Material for interim evaluation (draft): Failure Study Research Group

1. Objectives

The roles of the Failure Knowledge Management System (FKMS) to be implemented as a system of science and technology for society are (a) to provide the techniques and means for effectively utilizing failure knowledge to technicians, physicians, government administrators, and drivers (who provide society and individuals with the influence of science and technology), and (b) to foster a sense of safety and security towards science and technology among society and the individuals who are directly influenced by such science and technology.

This study aims to investigate the functions of the FKMS that could be implemented as a system of science and technology for society, to gather case examples that will be used as failure knowledge, to provide the means to utilize such knowledge as well as methods to predict and avoid such failures, and to present social-cultural methods that could help motivate society and people to use such a system.

2. Member

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3. Target achievements

This research aims at constructing a Failure Knowledge Management System (FKMS) that will serve as a system of science and technology for society through the utilization of failure knowledge.

It has become known that the failures that occur locally, throughout a variety of circumstances in our contemporary society, are rooted in many common causes/factors and social structures. To make further use of failure knowledge more effectively, we will classify those failures and study them individually. In the process of classifying them, we will share such common failure knowledge and widen its application so that it can be applied to other purposes. We will also investigate the factors that hamper the effective use of failure knowledge, will make not only technical efforts but will also study laws that could encourage such use by providing motivations, and will improve social systems, including legal and insurance programs as well as mass communication.

Under ordinary circumstances, this system would correspond with a social infrastructure component that society as a whole could make use of. Because of financial (research development funding) and time restrictions, however, our research

will tentatively aim at establishing a basic design and a prototype for the FKMS. To have this system implemented on a full-fledged scale, we hope that measures be carried out from the safety policy standpoints of science and technology for society.

4. Status and self-evaluation

4-1. Clarification of an ideal social system suited to circulating failure knowledge

To have failure knowledge circulated and disseminated, society must have the following system in place:

(1) Case examples of failures as accidents and problems are investigated,

(2) Failures are converted into "knowledge" by having the results of the investigations on actual case examples analyzed, and

(3) Information obtained from failures is accessible as a form of knowledge.

At present, however, there is an awareness among various sectors in Japan that such a social system is not functioning effectively in each of the above stages, and, as a result, failure knowledge is not being fully circulated. Therefore, the research group conducted surveys to examine the current status of social systems pertaining to the circulation of failure knowledge in various sectors, and, while comparing such systems with overseas systems that are acclaimed as having high-level circulation capabilities, we investigated how such systems in Japan should ideally be from now on. Our survey and investigation primarily targeted accidents caused by technical mishaps, such as medical malpractices, railway accidents, airline accidents, and automobile accidents, as well as complaints about industrial products.

As a result of our investigations based on these surveys, we identified the need for the following so that a social system related to the circulation of failure knowledge may function properly:

- Establishment of a failure-related legal system
- Independence and neutrality of institutions investigating and analyzing various accidents
- Securement of a channel for directly gathering information on failure case examples

4-2. Development of "Seiko Taiken," a failure simulation software

Seiko Taiken is a failure simulation software for experiencing an incident as it would occur inside a factory. Users must come up with their own countermeasures after an incident occurs, and, in the course of simulating this experience in a game format, they can foster an implicit knowledge of danger prediction and learn ways to actively use failure experiences.

We actually tested this software on 33 members of the Japanese Society of Mechanical Engineers' Failure Knowledge Utilization Subcommittee and the Design Research Group that created the actual software. We found that only about 20% of these people knew exactly what steps to take and in what order, and only about 31% were able to identify the steps that should not be taken. About half of the individuals taking the test were able to improve their scores to between 70 and 100% after repeating the same series of questions roughly three times. This shows that this software is effective in studying failure experiences. Incidentally, engineers who actually work at a steel plant tested the software and answered over 80% of the answers correctly on their first try. Some of the comments sent in by those who tested the software included: "I was able to feel the kind of tension I would experience right after an accident occurs;" "The scariest thing was that I was placed in a situation where I had to deal with a power outage and that I could not imagine what would become a source of danger:" "The software is effective in helping us grasp the overall picture of the real experience of dealing with an accident, and the flow of things;" "The terminology specific to a steel plant was hard to understand;" "It would be even more effective if two people were formed into a team and studied the countermeasures through dialogue. This way, we could share knowledge and information and could definitely deepen our understanding."

This software uses a power outage at a steel plant as an example. However, it is designed so that individual failure experiences can be broadened to a general implicit knowledge of danger prediction. In other words, as types of industries where general implicit knowledge may exist, we simulate an even wider range of businesses besides steel manufacturing, such as machinery, electricity and semiconductors. This way, users can gain even more from their learning experiences. Moreover, to enhance people's danger prediction capabilities, we plan to incorporate into this game not only forward calculations (studying the situations chronologically from the time the incident in question occurs) but also reverse calculations (anticipating beforehand the undesirable situations and studying the methods to prevent them from occurring). Other future tasks may include linking failure situations with management revenue/expenditure, implementing problem countermeasures in a more real-time manner, and providing guidance in case erroneous steps have been chosen.

4-3. Development of a method for anticipating and avoiding failures in creative designing exercises

The Failure Research Group took note of failures that occurred in the course of implementing creative work, and studied prediction and diagnosis methods to enable a

team to carry out their creative endeavors while avoiding failures.

We observed and analyzed the Creative Design Exercise Program established by the University of Tokyo's Faculty of Engineering, and analyzed the relationship between creation and failure among 80 targeted students (40 teams). The following findings were obtained through this study:

(1) Clarification of the relationship between individuals/teams and creativity/ability to cope with failures

(2) Clarification of key points in failure predictions

4-4. Development of a method for quantitatively evaluating a failure's degree of social impact

We used various companies that had experienced failures as case examples to compare the profits they gained through fraudulent acts (causing failures and covering up such failures, etc.) and the losses they were made to pay as a result of having such failures revealed. In other words, we established the following definitions for the profits gained through acts that led to failures and the losses incurred by failures, and then evaluated them.

- Profits from failure: These include profit that an operator had obtained by conducting a fraudulent act and the amount of investment needed to prevent accidents and other failures that an operator decided not to make. To evaluate and calculate these profits, we used the information that was made public, as well as losses that had incurred after an incident had actually been revealed.
- Losses from failure: These are defined as losses an operator suffered after it was revealed that the operator had committed fraudulent acts, and had caused accidents and other failures. To evaluate these losses, we primarily used the total value of share prices from the time such failure had been revealed, as well as reductions in sales.
- We focused on 21 recent corporate failure incidents and calculated for each case the amount of profits from failure and of losses from failure.

By evaluating the cost benefits of failures, we were able to quantitatively demonstrate, as below, that it does not pay, economically, to make mistakes or to cover them up.

- Failures of private companies related to wrongdoings such as falsified labeling of meats and provision of payoffs become targets of strong social criticism. Therefore, the value of losses from failure becomes greater than that of profits from failure.

The former was far greater than what we had initially anticipated; companies suffered from 100 to 10,000 times greater losses from failure than profits from failure. In other words, companies end up paying huge amounts of money in return for their failures resulting from wrongly pursuing profits, etc. So companies should never resort to such acts.

- Users have not much choice when it comes to electricity, railway, and other public services. Therefore, the value of losses from failure is almost the same as the value of profits from failure for these industries. In other words, people are compelled to use such services even after accidents. Concerning these businesses, we must encourage each entity to make independent efforts and instruct them to carry out adequate regulations and supervisions to prevent failures and mishaps.