Methods of Measuring the Effectiveness of On-Site Human Error Response Training Based on Employee Engagement Indicators

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ABSTRACT

One of the important issues in the field of safety management is effective human error prevention education for on-site staff. Currently, many sites not only provide basic human error response training such as confirmation and thorough implementation of basic actions, but also various education methods such as work improvement that takes human factors into consideration, active follow-up with team members, and communication methods that lead to accurate reporting, contact, and consultation. However, the effectiveness of such human error prevention education has only been measured qualitatively. Therefore, this study focused on the engagement of workers and examined a method to multifacetedly evaluate each trainee's attitude toward safety activities before and after the course, including the individual characteristics of the workers (personality such as personality analysis). A questionnaire was designed with work engagement, personal engagement, burnout, employee engagement, psychological safety, personality (Big Five theory), and attributes (job type, position, years of experience) as basic parameters, and a model was created to evaluate the following four main factors based on the answers. The four main factors are: (i) loyalty to work, (ii) desire for growth, (iii) desire to contribute to the company, and (iv) sense of happiness (well-being). These indicators were evaluated on a 10-point scale. The effectiveness of the method of measuring the effectiveness of on-site human error prevention training based on the employee engagement indices obtained in this study was verified through surveys at several hospitals in Japan. Since the measurement of effectiveness may be unclear in some cases, we are still working to expand the accuracy of the method by expanding the data.

Keywords: Engagement, Human error, Human resource development

INTRODUCTION

Many companies provide safety education, such as safety management training. The two purposes of education mentioned here are to improve safety-related knowledge and to develop human resources who understand the essence of safety education so that they can actively participate in safety activities and apply it to their practical work. The former is measured quantitatively using assignments, reports, and tests in the course. The latter is particularly important, but it is mostly measured qualitatively based on the

instructor's subjectivity, and no quantitative measurement method has been established.

The purpose of this study was to assist in measuring the effectiveness of education and the subsequent positive attitude toward safety activities, and a model was created that can assess the following four main factors: (i) loyalty to work, (ii) desire for growth, (iii) desire to contribute to the company, and (iv) sense of happiness (well-being). These indicators were evaluated on a 10-point scale based on the results of the questionnaire responses regarding the personal characteristics and engagement.

In human resource development, an important perspective is the spirit of company loyalty. This is because even when safety training is provided, the response to accidents and emergencies varies greatly depending on the degree of company spirit. This is due in large part to engagement, which is the connection between the company and the individual. Therefore, I wanted to use engagement to measure the part related to human resource development, which is the purpose of education, and created a questionnaire on engagement.

METHOD

Below are details on personality and engagement, and the sequence of steps from measuring personality and engagement on the questionnaire to calculating the main factor scores.

Extraction of Factors

Personality and engagement were categorized in detail.

Personality was based on the Big Five theory. It is a common trait theory model that attempts to comprehensively understand personality through five trait factors.

The five traits in the Big Five Theory are mainly Extraversion, Emotional Stability, Intelligence, Agreeableness, and diligence.

In addition, the Big Five theory has been expanded to seven factors by incorporating the perspective of the relationship between personality and human behavior at work into the Big Five theory, which is called Ariki's Seven Factors. Among the five factors, "extroversion" is classified into "sociability" and "proactivity", and "emotional stability" is classified into "stability" and "optimism". From the above, personality was classified into seven factors.

Also, several types of engagement exist. Mainly, there are three typical systems of engagement at work: work engagement, personal engagement, and employee engagement.

In addition, burnout exists as a counter-concept to engagement. I used these four in this study because each engagement and burnout has a slightly different meaning, and the use of multiple engagements allows us to measure engagement from different angles.

The eleven elements of personality and engagement were used to measure the four main factors. Table 1 lists the eleven factors and their descriptions.

Table 1. Analysis categories.

Personality	Sociability	A disposition in which mental energy is directed toward an object, such as another person or thing. Lively, energetic, talkative, adventurous, and aggressive personality
	Proactivity	
	Agreeableness	Indicates the degree of cooperation with one's surroundings. Warm, friendly to all, pleasant, humane, generous, and cooperative personality.
	Diligence	It is a dimension related to self-discipline, which indicates solidity in planning and execution of things. Responsible, conscientious, energetic and diligent in work and study.
	Optimism	A tendency to show emotional irritability. A tendency to be less likely to cause mental confusion in response to stress. An ideal personality that is stable in mood, free of complaints, easy going, and not jealous.
	Stability	
	Intelligence	Curious, has a wide range of knowledge, analyzes and thinks things through. Thoughtful, creative, and intelligent.
Engagement	Work engagement	A positive and fulfilling state of mind in which one is energetic (willing to persevere), enthusiastic (ambitious and challenging in one's work), and absorbed (focused on one's work) in one's work.
	Personal engagement	A state of feeling a sense of meaningfulness (a sense of being able to expect a return on one's investment in performing one's role), security (a sense of being able to use and express oneself), and availability (a sense of having the necessary resources to perform one's role) when performing one's role at work.
	Employee engagement	The voluntary attitude and behavior of employees who are willing to contribute to the organization.
	Burnout	Burnout with symptoms of emotional exhaustion (feeling physically and mentally drained and not wanting to do anything), depersonalization (no longer caring about others), and decreased sense of personal accomplishment (unable to take pleasure in their work and underestimating the importance of their work).

Structuring the Factors

Next, a questionnaire was administered regarding the relationship between the 11 elements and each of the four primary factors. In this case, the questionnaire was administered to one subject who had sufficient knowledge of personality and engagement. The questionnaire was a pairwise comparison of the elements, asking which was more related to the main factor, element

i or element j. This questionnaire was taken for all elements and the results were put into the ISM(Interpretive Structure Modeling) and structured.

Figures 1~4 show the ISM structural model derived from the questionnaire results for each of the four main factors: (i) loyalty to work, (ii) desire for growth, (iii) desire to contribute to the company, and (iv) sense of happiness (well-being).

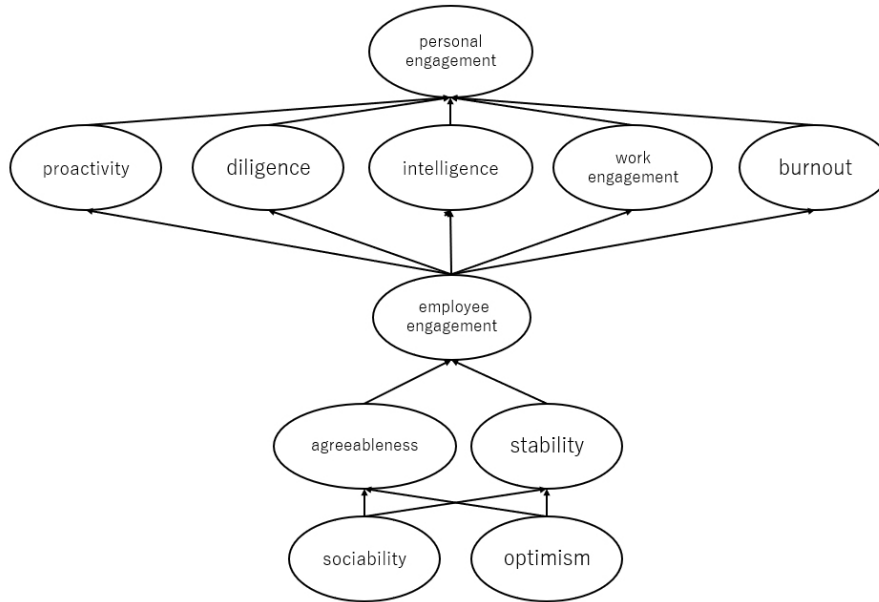The factors at the top indicate that they were rated as having a greater impact on the main factor.

Figure 1: Structuring the factors that form "loyalty to work".
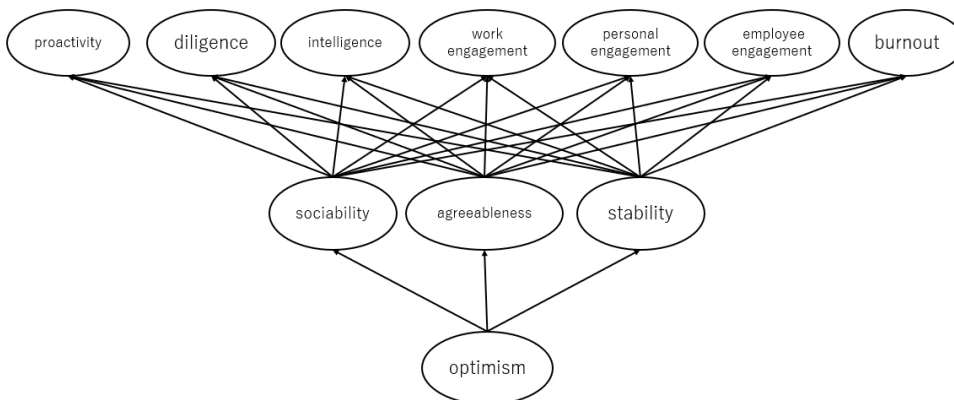
Figure 2: Structuring the factors that form "desire for growth".
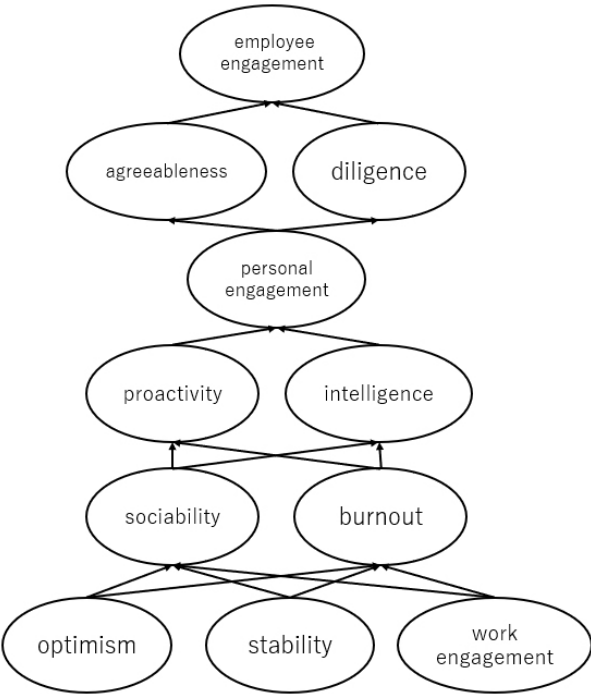
Figure 3: Structuring the factors that form "desire to contribute to the company".
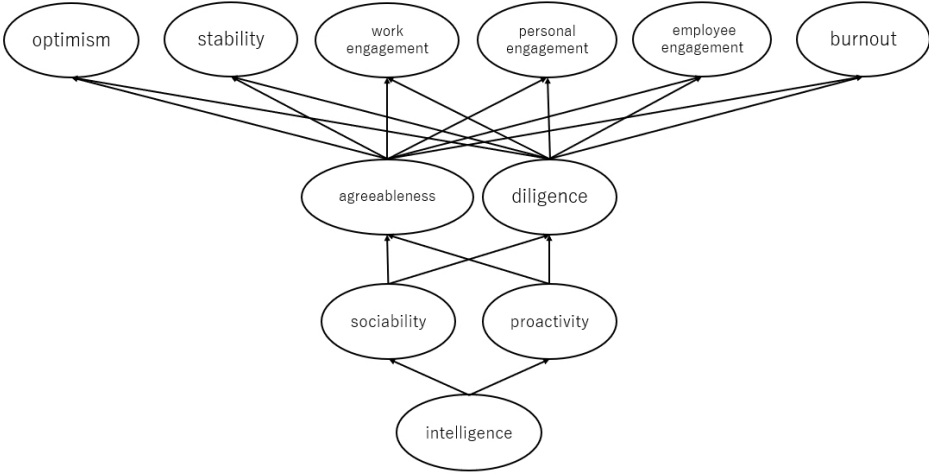
Figure 4: Structuring the factors that form "well-being".

To score the main factors, an influence score was given. Elements of the top row of the figure 1~4, which was more related to each main factor, was assigned a score of 1, and the elements of the second upper row was assigned 0.5, and this score was used as the influence score. After the third upper row, the main factor was not considered relevant, and an influence score was assigned to the second upper row.

Calculation of Main Factors Score

The relationship between the 11 factors and the main factor is quantified. The scores for each factor are obtained by taking a questionnaire. The questionnaire consists of 70 personality questions and 43 engagement questions. After each person completes the questionnaire, they receive a radar chart showing their personality and engagement scores, and comments corresponding to their scores on the personality factors.

These comments were prepared after organizing each of the personality traits and the behaviors that are considered likely to result from various psychological perspectives.

For the personality analysis, the factor structure of the results of Murakami's main 5-factor personality test was used to score everyone's personality building factors, with a minimum score of 0 and a maximum score of 100.

In addition, there are different ways to measure engagement. The Utrecht Work Engagement Scale was used for work engagement, the 13-item measurement tool for personal engagement, the Q12 for employee engagement, and the JBS scale for burnout. For this survey, all responses were scored with a minimum score of 0 and a maximum score of 100. For burnout, a score closer to 100 indicates that the employee is not in a state of burnout.

The figure 5~7 shows a portion of the questionnaire, the radar chart that appears after the survey, and comments.

No.	questionnaire	Answer
1	I think things through logically.	Yes
2	I feel that this job suits my personality.	Yes
3	I tend to worry about trivial matters.	Maybe no
4	I'm not particularly concerned about being in front of others.	Maybe yes
5	I am thorough in what I do.	Yes
6	This past week, I was praised or recognized for doing a good job.	Yes
7	I can stay calm and handle situations.	Maybe no
8	I am quiet and unassuming.	No
9	I am knowledgeable about a wide range of topics.	Maybe no
10	I feel energized and motivated at work.	Maybe yes
11	I often feel confused when faced with difficult problems.	Maybe yes
12	I have a more refined way of thinking than most people.	Yes
13	I believe that people's words often have hidden meanings, so it's best not to take them at face value.	Maybe no
14	I tend to give up easily and lack persistence.	Maybe yes
15	I feel that my boss or someone at work cares about me as a person.	Yes
16	When it comes to traveling, I often make detailed plans in advance.	Yes
17	I am not a particularly anxious person.	Maybe no
18	I often feel emotionally detached from my work.	No
19	There are times when I think I've done a good job.	Maybe no
20	I can see the essence of things.	Maybe yes
21	I always try to put myself in others' shoes.	Maybe yes
22	There are times when I feel that my current job doesn't have much meaning for me.	Yes
23	Talking to people I meet for the first time can be challenging.	Maybe no

Figure 5: Questionnaire sheet.

The personality trait scores and engagement scores (x_i) obtained from the questionnaire responses were multiplied by their corresponding impact scores (α_i) and summed ($y = \sum \alpha_i x_i$). All the scores were then re-scaled to a 10-point scale, which was used as the main factor score.

Sociability	Proactivity	Agreeableness	Diligence	Optimism	Stability	Intelligence	Work engagement	Personal engagement	Employee engagement	Burnout
50.2	58.3	72.9	60.0	38.9	58.8	63.8	60.0	61.5	58.3	73.8
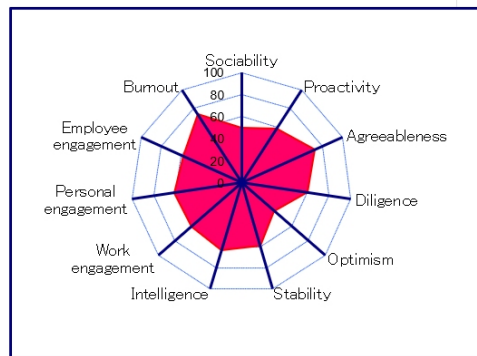
Figure 6: An example of inidividual score evaluated by the proposed method.

Figure 7: An example of advice document according to the individual score.

Verification

In this study, 21 employees of a company that conducts human error education and human error response activities were surveyed about their personality and engagement, and their main factor scores were calculated.

The employees who completed the questionnaire were divided into two groups: those who had received individualized active learning and those who had not. The average of the main factor scores calculated for each group was averaged and a graph was created. In the figure5, the blue bars indicate employees with individualized active learning (8 employees) and the red bars indicate employees without it (13 employees). Figure 5 shows the results.

The vertical axis is the average of each main factor score, on a 10-point scale, with a score closer to 10 indicating higher loyalty to work, desire for growth, desire to contribute to the company, and sense of happiness (well-being).
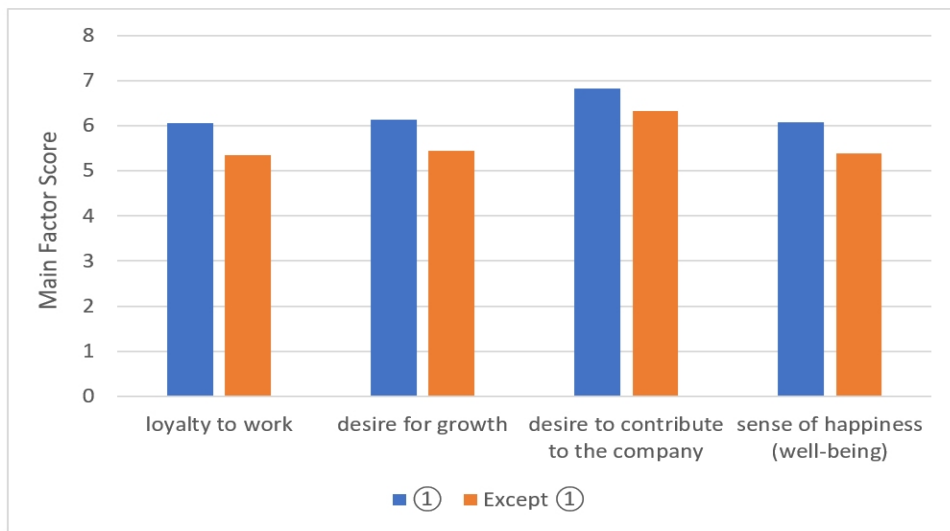
Figure 8: Average of main factor scores.

The figure shows that the group receiving individualized active learning had higher overall scores than the group not receiving this form of education. This suggests that this form of education may increase the spirit of company loyalty. In fact, interviews with the employees receiving the training revealed that they were positive about their work and the company, commenting that they were able to rely on the organization when they had problems in their fulfilling work, indicating that the measurement was effective.

In this study, we attempted to measure educational effectiveness through the scores of the four main factors. In the future, I intend to further analyze the relationship between educational methods and educational effects in more detail. First, I would like to characterize each educational method by evaluating its involvement in the following seven axes. The seven axes are (1) expressiveness, (2) logic, (3) diversity, (4) comprehensiveness, (5) ripple effect, (6) adaptability to the field, and (7) versatility. The method of characterization was determined by morphological analysis of the explanatory documents of the educational methods.

Finally, I would like to create a matrix of "advice for future training plans" based on the relationship between "each worker's four main factors" and "each worker's degree of involvement in the seven axes with respect to the training content already learned."

This matrix allows each worker to understand their current achievement status and obtain the outline of the next step of training.

CONCLUSION

One of the most important issues in safety management is effective human error prevention education for on-site personnel. A sense of company loyalty and volunteerism are essential characteristics for personnel who play a central role in safety activities. In this study, we measured these characteristics

of belongingness to the company, work engagement, personal engagement, burnout, employee engagement, psychological safety, personality (Big Five theory), and attributes (job title, position, and years of experience) to determine the following: (1) loyalty to the job, (2) desire to grow, (3) desire to contribute to the company, and (4) happiness (wellbeing). The effectiveness of the developed method was verified through surveys at several hospitals and companies in Japan. However, the practicality of the method cannot be achieved unless it is connected to the proposal of guidelines for improvement of educational methods through effectiveness measurement. In the future, we plan to establish a method for characterizing educational methods based on the seven characteristic indices described in the previous chapter and develop it into a method that can evaluate and improve competency education practiced in companies.

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