective temperature hypothesis, which explains that each member's sense of "nurumayu" is caused by the low effective temperature. The effective

temperature is defined as the difference between the system temperature and the body temperature, which are respectively defined as the indexes of propensity to change of the organizational system and the members. We develop a method to measure the body temperature and the system temperature, and by using this method, the effective temperature hypothesis is supported by our empirical research on Japanese firms. In 1988, we made the second survey. The data from 626 middle managers of eight Japanese companies verify the effective temperature hypothesis again.

In 1989 to 1990, we made the third survey of 564 white-collar workers of two Japanese manufacturing companies and the fourth survey of 853 white-collar workers of nine Japanese companies, respectively. And then we refined the questionnaire and succeeded in developing an effective temperature "thermometer," which can be used to forecast the lukewarm feeling ratio. This thermometer is supported by five surveys of 4,489 white-collar workers of 39 Japanese companies from 1990 to 1994. Our data indicate a strong linear relationship between the lukewarm feeling ratio and the effective temperature.

From these studies, we conclude that our effective temperature hypothesis provides a useful method to examine the states of the organizations and also explains the boiled frog phenomenon (Tichy & Devanna, 1986) in the organizations.

## **STATEMENT OF THE PROBLEM**

### **Methods**

In order to get fact findings of the "nurumayu" phenomenon, we made the first survey in 1987. First, we selected eleven Japanese companies who were all members of Japan Productivity Center in the industries: petroleum products (Company A), pharmaceuticals (Company B), railroad transportation (Company C), retail trade (Companies D and E), electric service (Company F), electric machinery (Company G),

electronic machinery (Companies H and K), telecommunication (Company I), and hotels (Company J). The member companies of Japan Productivity Center are the biggest and representative firms of Japan. Most of them are listed on the First Section of Tokyo Securities Exchange and satisfy the high-level initial listing requirement.

The study was conducted in two phases. Phase 1 began in April, 1987 and was completed by August. In this phase, group interviews were conducted. The respondent of each company was interviewed for approximately two hours to express its corporate and organizational culture. The objectives of Phase 1 were to develop the original questionnaire. We prepared an exhaustive list of frank statements of the job attitudes and the phenomena of non-activated state of the organization. Finally, we carefully revised all the items and prepared the selected list of disjunctive yes-no questions: 25 questions on job attitudes and 25 questions on phenomena. The original questionnaire was written in Japanese.

Phase 2 involved a sampling survey. The objectives of this phase were to obtain fact findings of a "nurumayu" constitution. We initially selected for each company one or more organizational units of white-collar workers in its corporate division. Then we investigated all the employees of the selected 39 organizational units. The research was carried out from August 26 to September 7, 1987 through the delivery-collection and self-recording method. We obtained 580 respondents' data from the questionnaires (response rate was 84.1%). 70.8% were men, 22.6% were managers, an average age was 35.0 years, and 70.6% had college degrees.

### **Findings**

We investigated the lukewarm ("nurumayu") feeling in Japanese firms, and each respondent answered the following key question on phenomena:

Question 1. Do you feel that the atmosphere at your working place is lukewarm

("nurumayu")? (1. Yes. 2. No.)

55.4% of the total respondents answered "yes", and 44.6% answered "no", that is, approximately the half of the total respondents expressing the lukewarm feeling. Pearson's correlation coefficients between Question 1 and the other questions on phenomena are relatively high, but those between Question 1 and job attitudes questions are generally low. Therefore a lukewarm feeling is closely related to the phenomena of the working place. But the low correlation coefficients with the job attitudes arouse a question in our mind. Is it true that a lukewarm feeling is a typical signal of non-activated state of the organization? This question will be further complicated by the fact that coexistence of a lukewarm feeling and job satisfaction as shown below.

The terms job satisfaction and job attitudes may be typically used interchangeably, and positive attitudes toward the job are conceptually equivalent to job satisfaction (Vroom, 1964, p.99). Unfortunately, there has been little standardization of job satisfaction measures. In this study, job satisfaction is measured by means of the following question on job attitudes:

Question 2. Are you satisfied with your job? (1. Yes. 2. No.)

62.0% of the total respondents answered "yes", and 38.0% answered "no". We make a fourfold (two-by-two) table by Questions 1 and 2, and obtain Table 1, which suggests the negative relevance between the lukewarm feeling and the job satisfaction at significant level 0.001 by chi-square test. Pearson's correlation coefficient,  $r = -0.140$ , and this also designates negative correlation between them. But strictly speaking, the configuration of Table 1 clearly reveals that the half of the respondents satisfied with their jobs simultaneously express the lukewarm feeling.

These tendencies can be shown in another way. The ratio of "yes" to total respondents in Question 1 is called the *lukewarm feeling ratio*, and the ratio of "yes" to total respondents in Question 2 is called the *job satisfaction ratio*. By using these two ratios, eleven companies are plotted on the scatter diagram and thus Figure 1 is obtained. This figure suggests the negative correlation between the lukewarm feeling ratio and the job satisfaction ratio except for Company C. Company C has the highest lukewarm feeling ratio and the third highest job satisfaction ratio. A further analysis, not shown in this paper, indicates the existence of many organizational units with high lukewarm feeling ratios and high job satisfaction ratios.

These findings suggest that the lukewarm feeling and the job satisfaction coexist together. Therefore, it is not reasonable that a lukewarm feeling is a typical signal of non-activated state of the organization. We need a new framework to determine the relationship between the lukewarm phenomena and the activated state of the organization.

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Insert Table 1 and Figure 1 about here

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## SYSTEM TEMPERATURE

Let us trace the origin of "nurumayu." A "nurumayu" feeling is usually explained by the analogy of a lukewarm bath in Japan. How can we take the temperature of the working place? We received a useful hint for taking the temperature from the dictionaries. The best dictionary to consult for determining the origin of Japanese words is the *Kojien* from Iwanami. If you open this dictionary, you will find the word "nurumayu" signified "hot water at a lower temperature or lukewarm water."



Furthermore, you will find the prevalent phrase "soak oneself in 'nurumayu' " is used by the Japanese in a sense that "accept the present situation and spend a carefree time."

Now, a *propensity to change* is defined as the propensity not to accept the present situation and not to spend a carefree time and to master the circumstances. Deci (1975) has asserted that people engage in many behaviors in order to feel a sense of competence and self-determination. Our concept of a propensity to change is within the same general camp. Using the need for feeling competent and self-determining, Deci considers the concept of the need for challenge, that is, the concept of a propensity to change. In order to examine a "nurumayu" feeling, we first consider the organization's propensity to change. You may easily suppose that the organization of a high propensity to change has a high temperature and its members would feel hot in it. If it has a low propensity, its temperature is low and its members would feel lukewarm in it. To take the temperature of the working place, by multivariate analysis (Takahashi, 1989) and logical examination, five questions were selected from among 25 yes-no questions on phenomena as follows:

- S1. Have high performing individuals been consistently promoted and given raises?
- S2. Is the atmosphere one which welcomes "positive failure" which would serve as a lesson to all?
- S3. Is your immediate superior able to exert influence on his or her superiors?
- S4. Are the present ways of doing jobs very unlikely to change? (-)
- S5. Do all the members believe they can move up the ladder to a certain extent solely on the basis of seniority? (-)

For questions S1, S2, and S3, "yes" means a high propensity to change. And for S4 and S5 indicated by (-), "no" means a high propensity to change. The yes-no answer of the question  $S_i$  can be quantified and represented by a dummy variable  $S_i$ ,  $i=1, \dots, 5$ .

The dummy variable takes only two values, zero and one, which signify that the observation belongs in one of two possible categories. Variables  $S_1$ ,  $S_2$ , and  $S_3$  are dummy variables designating the two categories, 1 for "yes" and 0 for "no". Variables  $S_4$  and  $S_5$  are also dummy variables coded as 0 for "yes" and 1 for "no". These dummy variables can be used to take the temperature of the working place, which is called the *system temperature (SINDEX)* and calculated as follows:

$$SINDEX = S_1 + S_2 + S_3 + S_4 + S_5.$$

*SINDEX* is an integer from 0 to 5. By system temperature, we try to measure the propensity to change of the organization as a system.

To test the validity of the system temperature, we use categories of "lukewarm" and "non-lukewarm", which are based on Question 1. For the lukewarm group (the group of "yes" respondents in Question 1) and the non-lukewarm group (the group of "no" respondents in Question 1), we calculate means of *SINDEX* as follows: 3.05 for the total ( $N = 525$ ), 2.72 for the lukewarm group ( $N = 292$ ), and 3.46 for the non-lukewarm group ( $N = 233$ ). Thus by *t*-test, the lukewarm group has significantly lower *SINDEX* than the non-lukewarm group at level 0.001 ( $t = -6.61$ ). Therefore it is a promising trial that a lukewarm feeling would be explained by the system temperature, *SINDEX*.

But *SINDEX* of Company C having the highest lukewarm feeling ratio is 2.73 and is not conspicuous in Table 2, which compares the averages of *SINDEX* for eleven companies. Table 2 indicates that there are significant differential effects at level 0.001 by *F*-test. Hence it is difficult to characterize Company C aptly only by *SINDEX*.

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Insert Table 2 about here  
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## EFFECTIVE TEMPERATURE HYPOTHESIS

The system temperature is not sufficient to explain the high lukewarm feeling ratio of the high job satisfaction ratio company, like Company C. We should find an alternative way to explain a lukewarm feeling. The problem of Company C demands the careful consideration of not only the phenomena but also the individual job attitudes. The biological temperature of the human body is normally 36 to 37 degrees Centigrade. But, consider the organization person characterized by the organization personality (Barnard, 1938). Does everyone have always a constant body temperature as an organization person? Does the high job satisfaction ratio company (like Company C) have a high average of body temperature? Does high body temperature emphasize lukewarm feelings?

Now, we hypothesize that the body temperature of an organization person may form a basis for his or her lukewarm feeling, where the *body temperature* is defined as the propensity to change of the individual as an organization person. In other words, the body temperature is an index to the organization personality not to accept the present organizational situation and not to spend a carefree time and to master the circumstances in the organization.

To take the body temperature, by multivariate analysis and logical examination, five questions were selected from among 25 yes-no questions on job attitudes as follows:

- B1. Do you constantly seek improved ways of doing your jobs better than the others?
- B2. Do you wish to maintain the "status quo" by avoiding to cause mistakes or problems rather than improving your performance by risk taking? (-)
- B3. Do you constantly seek to improve your practical knowledge and expertise required to do your job?
- B4. Do you continually welcome challenging new jobs?

B5. Do you hope to be promoted faster than the others at your company if possible?

For question B2 indicated by (-), "no" means a high propensity to change, and for the other four questions, "yes" means a high propensity to change. The yes-no answer of the question  $B_i$  was represented by a dummy variable  $B_i$ ,  $i=1, \dots, 5$ :  $B_1$ , and  $B_3$  to  $B_5$  respectively designated the two categories, 1 for "yes" and 0 for "no"; and  $B_2$  coded as 0 for "yes" and 1 for "no". The dummy variables can be used to take the body temperature (*BINDEX*) as follows:

$$BINDEX = B_1 + B_2 + B_3 + B_4 + B_5.$$

*BINDEX* is an integer from 0 to 5.

As we noted earlier in this section, we can expect that the organization persons would have lukewarm feelings on the basis of their body temperature. For example, there exists the tendency for the organization persons having high body temperature rather than low body temperature to have lukewarm feelings at the same level of system temperature. Therefore we can specify their expected consequences in the following hypothesis.

*Hypothesis 1 (Effective Temperature Hypothesis)*. Define the *effective temperature* ( $T$ ) as follows:  $T = SINDEX - BINDEX$ . Then the respondent expressing a lukewarm feeling has a lower effective temperature than the respondent expressing a hot feeling.

General support for the simplified equation in Hypothesis 1 is provided and examined by principal components analysis and discriminant analysis (see Takahashi (1989) for details).

Table 3 compares the averages of *BINDEX* for eleven companies by *F*-test, and there are significant differential effects at level 0.01. Company C having the third highest job satisfaction ratio has the third highest body temperature ( $BINDEX = 4.04$ ).

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Insert Table 3 about here  
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Let us begin with the analysis of Hypothesis 1. Unfortunately, we cannot use categories of "lukewarm" and "hot." We can only use categories of "lukewarm" and "non-lukewarm" based on Question 1. Then the non-lukewarm group may include not only the "hot" group but also the other groups. In fact, although we expected that most respondents of the hot group have high system temperature and low body temperature, the non-lukewarm group includes many respondents having high system temperature and high body temperature. For those who indicate that they have high body temperature, high system temperature would not cause hot feelings.

To test Hypothesis 1, we calculate the means of the effective temperature  $T$  as follows: -0.55 for the total ( $N = 525$ ), -0.91 for the lukewarm group ( $N = 292$ ), and -0.09 for the non-lukewarm group ( $N = 233$ ). By  $t$ -test, the lukewarm group has the significantly lower effective temperature than the non-lukewarm group at level 0.001 ( $t = -5.79$ ). In fact, Figure 2 clearly supports Hypothesis 1.

On the other hand, Table 3 has compared the averages of the effective temperature  $T$  for eleven companies by  $F$ -test, and there are significant differential effects at level 0.001. Company C has the lowest effective temperature:  $T = -1.31$ . Moreover, Figure 3 designates that only Company C is located at the lukewarm area of low system temperature and high body temperature.

From the above discussion, our empirical research supports Hypothesis 1, and the highest lukewarm feeling ratio of Company C can be explained by the lowest effective temperature.

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Insert Figure 2 and Figure 3 about here  
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## FOLLOW-UP TEST ON MIDDLE MANAGERS

In 1988, a follow-up was made in order to verify the effective temperature hypothesis again. First, we selected eight Japanese companies who were also members of Japan Productivity Center in the industries: railroad transportation, precision machinery, retail trade, motor vehicles and equipment, telecommunication, electronic machinery, and banking (2).

We initially selected for each company two or more organizational units, then we investigated all the middle managers of the selected 37 organizational units. The research was carried out from August 31 to September 5, 1988 through the delivery-collection and self-recording method. We obtained 626 middle managers' data from the questionnaires (response rate was 81.3%). 99.2% were men, an average age was 42.3 years, 77.1% had college degrees, and of course 100% were managers.

To test Hypothesis 1, we calculated the means of the effective temperature: -1.03 for the total ( $N = 609$ ), -1.19 for the lukewarm group ( $N = 422$ ), and -0.66 for the non-lukewarm group ( $N = 187$ ). Thus by *t*-test, the lukewarm group has the significantly lower effective temperature than the non-lukewarm group at level 0.001 ( $t = -4.11$ ). We obtained a figure, not shown in this paper, almost similar to Figure 2. Therefore, the empirical research on middle managers also supports our Hypothesis 1.

Apart from testing of Hypothesis 1, we obtain the empirical evidence that the lukewarm feeling ratio of the middle managers is very high. For Question 1, 69.7% of the total respondents answered "yes" and 30.3% answered "no". Why is the lukewarm feeling ratio of the middle managers so high? The mean of *SINDEX* is 3.06, which is almost equal to 3.05 of the first survey in 1987. Thus, the high lukewarm feeling ratio of the second survey in 1988 cannot be explained by the system temperature. But, the mean of *BINDEX* is 4.09 in 1988. This is remarkably higher than 3.60 of the first survey

in 1987. Hence, by using our effective temperature hypothesis, the distinguished high lukewarm feeling ratio of the second survey in 1988 is clearly explained from the fact that the middle managers have the high body temperature in Japanese firms.

## **REFINEMENT OF THE "THERMOMETER"**

If the discrepancy between the "non-lukewarm" group and the "hot" group is appalling, it is not appropriate to compare a lukewarm feeling with a hot feeling. We are now in position to propose a new version of Hypothesis 1.

*Hypothesis 2 (Refined Effective Temperature Hypothesis).* The lukewarm feeling ratio of a group is in reverse proportion to its mean of the effective temperature.

### **Method**

We were prompted to search for a more refined "thermometer" with better properties to explain the lukewarm feeling ratio. The first survey in 1987 and the second survey in 1988 used same questions S1 to S5 and B1 to B5 in order to test Hypothesis 1. These ten questions were selected from among only 50 questions of the first survey which was planned to get fact findings of the "nurumayu" phenomenon. There are some prospects of improvement on the questions. If measures of them could be developed, they might prove to be useful criteria in evaluating the validity of our Effective Temperature Hypothesis.

In 1989 to 1990, we made the preliminary third survey of 564 employees of two Japanese manufacturing companies (response rate was 84.1%). In this third survey, we prepared a comprehensive list of 100 yes-no questions made of preceding surveys' questions and new questions. Through this preliminary survey, we selected 35 questions

from among these 100 questions by multivariate analysis (see Takahashi (1990; 1993) for details).

Using these 35 questions, we made the fourth survey in 1990 in order to refine the "thermometer" to measure the effective temperature. We selected nine Japanese companies who were members of Japan Productivity Center in the industries: motor vehicles and equipment (3), telecommunication, railroad transportation (2), petroleum products, banking (2). We initially selected for each company one or more organizational units, then we investigated 39 organizational units. The research was carried out from September 5 to 10, 1990 through the delivery-collection and self-recording method. The questionnaires were completed by 853 white-collar workers (response rate was 88.9%). 80.8% were men, 23.3% were managers, and an average age was 34.9 years.

By multivariate analysis, Questions S2 to S5 and B2 to B5 were replaced by newcomers, and the following questions were selected (see Appendix).

#### *System Temperature*

- S1. Have high performing individuals been consistently promoted and given raises?
- S6. Is avoiding failure considered more important than improving performance through trial and error? (-)
- S7. Is the atmosphere one which welcomes challenging new jobs?
- S8. Is adopting the corporate culture more important than developing your own individuality? (-)
- S9. Is the atmosphere a competitive one in which members strive to achieve their goals?

#### *Body Temperature*

- B1. Do you constantly seek improved ways of doing your jobs better than the others?
- B6. Do you do your job in the way you want regardless of the way it was done in the



past?

B7. Do you go out of your way to do new jobs before they are assigned to some sections?

B8. Do you believe you are able to cut your own way to success even at another company?

B9. Do you obey the orders of your superiors even if you disagree? (-)

For three questions S6, S8 and B9 indicated by (-), "no" means a high propensity to change, and for the other seven questions, "yes" means a high propensity to change. These yes-no answers were quantified by dummy variables:  $S_6$ ,  $S_8$  and  $B_9$ , respectively designated the two categories, 0 for "yes" and 1 for "no"; and the other variables coded as 1 for "yes" and 0 for "no". These dummy variables can be used to take the system temperature (*SINDEX*), the body temperature (*BINDEX*), and the effective temperature (*T*) as follows:

$$SINDEX = S_1 + S_6 + S_7 + S_8 + S_9,$$

$$BINDEX = B_1 + B_6 + B_7 + B_8 + B_9,$$

$$T = SINDEX - BINDEX.$$

To test these "thermometers," additional four surveys using same method were conducted from 1991 to 1994. In 1991, we investigated all the white-collar workers in 30 organizational units of six Japanese companies in the industries: railroad transportation (2), retail trade, electric service, telecommunication, banking. The research was carried out from August 28 to September 2, 1991 through the delivery-collection and self-recording method. We obtained 907 respondents' data from the questionnaires (response rate was 89.2%). 87.2% were men, 29.0% were managers, and an average age was 36.6 years.

In 1992, we investigated all the white-collar workers in 27 organizational units of seven Japanese companies in the industries: railroad transportation, hotels, construction,

security, life insurance, consultant, computer. The research was carried out from September 2 to 7, 1992 through the delivery-collection and self-recording method. The questionnaires were completed by 740 white-collar workers (response rate was 89.6%). 76.4% were men, 25.1% were managers, and an average age was 35.5 years.

In 1993, we investigated all the white-collar workers in 33 organizational units of six Japanese companies in the industries: railroad transportation (2), petroleum products, banking, telecommunication, security. The research was carried out from August 25 to 30, 1993 through the delivery-collection and self-recording method. We obtained 1160 respondents' data from the questionnaires (response rate was 91.0%). 86.8% were men, 18.1% were managers, and an average age was 38.0 years.

In 1994, we investigated all the white-collar workers in 39 organizational units of eight Japanese companies in the industries: heavy industries, real estate development, railroad transportation, house building, construction consultant, computer, banking (2). The research was carried out from August 31 to September 5, 1994 through the delivery-collection and self-recording method. The questionnaires were completed by 829 white-collar workers (response rate was 93.7%). 72.0% were men, 24.6% were managers, and an average age was 35.7 years.

## Results

We use the pooled lukewarm feeling ratios of five surveys from 1990 to 1994 as indicated in Table 4. The means of *SINDEX* and *BINDEX* are 2.13 and 3.12 respectively. (The standard deviations of *SINDEX* and *BINDEX* are 1.51 and 1.31 respectively.) The graph of the lukewarm feeling ratio versus the effective temperature in Figure 4 suggests a straight line relationship. It is fairly clear that a point ( $T = 5$ ) would deflate the slope of the line. This point should be regarded as outliers. We had only four respondents (0.09% of the sample) at  $T = 5$  as designated in Table 4, so that we were reluctantly compelled to measure the lukewarm feeling ratio with large sampling

error at  $T = 5$ . Therefore, by dropping this point from the data, a linear model is fitted to the data. To test Hypothesis 2, we regressed lukewarm feeling ratio on the effective temperature. The estimated coefficients are given in Table 5, and every coefficient is significant at level 0.0001. The high value 0.9803 of adjusted  $R^2$  indicates a strong linear relationship between the lukewarm feeling ratio and the effective temperature. For each degree increase in the effective temperature, the lukewarm feeling ratio is expected to decrease by 6.347%, and the lukewarm feeling ratio is almost 50% at 1 degree. Thus the thermometer of the effective temperature can be used to forecast the lukewarm feeling ratio.

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Insert Table 4, Figure 4, Table 5 about here  
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## DISCUSSION

Thus far, we explain the lukewarm feeling by the effective temperature defined as the difference between the system temperature and the body temperature. If our effective temperature hypothesis is valid, lukewarm feelings may mislead the members' judgment on the state of their organization. For example, the northeast corner ( $SINDEX = 5$  and  $BINDEX = 5$ ) of Figure 5 has the same effective temperature 0 as the southwest corner ( $SINDEX = 0$  and  $BINDEX = 0$ ). But these two corners represent two extremes of the organizational state. The northeast corner represents the activated state of the organization (Takahashi, 1992). The white-collar workers in Japanese firms use the term activated state to refer to the state where both of members and the system have the highest propensity to change. However, the southwest corner represents typical non-activated state, where both of members and the system make scarcely any changes.

(Thus, it is also clear that the northwest area of lukewarm is neither the typical non-activated state nor the typical activated state of the organization!)

Let us apply this model to the persons whose body temperature declines. Consider persons who are in the process of gradually moving along the line from (5, 5) to (0, 0) in Figure 5. According to the hypothetical framework that we have proposed, they would feel suitable or at least would not respond to avoid catastrophic consequences because their effective temperature is always 0. A similar phenomenon is called the *boiled frog phenomenon* in the management theory (Tichy & Devanna, 1986, p.44), which comes from a classic physiological response experiment. If we place the frog in a pan of boiled water, it will promptly jump out. But, if the frog is placed in a pan of cold water and the heat is turned up very gradually, the frog will sit in the pan until it boils to death. Tichy & Devanna (1986, p.46) explain that, like the frog, the organization and its members do not respond to trigger events in time to avoid catastrophic consequences, since the cultural cocoons created by the organization surround them with a false sense of security. Our effective temperature hypothesis offers an alternative and scientific explanation of an organizational version of the boiled frog phenomenon in comparison with their "cultural cocoons" theory.

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Insert Figure 5 about here  
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## APPENDIX

### Principal-Components Analysis

By principal-components analysis, we obtain eigenvalues; 1.696, 1.104, 0.844, 0.712, 0.645 for  $S_1$  and  $S_6$  to  $S_9$ . The first eigenvalue exceeded unity and the rest fell heavily. The first principal-component *SPRIN1* is as follows:

$$SPRIN1 = 0.455S_1 + 0.452S_6 + 0.489S_7 + 0.405S_8 + 0.431S_9.$$

All the weights are at the almost equal level, then in a practical sense *SINDEX* can be calculated as the equally weighted sum of  $S_1$  and  $S_6$  to  $S_9$ :

$$SINDEX = S_1 + S_6 + S_7 + S_8 + S_9.$$

Similarly, we obtain eigenvalues; 1.960, 0.980, 0.820, 0.659, 0.581 for  $B_1$  and  $B_6$  to  $B_9$ . Only the first eigenvalue exceeded unity and the rest fell short of it. The first principal-component *BPRIN1* is as follows:

$$BPRIN1 = 0.515B_1 + 0.499B_6 + 0.509B_7 + 0.351B_8 + 0.322B_9.$$

The weights of  $B_8$  and  $B_9$  are slightly small, but we may also conclude that *BINDEX* can be calculated as the equally weighted sum of  $B_1$  and  $B_6$  to  $B_9$ :

$$BINDEX = B_1 + B_6 + B_7 + B_8 + B_9.$$

### Discriminant Analysis

Discriminant analysis was performed by using the ten dummy variables between two groups: A "lukewarm" group and a "non-lukewarm" group, which were based on Question 1. We obtained the following linear discriminant function:

$$u = -0.414 + 0.097S_1 + 0.263S_6 + 0.653S_7 + 0.514S_8 + 0.711S_9 \\ - 0.254B_1 - 0.311B_6 - 0.022B_7 - 0.138B_8 - 0.191B_9.$$

Each respondent would be classified into "lukewarm" if  $u < 0$  and "non-lukewarm" if  $u > 0$ . The weights of  $S_1$  and  $S_6$  to  $S_9$  are all positive and the weights of  $B_1$  and  $B_6$  to  $B_9$  are all negative. This supports our Hypothesis 1 that the effective temperature is defined as the difference between the system temperature and the body temperature. However, the absolute values of these weights scatter. Is this critical in classifying into two groups? Table 6 compares the results of classification. Actual error rate of classification by using the linear discriminant function is 38.0% and is almost equal to 38.5% by using the effective temperature (each respondent was classified into "lukewarm" if  $T \leq 0$  and "non-lukewarm" if  $T > 0$ ). Therefore, our data verify this equally weighted equation:

$T = SINDEX - BINDEX$  of Hypothesis 1.

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Insert Table 6 about here  
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Table 1. Cross-Tabulation by Lukewarm Feeling and Job Satisfaction.

| Question 2.<br>Job satisfaction | Question 1. Lukewarm feeling |            |             |
|---------------------------------|------------------------------|------------|-------------|
|                                 | 1. Yes                       | 2. No      | Total       |
| 1. Yes                          | 175 (49.9)                   | 176 (50.1) | 351 (100.0) |
| 2. No                           | 138 (64.2)                   | 77 (35.8)  | 215 (100.0) |
| Total                           | 313                          | 253        | 566         |

Pearson's  $r = -0.140$      $\chi^2(1) = 11.074$      $p < 0.001$ .

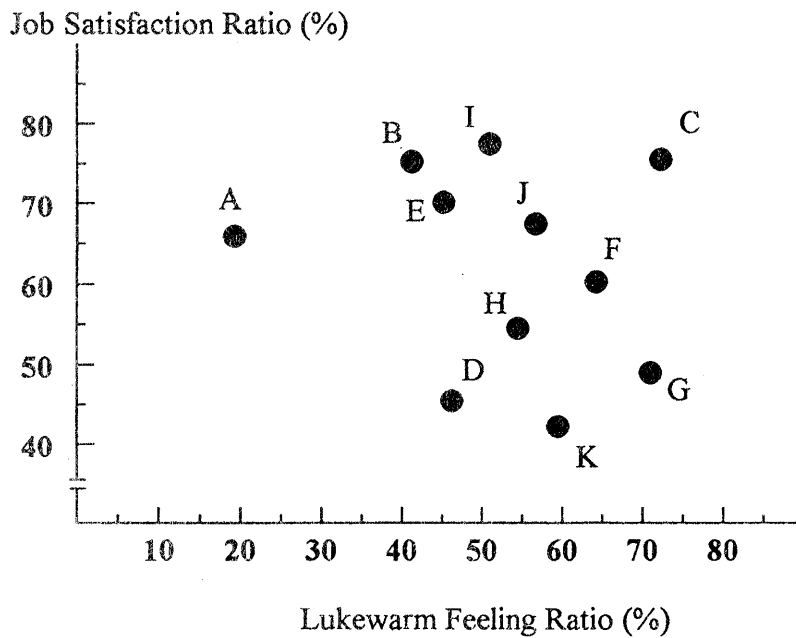


Figure 1. Scatter Diagram of Eleven Companies.



Table 2. System Temperature (*SINDEX*).

| Company           | <i>N</i> | <i>SINDEX</i> |
|-------------------|----------|---------------|
| A                 | 19       | 4.00          |
| B                 | 27       | 3.19          |
| C                 | 55       | 2.73          |
| D                 | 18       | 2.50          |
| E                 | 96       | 3.72          |
| F                 | 78       | 2.36          |
| G                 | 65       | 2.86          |
| H                 | 53       | 2.92          |
| I                 | 26       | 3.92          |
| J                 | 40       | 3.15          |
| K                 | 48       | 2.81          |
| Total             | 525      | 3.05          |
| <i>F</i> (10,514) |          | 8.80          |
|                   |          | $p < 0.001$   |

Table 3. Body Temperature (*BINDEX*) and Effective Temperature (*T*).

| Company           | <i>N</i> | <i>BINDEX</i> | <i>T</i>    |
|-------------------|----------|---------------|-------------|
| A                 | 19       | 4.05          | -0.05       |
| B                 | 27       | 3.52          | -0.33       |
| C                 | 55       | 4.04          | -1.31       |
| D                 | 18       | 3.44          | -0.94       |
| E                 | 96       | 3.68          | 0.04        |
| F                 | 78       | 3.23          | -0.87       |
| G                 | 65       | 3.45          | -0.58       |
| H                 | 53       | 3.26          | -0.34       |
| I                 | 26       | 4.54          | -0.62       |
| J                 | 40       | 3.98          | -0.83       |
| K                 | 48       | 3.25          | -0.44       |
| Total             | 525      | 3.60          | -0.55       |
| <i>F</i> (10,514) |          | 4.07          | 3.34        |
|                   |          | $p < 0.001$   | $p < 0.001$ |

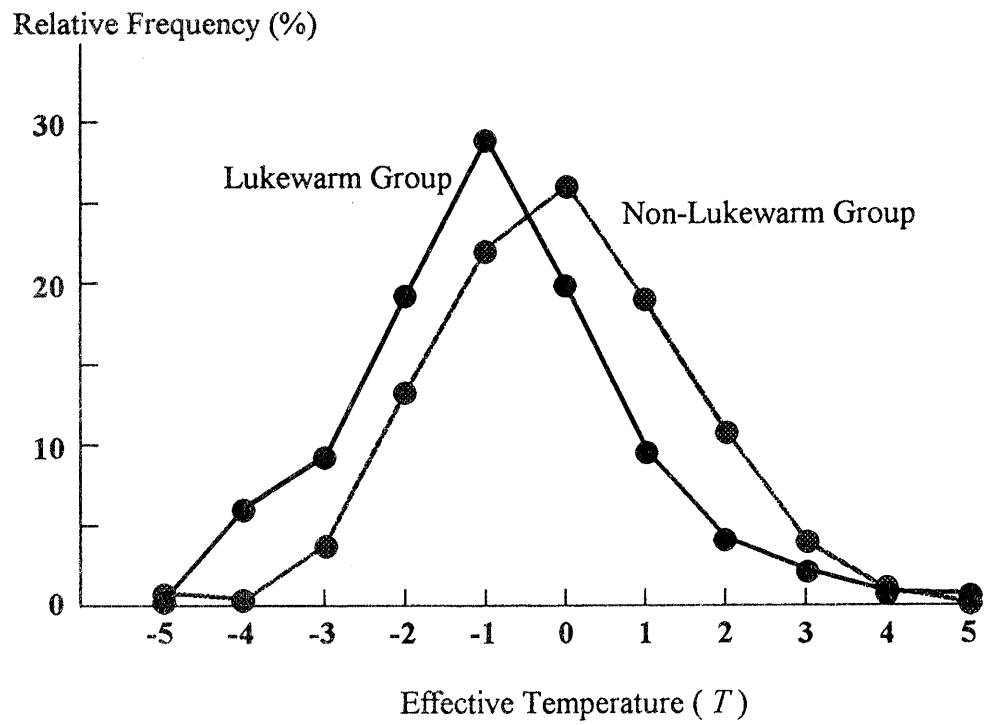


Figure 2. Relative Frequency Diagram.

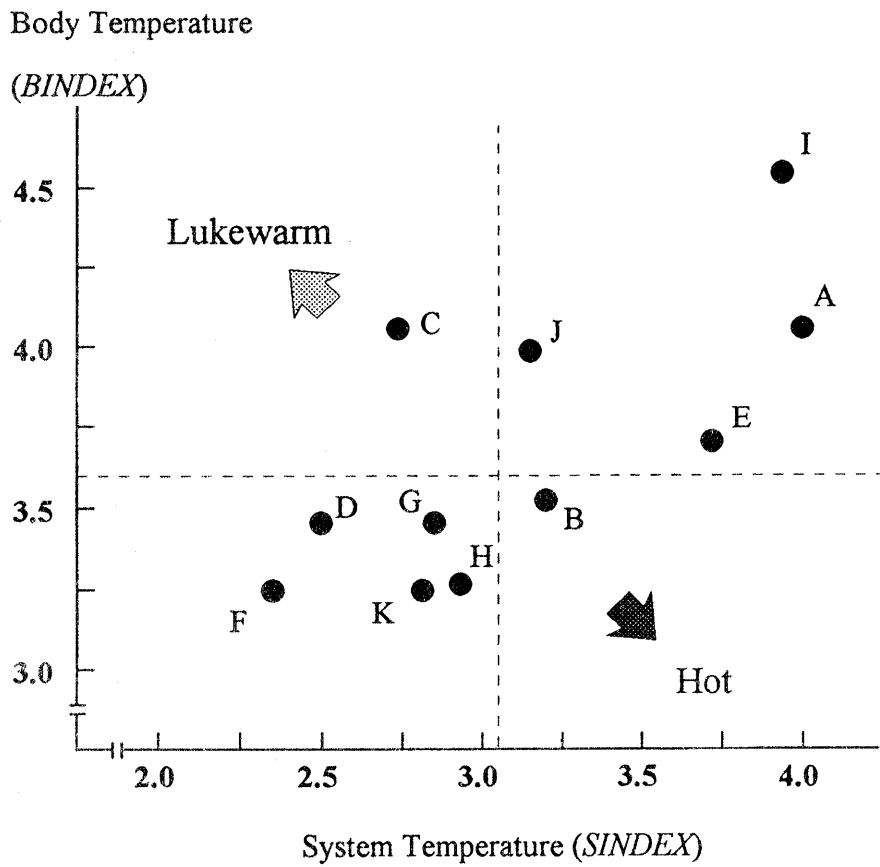


Figure 3. Scatter Diagram of Eleven Companies.

(Dotted lines indicate the means.)

Table 4. Effective Temperature and Lukewarm Feeling Ratio.

| Question 1                 |       | Effective temperature ( $T$ ) |       |       |       |       |       |       |       |       |       |     |       |
|----------------------------|-------|-------------------------------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-----|-------|
|                            |       | Year                          | -5    | -4    | -3    | -2    | -1    | 0     | 1     | 2     | 3     | 4   | 5     |
| 1. Yes                     | 1990  | 14                            | 34    | 68    | 98    | 98    | 82    | 46    | 18    | 3     | 1     | 0   | 462   |
| Lukewarm                   | 1991  | 17                            | 52    | 84    | 133   | 121   | 101   | 60    | 26    | 9     | 1     | 0   | 604   |
|                            | 1992  | 23                            | 40    | 90    | 97    | 103   | 93    | 46    | 20    | 11    | 2     | 0   | 525   |
|                            | 1993  | 24                            | 64    | 125   | 136   | 132   | 113   | 62    | 30    | 8     | 4     | 0   | 698   |
|                            | 1994  | 22                            | 51    | 87    | 104   | 110   | 91    | 62    | 33    | 11    | 4     | 0   | 575   |
|                            | Total | 100                           | 241   | 454   | 568   | 564   | 480   | 276   | 127   | 42    | 12    | 0   | 2864  |
| 2. No                      | 1990  | 3                             | 12    | 31    | 51    | 80    | 69    | 61    | 31    | 8     | 7     | 1   | 354   |
| Non-lukewarm               | 1991  | 1                             | 8     | 20    | 34    | 55    | 59    | 53    | 27    | 8     | 8     | 0   | 273   |
|                            | 1992  | 1                             | 8     | 24    | 20    | 35    | 47    | 27    | 17    | 3     | 0     | 0   | 182   |
|                            | 1993  | 1                             | 14    | 31    | 60    | 75    | 90    | 77    | 50    | 16    | 8     | 2   | 424   |
|                            | 1994  | 2                             | 9     | 22    | 22    | 42    | 43    | 40    | 27    | 14    | 3     | 1   | 225   |
|                            | Total | 8                             | 51    | 128   | 187   | 287   | 308   | 258   | 152   | 49    | 26    | 4   | 1458  |
| Total                      |       | 108                           | 292   | 582   | 755   | 851   | 788   | 534   | 279   | 91    | 38    | 4   | 4322  |
| Lukewarm feeling ratio (%) |       | 92.59                         | 82.53 | 79.01 | 75.23 | 66.27 | 60.91 | 51.69 | 45.52 | 46.15 | 31.58 | 0.0 | 66.27 |

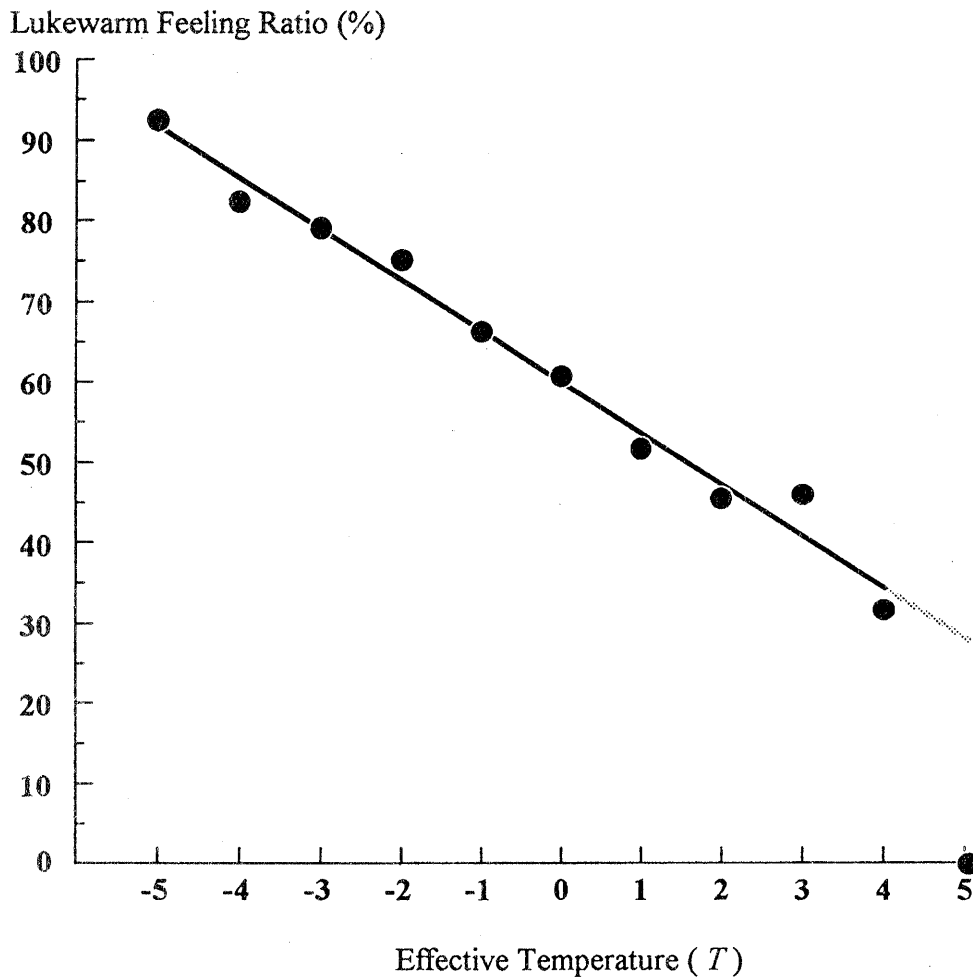


Figure 4. Graph of the Lukewarm Feeling Ratio Versus the Effective Temperature.

Table 5. Regression Analysis of Lukewarm Feeling Ratios (Except for  $T = 5$ ).

| Variable                                  | Coefficient | Standard error     | $t$     | Significance |
|-------------------------------------------|-------------|--------------------|---------|--------------|
| Effective temperature ( $T$ )             | -6.347      | 0.300              | -21.166 | $p = 0.0001$ |
| Constant                                  | 59.975      | 0.874              | 68.604  | $p = 0.0001$ |
| $R^2 = 0.9825$ (Adjusted $R^2 = 0.9803$ ) |             | $F(1,8) = 447.981$ |         | $p = 0.0001$ |

Body Temperature

(*BINDEX*)

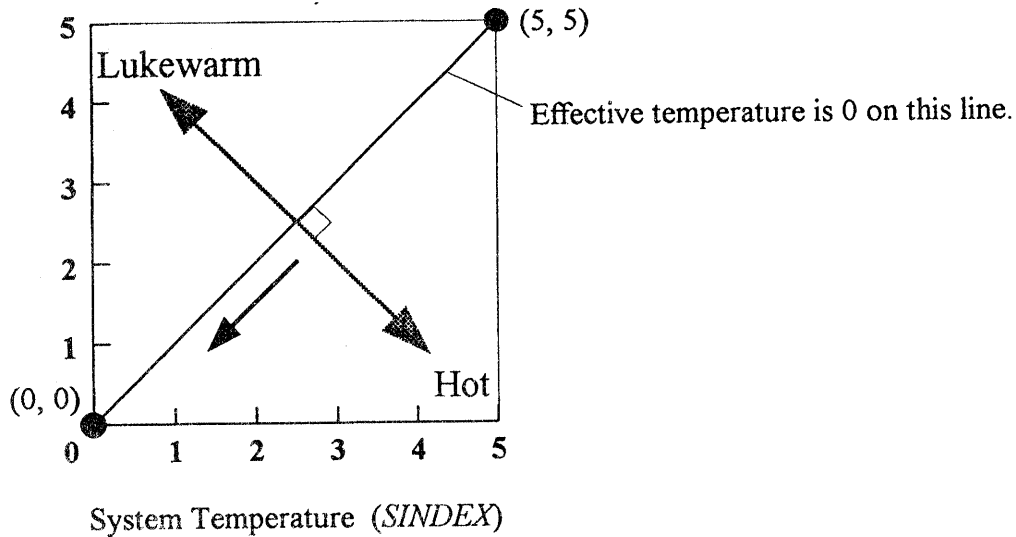


Figure 5. Boiled Frog Phenomenon Explained by Effective Temperature.

Table 6. Classification Summary.

| From         | Number of respondents classified into two groups |              |                       |              |       |
|--------------|--------------------------------------------------|--------------|-----------------------|--------------|-------|
|              | Discriminant function                            |              | Effective temperature |              |       |
| Question 1   | Lukewarm                                         | Non-lukewarm | Lukewarm              | Non-lukewarm | Total |
| Lukewarm     | 284(61.5)                                        | 178(38.5)    | 394(85.3)             | 68(14.7)     | 462   |
| Non-lukewarm | 132(37.3)                                        | 222(62.7)    | 246(69.5)             | 108(30.5)    | 354   |
| Total        | 416                                              | 400          | 640                   | 176          | 816   |
| Error rate   | (178+132) / 816=38.0%                            |              | (68+246) / 816=38.5%  |              |       |

Row percents are in parentheses.