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Role of Certification and Supervision in Safety Management of Elevators

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Abstract : This study focuses on the issue of improving safety management of elevators. The role of certification and supervision in reducing the associated accidents is specifically addressed. The results of simple statistical analysis suggests that a certification procedure emphasizing the quality assurance during manufacturing and supervision during assembly and installation of elevators are needed and can be effective in minimizing the associated accidents.

Key words: certification, elevator, inspection, safety management, supervision

1. Introduction

Safety management of elevators in Korea is known to be non-systematic and inefficient, and has resulted in 108 cases of death and 129 cases of severe injuries from 1993 to 2004. In 2004, 5,511 locked-in accidents have been reported and 12,078 individuals were rescued from these accidents. Compared to the current safety management system, more realistic and efficient safety management system is, therefore, required to prevent the elevator-related accidents.

This study focuses on the issue of improving safety management of elevators. The role of certification and supervision in reducing the related accidents is specifically addressed. The effectiveness of such procedure can be demonstrated by performing simple statistical analysis.

2. Statistical Analysis

Table 1 shows that Fatality Rate in Korea (the number of death in elevator accidents divided by the total number of installation) is about 5 to 10 times that of a typical European nation.

Number of the injured and the dead in elevator accidents in Korea are compared with the total number of elevators installed (accumulated or newly-installed) in Figure 1. In the figure, all the data were normalized by the data in the reference year (the year 2000 in this case). It is desirable to have the decreasing trend of the number of injured and the dead even when the number of elevator in use increases. The data in Figure 2, however, indicates the increasing trend over the past five years. Furthermore, the rate of increment of the injured/dead surpasses that of the number of elevators installed so that slope of the injured and the dead becomes steeper. It is noticed from the figure that the current safety management system is not able to cope with the increasing number of new installations. It is not even effective in terms of reducing the accidents and saving lives of the users and properties of the owners.

Figure 2 and Figure 3 shows the statistical relationship between the number of injured and the dead and the annual rate of failure/the annual rate of conditional

Table 1. Total number of injured/dead in elevator-related accident in major countries

	Total Number of Installation (Units)	Annual Number of Death (Person2)	Comparison Index
Korea	211,741	9	100(Basis)
Germany	433,660	2	10.8
England	172,000	1	13.7
France	491,000	4	19.2

*The above statistics were taken from the year 1996 to 2003.

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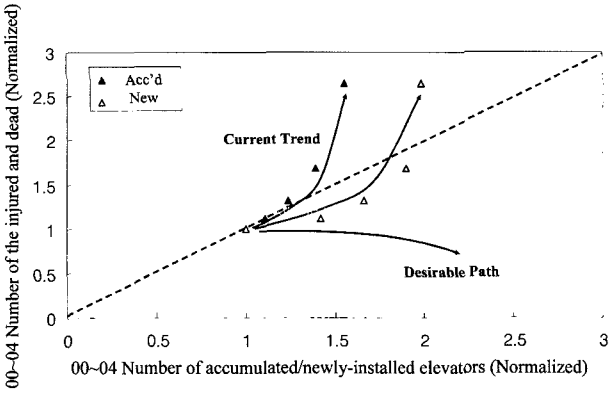


Fig. 1. The relationship between the number of the injured and dead in elevator accidents and the total number of elevators installed(accumulated)/newly-installed.

pass in regular (periodic) inspection, respectively. The regular inspection is executed every other year after installation. Conditional pass implies pass of inspection under the conditions that the owner fixes any inspector-stated deficient functions of the elevator within the given period of time.

All the elevators that failed the inspection are not to be used and, therefore, have no significant correlations with the number of injured/dead in elevator accidents. It is, however, interesting to see that between the number of injured and dead and the rate of conditional pass a strong correlation exists. A possible reason for this is that conditional pass in completion and regular inspection leads to a poor maintenance by the users, which may cause the accidents.

Furthermore, Figure 4 shows both the non-compliance rate in the first year inspection (for the elevators used for one year after installation) and the average non-compliance rate of all elevators in use. Non-compliance means both failure and conditional pass in inspection.

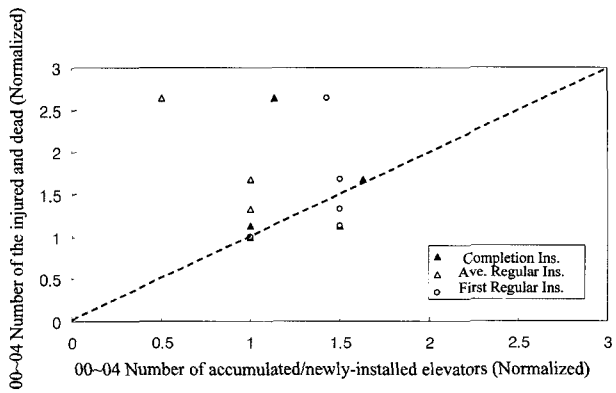


Fig. 2. The relationship between the number of injured/dead and the annual rate of failure in regular inspection.

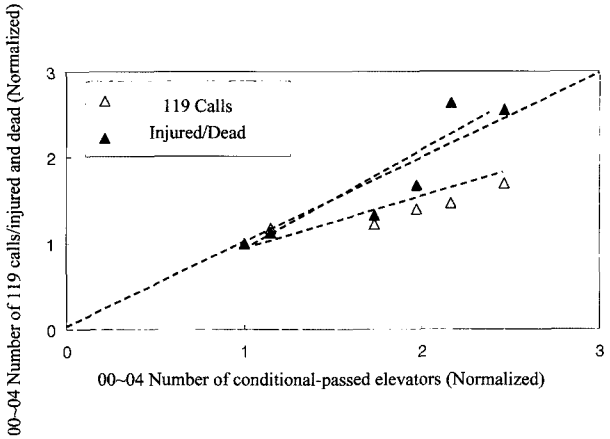


Fig. 3. The relationship between the number of injured/dead and the conditional pass in regular inspection.

The first year non-compliance rate appears to be excessively higher than the average rate of all elevators in use. This leads to a conclusion that either assembly and installation must be performed at a higher level of integrity or the inspection in the early stage of use must be more strict and complete.

3. Problems in Current Safety Management of Elevators

3.1 Safety Management System

In general, in order to maintain high standards of safety for high risk device such as elevators various ways of ensuring product safety of elevators at each level of the safety management, ie, certification in the manufacturing stage, supervision in assembly and installation stage, completion inspection after assembly and installation but before put into service, and regular inspection for elevators in use re required. As of July

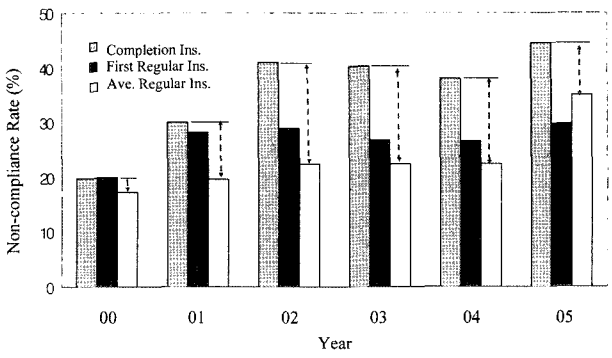


Fig. 4. Non-compliance rate in first year inspection (for the elevators used for one year) and the average non-compliance rate of all elevators in use.

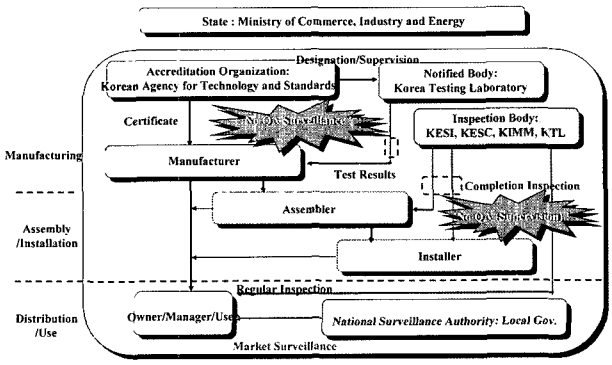


Fig. 5. Certification and inspection organizations and their roles in Korea.

1st of the year 2007, new regulation enforces to certify the five major parts but the system of elevator is still subject to the voluntary certification. Supervision in the assembly and installation stage is, however, not required. Figure 5 describes the current certification and inspection organizations in Korea and their roles.

Figure 6 indicates the problem of absence of the appropriate safety management functions in the system. As the degree of danger in using the products increases, more tight and thorough method to ensure the safety performance of the finished products is required. One way of doing that is the quality assurance, ie, the full quality assurance in the manufacturing stage and the other form of quality assurance in the assembly and installation stage, the supervision. As for the elevators in use, the thorough inspection or more advanced form of risk assessment would be necessary.

Increasing rate of non-compliance (both conditional pass and failure) and failure to meet the inspection standards over the long period in use are shown in Figure 7 and Figure 8, respectively. These data result from the fact that the certification and the associated quality con-

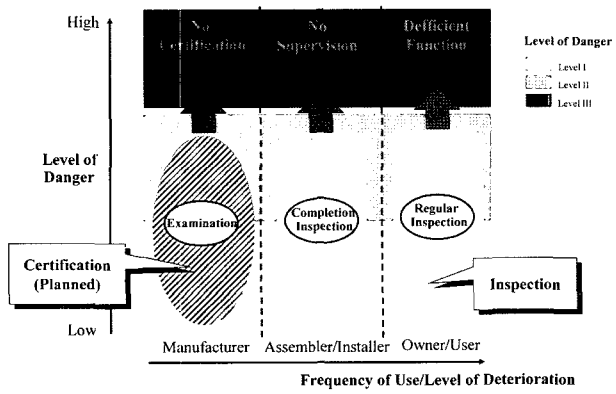


Fig. 6. Absence of critical functions in the current safety management system in Korea.

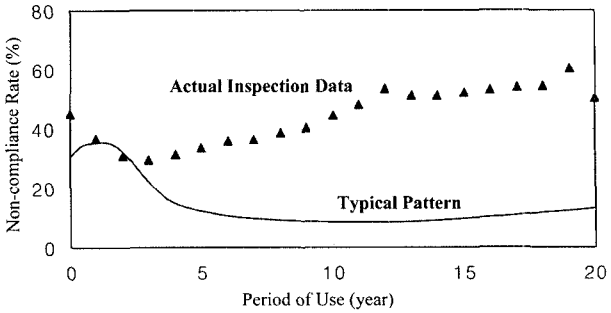


Fig. 7. Non-compliance rate over the period in use.

trol and the supervision in assembly and installation are not enforced. Unusually high rate of non-compliance and failure are the combined results of the absence of certification and supervision, the unreliable inspection in the early stages of use and the insufficient maintenance by the owner, which leads to the sharp deterioration of parts and system of elevators. Therefore, it is needed to certify the parts and the system in the manufacturing stages, to supervise the assembly and the installation in addition to the completion inspection. Furthermore, the regular inspection must be performed based on the objective and quantitative inspection standards. This is particularly important since it eliminates the subject and qualitative judgement of the inspector on site.

3.2 Strategy to Promote the Safety of Elevators

In general, any product including elevators can cause safety problems for various reasons. The technical reasons are:

- the average performance of the products falls short of the safety requirements and, therefore, resides outside the safety band defined in Figure 9 or
- the average performance of the products satisfies the safety requirements but any performance of a particular product resides outside the safety band due to poor quality assurance in the manufacturing

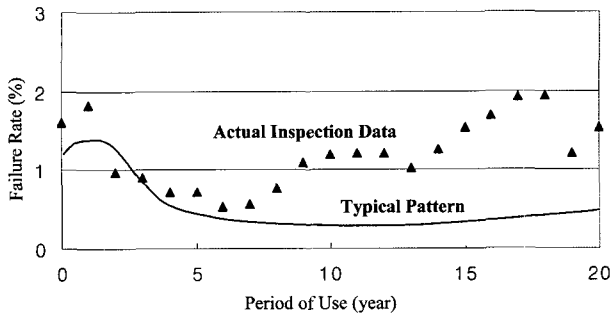
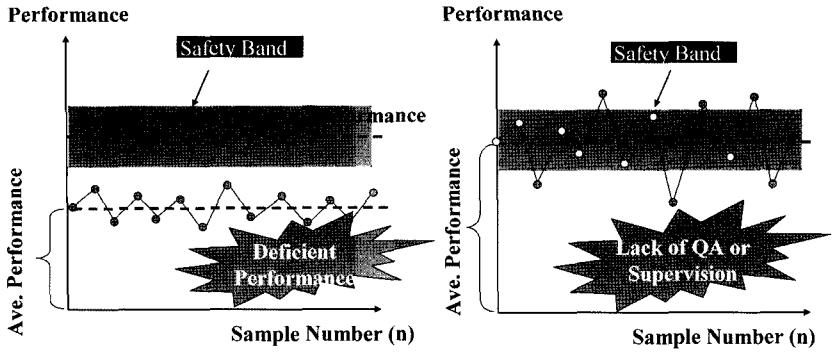


Fig. 8. Failure rate over the period in use.



Safety problem caused by deficient average performance
Keywords: Performance Specs.

Safety problem caused by uneven quality of product
Keywords: Quality Management

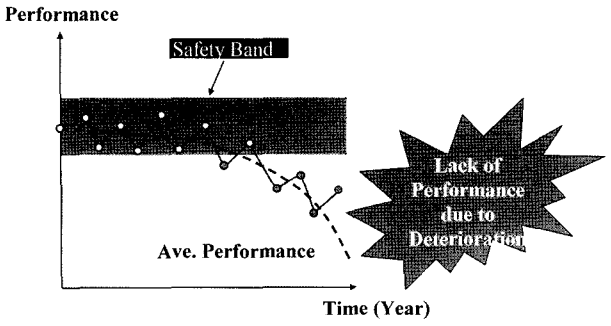
Fig. 9. Factors that affects the product safety.

or the assembly and installation stage or

- the average performance of the product resides outside the safety band due to deterioration of the composing parts and the products over the period of use as in Figure 10.

In order to solve the above problems, one has to

- first of all enhance the average performance of the products by certification in manufacturing stage so as to meet the safety requirements defined by the safety band as in Figure 11 and
- minimize irregularity of the quality of the product by quality assurance so that the performance of every product falls within the safety band and
- prevent the deterioration of the parts and products by the appropriate maintenance and the effective regular inspection.



Cases without regular (yearly) Inspection
Keywords: Inspection/Maintenance

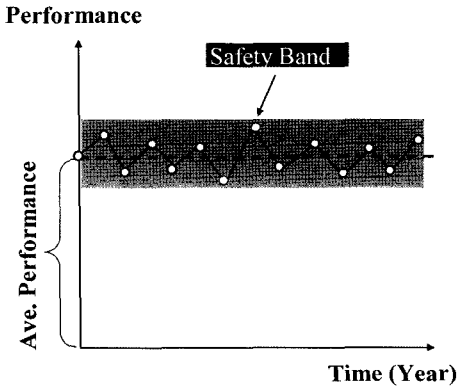
Fig. 10. Ensuring product safety by certification and supervision.

The above three requirements are satisfied by the safety management system including the following functions:

- examination of the performance of the products and
- quality assurance of either the product or the production system r both in the manufacturing stage and
- supervision during assembly and installation and
- completion inspection before the elevator is put into service and
- regular inspection.

4. Supervision during Assembly and Installation

Supervision is the process of assuring the quality and the safety of the elevator before they are put into service. Assembly and installation of elevators require high level of technical and management skills. Supervisors



Effect of Certification, Supervision and Inspection

Fig. 11. Ensuring product safety by regular inspection.

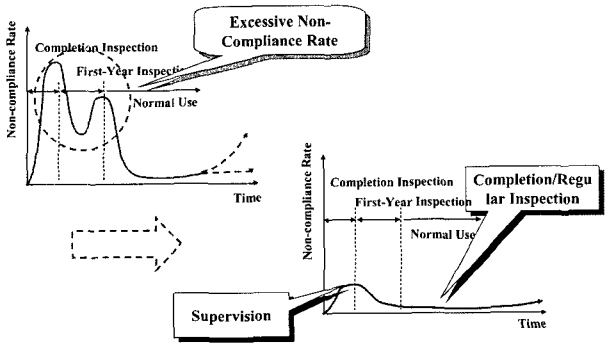


Fig. 12. Effect of supervision in assembly and installation stage.

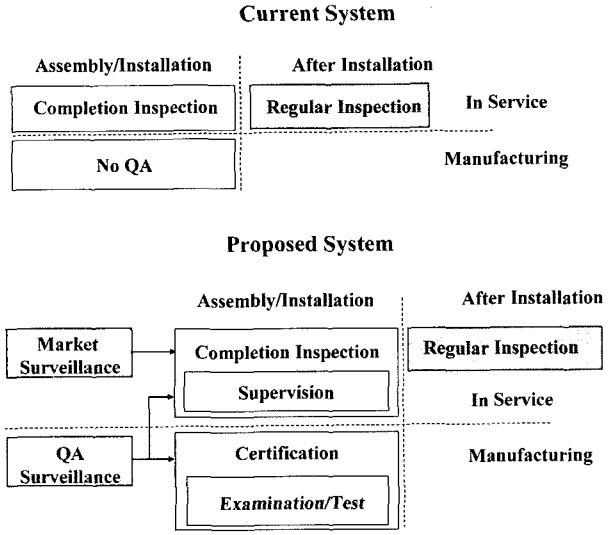


Fig. 13. Suggested safety management including certification and supervision at the appropriate stages.

need to have sufficient knowledge and experiences. Effects of Supervision are manifested by the low rate of non-compliance or failure in inspection in the early stage of use, which in turn leads to the prevention of safety-related accidents. This will also minimize the unnecessary maintenance cost and other social cost. Figure 12 explains the effect of supervision during assembly and installation of elevators. Minimum rate of non-compliance or failure will certainly reduce the rate of failure in the regular inspection and validation later on.

Figure 13 below indicates the plan for introducing certification and supervision program in manufacturing and assembly and installation stages, respectively.

5. Conclusions

Simple statistical analysis suggests that certification emphasizing the quality assurance in manufacturing and supervision in assembly and installation of elevators are needed and can be effective in terms of minimizing the associated accidents. These procedures may promote the quality of production, and therefore, the quality of product, and reduce the rate of non-compliance or failure during the regular inspection and validation stage.

Acknowledgement

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