Quantitative evaluation of consciousness improvement in BRM training

K. Inoue & H. Takahashi
Faculty of Maritime Sciences, Kobe University, Japan

Abstract

In the aviation world, the introduction of Cockpit Resource Management (CRM) has been said to be the greatest success in preventing human errors ever attained in the 20th century. Human error is very likely to be made, and it is impossible to eliminate every error. CRM was introduced from the awareness that human beings are always prone to making errors, and by developing the idea that any possible error chain should be cut before the human error caused an accident. In the shipping world, especially in Japan, the accident involving "Diamond Grace", which was stranded west of Nakanose in Tokyo Bay in 1998, motivated the study of a Bridge Resource Management (BRM) training program following the model of the CRM concept. However, it is still underway and will probably take much more time for BRM to become a dependable system in the shipping world and become firmly established.

The authors, while collaborating with CRM experts, are studying how to organize a BRM training program to apply the system in the shipping world. In this paper, the authors report on the process of planning the BRM Basic Course for introduction to beginners and on the results obtained from a quantitative analysis of the effects of such planning.
Keywords: BRM, CRM, training, evaluation.

1 Bridge Resource Management

1.1 Objective of a BRM Training Program

Generally, an accident is likely to be caused by various factors that interact in a complex way. It is considered that an accident is usually caused not by a single event but by many trivial events that interact with each other. In other words, a

human error that is connected with other errors in a chain can cause an accident. Therefore, to prevent accidents, we should find such errors quickly and should break the error chain under accurate situation awareness.

Naturally, human errors should be eliminated, and if a human error should happen by any chance, members of the team should cooperate with each other and try to cut the error chains to prevent the error from causing a real accident. The objective of the BRM training program is to improve the total performance of the team under such a concept as stated above.

1.2 Cutting the error chain

To cut the error chain as soon as possible and prevent the possible connection of a human error with an accident, the key point is to promote communication and teamwork between crew members. Consequently, it is indispensable to produce a friendly atmosphere in which crew members can make reports or suggestions freely, and also to try to promote a correct understanding of any information received. It should be noted that under an authoritative regime, one person's arbitrary decision, conjecture, or prejudice may lead to overconfidence, inviting confusion and finally creating a chain of errors without being able to make use of the resources that are available.

The BRM training program, in this sense, provides measures to promote the total performance of the team with serious efforts being made to eliminate an authority gradient and to improve communication. The essence of the BRM training program is to improve the quality of ship operations by fully using every resource, including human resources, and by having members cooperate with each other in a spirit of mutual reliance and respect, in the conviction that the key to safe navigation is good teamwork and communication. Consequently, it is important for each crew member, in the BRM training program, to try to understand the importance of human relations and the effects that words and behavior have on other members.

That is why the BRM training program is said to be a program that is not about to improve ship maneuvering skills on the bridge, but is about promoting an improvement of consciousness about each person's behavioral patterns.

2 BRM Basic Course

2.1 Planning the BRM Basic Course

The purpose of a BRM training program is to make each member of the team understand how he should behave as a member, namely the basic attitude required and the most desirable behavior.

The authors, in collaboration with CRM experts, are planning the BRM Basic Course as an introductory course for beginners. Also while verifying the effectiveness of the training program, they are working to establish a dependable BRM system in the shipping world. The focus in this BRM Basic Course is the efforts to eliminate an authority gradient and enhance communication.

2.2 BRM Basic Course in practice

The BRM Basic Course is a short one-day program planned as an introductory course for beginners. It is a combination of lectures and practice using a ship-handling simulator. In the morning, lectures aim at changing the consciousness of members so that they can understand the way of thinking and the nature of behavior under the BRM concept and utilize the results in their routine work. In the afternoon, practice using a ship-handling simulator is provided so that the change of consciousness under the BRM concept can be established in practical behavior.

Table 1: The group construction of trainees.

Training Session	Job Experiences (Year)	Class		Q/M	3/O	C/O	Master	Totals
1st	3	3/O						
	9	3/O						
	10	Q/M						
	11	C/O		1	2	3	0	6
	21	C/O						
	23	C/O						
2nd	7	Q/M						
	10	3/O						
	22	C/O						
	23	C/O		1	1	2	2	6
	23	Master						
	27	Master						
3rd	2	3/O						
	5	3/O						
	12	Q/M						
	15	C/O		1	2	3	1	7
	15	C/O						
	17	C/O						
	24	Master						
			Totals	3	5	8	3	19

The BRM Basic Course was delivered at Kobe University; Faculty of Maritime Sciences and was divided into three sessions. Nineteen officers and crew from the same shipping company including Masters, Chief Officers, Second Officers, Third Officers and Quarter Masters participated as indicated in Table 1.

3 Evaluation of training results in the BRM Basic Course

3.1 Evaluation index

It is a principle of the CRM training program in aviation, which is the model of BRM, not to evaluate the progress of each member. However, if the results of training could be observed in changing the consciousness of each person, whether in CRM or BRM, we might evaluate how far and in what manner the

change of consciousness has progressed in an individual or group. So, the authors have started work on developing a technique to evaluate the training results.

In the BRM Basic Course an evaluation test in the form of a questionnaire was given before and after the training to evaluate the results by analyzing variations in scores. This test evaluated nine different areas such as (1) inquiry, (2) sharing of sense of risk, (3) sharing of crisis awareness, (4) advocacy, (5) conflict resolution, (6) decision making, (7) critique, (8) leadership, and (9) followership. Five questions were prepared to cover each area for a total of 45. Among the five questions on each evaluation item there were two or three reverse questions placed at random. These answers required a selection from among the following: (1) absolutely will not, (2) perhaps will not, (3) don't know, (4) perhaps will, (5) absolutely will.

The score for each member is described as a numerical value using the following index:

Consciousness level

Consciousness level before training

= score in the test beforehand/full marks x 100

Consciousness level after training

= score in the test after training/full marks x l00

Improvement degree of consciousness

Improvement degree of consciousness

= (consciousness level after training - consciousness level before training)

Improvement rate of consciousness

Improvement rate of consciousness

= Improvement degree of consciousness/(100 - consciousness level before training)

3.2 Results of evaluation

3.2.1 Effects of training as a whole

An evaluation was made to see if any change was observed in consciousness after BRM Basic Course training, paying particular attention to the consciousness level before and after training, as well as the improvement degree and improvement rate of consciousness. The index figures of this evaluation are shown in the average figures according to occupational classes in Table 2.

As the figures under the consciousness level before training in Table 2 show, there is not much difference in BRM consciousness by occupational class before training.

But, if we pay attention to improvement degree and improvement rate of consciousness shown in Figure 1, although a change of consciousness has been made in every class, it is clear that the training effect was remarkable in crew members of the lower occupational classes such as Third Officer and Quarter Master. Therefore, it can be said that the BRM Basic Course has had a greater impact on improving the consciousness of members in the lower occupational class and encouraged their change of consciousness regarding BRM behavior.

Table 2: The average figures according to occupational classes.

	Consciousness level before training	Consciousness level after training	Improvement degree of consciousness	Improvement rate of consciousness
Q/M	69.6	80.6	10.9	36.0
3/O	71.6	83.4	11.9	41.8
C/O	76.0	80.8	4.8	20.0
Master	72.6	78.1	5.6	20.3
Averages	73.3	81.1	7.7	29.0

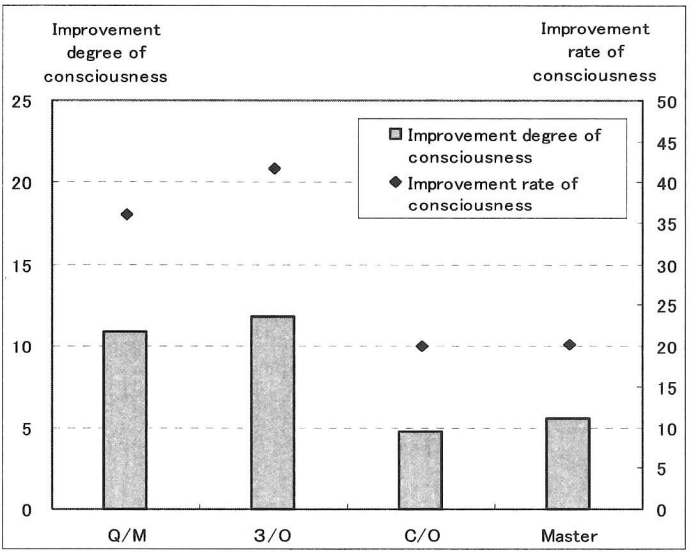

Figure 1: Improvement degree and improvement rate of consciousness.

3.2.2 Effect of Training from Focus Point

An evaluation was made to see which of nine evaluation items showed the most remarkable change of consciousness, paying attention to consciousness levels before and after training. The index figures in the evaluation are shown as averages according to the evaluation items in Table 3 and Figure 2.

Comparing the consciousness levels before and after training, it can be noted that the level has been raised for every item.

The average figure for consciousness level before training, taking every evaluation item and every trainee into account, is 73.30, while the corresponding figure after training is 81.05.

Considering these figures, we can observe in Table 3 and Figure 2 that the improvement of consciousness level due to training is sufficient for items 1-5. In

the BRM Basic Course, the lecture and practice using a ship-handling simulator focus on evaluation items 1 to 5. As the trainees' change of consciousness for these items was deemed to be sufficient, it can be certainly maintained that the training had some remarkable results.

Table 3: Averages according to the evaluation items.

Evaluation Items	Consciousness level before training	Consciousness level after training
1	78.16	84.21
2	81.32	91.05
3	79.21	86.32
4	78.16	83.95
5	71.84	82.89
6	68.16	78.95
7	65.00	68.68
8	71.05	76.05
9	66.84	77.37
Averages	73.30	81.05

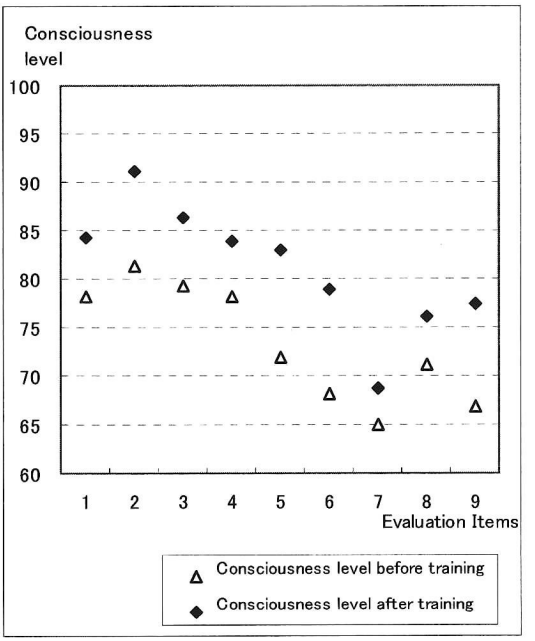

Figure 2: Averages according to the evaluation items.

Table 4: The Improvement rate of consciousness after training according to evaluation items and occupation classes.

Evaluation Items	Q/M	3/O	C/O	Master	Averages
1	40.00	39.13	20.69	0.00	27.71
2	69.57	50.00	38.89	40.00	52.11
3	33.33	43.33	28.00	22.22	34.18
4	23.53	60.00	14.71	8.33	26.51
5	44.44	62.96	29.55	22.22	39.25
6	37.50	55.56	25.00	26.92	33.88
7	-5.26	5.56	14.81	20.83	10.53
8	44.44	29.41	-2.50	11.11	17.27
9	27.78	48.72	22.45	25.00	31.75
Average	35.98	41.80	20.00	20.27	29.03

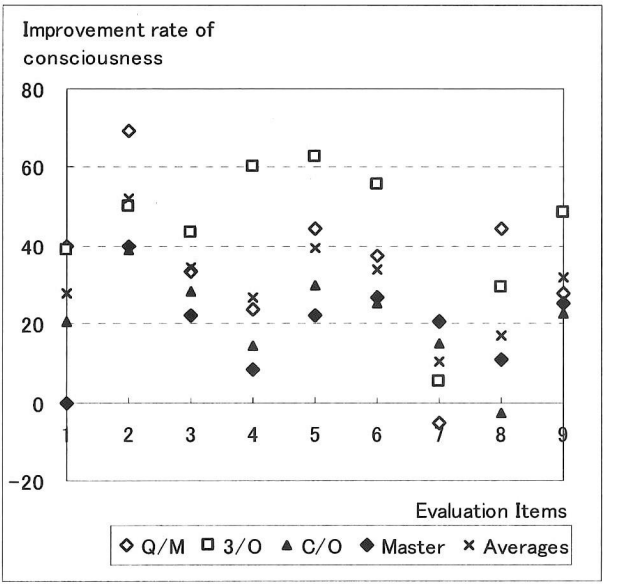

Figure 3: The Improvement rate of consciousness after training according to evaluation items and occupation classes.

3.2.3 Effect of training by evaluation item

Table 4 and Figure 3 show the rate of improvement of trainees' change of consciousness after training according to evaluation items and occupation

classes. With younger crew members, such as Third Officers and Quarter Masters, the improvement rate of consciousness was generally higher for each evaluation item. With Third Officers, the improvement of consciousness was remarkably high for item 4 "advocacy" and item 9 "followership". This may be because such behavior was required of younger crew members such as Third Officers and Quarter Masters on the bridge of a ship. This may be one of the main characteristics identified from evaluating the training results.

The item, for which the improvement rate of consciousness was high, regardless of the occupational class, was item 2 "sharing of sense of risk". This is probably because everybody believes it is important to have a common sense about the technical risks involved in ship operations regardless of occupational class. On the other hand, the item for which the improvement rate of consciousness was low regardless of occupational class was item 7, "critique". Critiques were not very common or prevalent among the ship's crew. This is because they do not perceive the necessity of this item yet.

4 Conclusion

BRM training, with Masters, Chief Officers, Third Officers and Quarter Masters in a team, was performed and a quantitative evaluation was made, on the results for 19 trainees. As a result, the following was clarified:

(1) Remarkable change of consciousness was promoted. This was clearly observed in communication and in being free from authority gradient, as these are the focal points of training in the BRM Basic Course. Thus, it can be judged that the expected results of the BRM Basic Course have been duly achieved.
(2) The BRM Basic Course had a greater impact in improving the consciousness of crew members in lower occupational classes. So it can be understood that the BRM Basic Course will encourage more young crew members to improve their consciousness in BRM behavior.
(3) With Third Officers, the consciousness improvement in item 4 "advocacy" and item 9 "followership" was remarkably high compared to other crew members.
(4) The item for which the rate of consciousness improvement was high regardless of occupational class was Item 2 "sharing of sense of risk".
(5) The item for which the rate of consciousness improvement was low regardless of occupational class was the item 7 "critique".

It had been common knowledge in BRM training that the result of consciousness improvement for individual trainees was not evaluated. However, the authors tried to evaluate quantitatively the results of consciousness improvement in BRM training. As a result, it became possible to decide, by applying index figures, "which part of the training is useful for what, and how much." These were not previously known. The results obtained will be as feedback to further improve the training system and the evaluation technique.

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