A COMPARATIVE ANALYSIS OF NEAR-MISS FALLING & SLIPPING INCIDENTS AT INDOOR AND OUTDOOR TELECOMMUNICATION CONSTRUCTION SITES

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This research aimed at clarifying near-miss incidents of falling accidents by telecommunication construction workers. Workers' subjective evaluations of their accidents were examined including situation awareness, thinking, fatigue, panic and unconscious action. As a result, differences in accident factors between indoor and outdoor construction sites were identified. Among items of near-miss incidents, "slipping" was found common to both indoor and outdoor construction sites. However, the slipping incidents at outdoor construction sites were characterized by their " -work behaviours", whereas those at the indoor construction sites by " -work behaviours" and "- feelings・emotions"Importance of accident prevention education learned from actual near-miss incidents was examined.

Introduction

A Trend Analysis of falling accidents in Japan's construction industry in 2012 indicated that most of them took place at the height of from two to four meters (Nagasaki Labor Bureau, 2013). In the case of telecommunication construction, electric shock accidents and slipping accidents showed a high rate of occurrence. Most of the slipping accidents were found to have taken place while working in a work vehicle at a high place, on a stepladder or on a temporary floorboard for work (The Japan Construction Occupational Safety and Health Association, 2013).

Since the telecommunication construction plays an important role in supporting the social communication infrastructure, accidents at construction sites such as mishandling of electric cables and erroneous setup of equipment cause communication troubles or network suspension and may eventually result in damaging data communication service (Ministry of Internal Affairs and Communications, 2012). For preventing such accidents, it is effective to discuss accident prevention based on actual cases of accidents and near-miss incidents at construction sites at a "Tool Box Meeting" before the work starts (Fang *et al*., 2006. Gherardi *et al*., 1998).

A preceding study (Usui, 1995) of near miss-incidents at construction sites and human errors indicates an accident prevention measure focusing on background and human factors of accidents which have been found in the analyses of their own near-miss incidents cases by the workers.

At medical service sites, any medical error may lead to a loss of human life. Therefore, nurses and pharmacists receive medical safety education in which they learn accident recurrence prevention measures by identifying and structuring error factors and risk factors through root cause analyses of actual cases of near-miss incidents (Kimura, 1998).

Tanimura (1995) offers a model of mental and physical functions necessary for work performance based on four areas of functions: grasping of situation awareness, integration of thoughts, feeling and emotion, and work behaviors. Using the model he analyses human errors

based on four different functions and focuses on qualitative differences among them. He proposes twelve checkpoints (Nshimura, 2007) for assessment consisting of three checkpoints for each of the four function areas. The grasping of situation awareness is concretely translated into the following three checkpoints:

(1) I could not see it, (2) I could not notice it, and (3) I forgot about it. Likewise, checkpoints for the integration of thoughts are: (4) I did not know, (5) I did not think about it, and (6) I thought it would be alright. Those for feelings and emotion are: (7) I was upset, (8) I was experiencing stress (I was stressed), and (9) I was feeling tired (I was tired). Those for work behaviors are: (10) I moved my hands absent-mindedly, (11) The work was hard for me (It was difficult), (12) I accidentally lost my balance. Medical doctors use these checkpoints when they conduct a medical examination by interview for their patients. They find out objective facts and problems from subjective explanation by the patients, which would eventually lead to development of systematic measures for human error prevention.

In this study, utilizing Tanimura's model of four mental and physical functions, we carried out an investigation to clarify the relationships between near-miss incidents and human error based on actual incidents at telecommunication construction sites focussing: (1) characteristics of near-miss incidents which experienced by telecommunication construction workers and (2) the relationship between near-miss incidents and human errors.

Subjects of survey and Method

Research object

The survey was conducted at B and C sections of A communication construction company (annual sales: 20 billion yen, number of employees: 264). The B section handles the design of information and communication facilities, construction, operation, and maintenance as mostly indoor work. The C section is in charge of outdoor work including antenna setting and mobile communication base station setting. The survey was carried out during the safety education hours of the two sections. Before conducting the survey, the person in charge of the safety education explained the purpose and contents of the investigation to the telecommunication construction workers.

Survey Method

The survey contained two types of questionnaires: the one asking its subjects to answer with their own words and the other asking them to answer multiple-choice questions. The question requiring a written answer asked, "If you have ever experienced any near-miss incidents at your construction site, please describe it in your own words." The next multiple-choice questions asked the subjects to check all of the items which apply from the twelve items of the mental and physical functions.

A pilot survey was conducted during the safety education hours of the B section on May 25, 2012 to 15 workers in order to confirm the clarity of the meaning of each question, proper space for the descriptive answer and the aggregation method.

The real survey was conducted nine times in the B section between June and September in 2012 and eight times in the C section between September and December in 2012.

Analysis Method

One person in charge of safety education classified the answers on near-miss incidents experiences and two others in charge of safety education aggregated the results and arranged them in graphs.

For the B section the survey targeted at the indoor work because most near-miss incidents took place at indoor locations such as in machine rooms and inside the office building. For the C section the survey focused on the outdoor construction work because most of near-miss incidents occurred at outdoor locations such as at rooftop mobile telecommunication station and on communication steel tower or utility poles.

Observing work contents of the two sections, additional clarification of some items of survey was provided to reflect images of near miss-incidents better. The "falling" was defined as falling from 2 meters or more in height. The incidents during the work on a stepladder or a ladder were

categorized into the "slipping" item.

A distribution-free test (χ^2; Chi-square test) was utilized to check significant difference among the items. The used software was SPSS Statistics Version19 of IBM Corporation for statistical analysis.

Findings

Trend analysis of near- miss incidents (Indoor)

175 indoor telecommunication construction workers were selected as the subjects of survey and 172 valid responses were collected. The response rate was 98.3%. According to sex of the respondents, 171 were male and one was female. In ratio to the total respondents, they were 99.4% and 0.6% respectively. The range of the age of the respondents was 38.9±9.6 years old and the range of experience 14.9±8.0 years.

Trend analysis of indoor near-miss incidents showed 3 cases of "falling"(1.7%), 42 cases of "slipping" (24.4%), 44 cases of "damaging cable/loosening cable"(25.6%), 42 cases of "improper connection and erroneous contact" (24.4%), 18 cases of "materials or tools dropped" (10.5%), and 23 cases of "Others" (13.4%). The result of the Chi-square test was χ^2 (688) = 20; p< 0.01.

The descriptive contents of "falling" included, "Inside of the work place was so dark that I lost the balance at the step between one vehicle for work at high place (10 meter or lower) and another when I was moving between them."

Table 1.Trend analysis of near-miss incidents (Indoor)

Item analysis (Number of cases)		χ^2 Test	Sites				
			Internet Data Center・Machine Room	Building	Plant・Construction	School Grounds and Hospital Facility	Others
Falling	3 (1.7%)	*	0 (0.0%)	0 (0.0%)	3 (10.0%)	0 (0.0%)	0 (0.0%)
Slipping	42 (24.4%)	*	11 (19.3%)	12 (23.1%)	13 (43.3%)	6 (24.0%)	0 (0.0%)
Damaging Cable / Loosening Cable	44 (25.6%)	*	21 (36.8%)	14 (26.9%)	3 (10.0%)	6 (24.0%)	0 (0.0%)
Improper connection and Erroneous contact	42 (24.4%)	*	15 (26.3%)	16 (30.8%)	4 (13.3%)	7 (28.0%)	0 (0.0%)
Materials tools tools dropped	18 (10.5%)	*	6 (10.5%)	6 (11.5%)	4 (13.3%)	1 (4.0%)	1 (12.5%)
Others	23 (13.4%)	*	4 (7.0%)	4 (7.7%)	3 (10.0%)	5 (20.0%)	7 (87.5%)
Total	172 (100%)		57 (100%)	52 (100%)	30 (100%)	25 (100%)	8 (100%)

*p<0.01

Trend analysis of near- miss incidents (Outdoor)

The survey was given to 132 outdoor telecommunication construction workers. 131 valid responses were collected. The response rate was 99.3%. According to sex, 130 respondents were "male" (99.2%) and one was "female" (0.8%). The range of the age was 40.9±8.6 years old and the years of experience 17.8±9.7 years.

The trend analysis of outdoor near-miss incidents showed 25 cases of "falling" (19.1%), 34 cases of "slipping" (26.0%), 18 cases of "while driving an automobile" (13.7%), and 8 cases of "improper connection and erroneous contact" (6.1%) as shown in Table 2. The result of the Chi-square test was χ^2 (1048) =64; p< 0.01.

Many "falling" incidents took place during "working on communication steel tower or utility

poles". Some descriptive answers were as follows. "15 years ago, due to a sudden request for work, I had to go up the utility pole. Because of the electricity leaking to the scaffold, I nearly fell from the high place. From now on, we should examine the electric environment before moving up the pole." "My safety seat belt was not securely fastened. So when rested my weight on feet, I nearly lost my footing. I lost the balance of my body."

Trend analysis of the common items in the near- miss incidents indoor and outdoor
 "Slipping" was the common item in the near-miss incidents indoor and outdoor. The "slipping" item was further subdivided into in 12 items based on "four mental and physical functions".

In the indoor construction work, 93 cases were reported from 42 respondents (the response rate of 24.4%). Among them, 28 cases related to "situation awareness" (30.0%), 31 cases to "integration of thinking" (33.3%),15 cases to "feelings・emotions" (16.2%)," and 19 cases to "work behaviors" (20.5%).

In the outdoor construction work, 83 cases were reported from 34 respondents (the response rate of 26.0%). Among them, 15 cases related to "situation awareness " (18.0%), 33 cases to "integration of thinking" (39.8%),11 case to "feelings・emotions " (13.3%)," and 24 cases to "work behaviors" (28.9%). As the common construction work, in the "stepladder work" 15 cases were reported in the indoor construction, and 13 cases in the outdoor construction. Table 4 shows some of the reported contents of "the stepladder work".

Table 2.Trend analysis of near-miss incidents (Outdoor)

Item analysis (Number of cases)		χ^2 Test	Sites						
			Mobile Telecommuni cation Station	Roof of the Building	While Operating a Vehicle	Works on Communication Steel Tower and Utility Poles	Outdoor Work	Plant・ Construction	Others
Falling	25 (19.1%)	*	2 (7.7%)	5 (20.8%)	1 (4.5%)	13 (65.0%)	3 (17.6%)	1 (20.0%)	0 (0.0%)
Slipping	34 (26.0%)	*	8 (30.8%)	11 (45.8%)	2 (9.1%)	1 (5.0%)	3 (17.6%)	2 (40.0%)	7 (41.2%)
While Driving an Automobile	18 (13.7%)	*	0 (0.0%)	0 (0.0%)	15 (68.2%)	0 (0.0%)	1 (5.9%)	0 (0.0%)	2 (11.8%)
Improper connection and Erroneous contact	8 (6.1%)	*	5 (19.2%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	2 (11.8%)	1 (20.0%)	0 (0.0%)
Materials or Tools Dropped	14 (10.7%)	*	2 (7.7%)	3 (12.5%)	1 (4.5%)	5 (25.0%)	3 (17.6%)	0 (0.0%)	0 (0.0%)
Cuts / illnesses	6 (4.6%)	*	1 (3.8%)	1 (4.2%)	0 (0.0%)	0 (0.0%)	1 (5.9%)	1 (20.0%)	2 (11.8%)
While Working in a Vehicle for work at high place	2 (1.5%)	*	0 (0.0%)	0 (0.0%)	2 (9.1%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)
Damaging Cable /Loosening Cable	3 (2.3%)	*	2 (7.7%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	1 (5.9%)	0 (0.0%)	0 (0.0%)
Others	21 (16.0%)	*	6 (23.1%)	4 (16.7%)	1 (4.5%)	1 (5.0%)	3 (17.6%)	0 (0.0%)	6 (35.3%)
Total	131 (100%)		26 (100%)	24 (100%)	22 (100%)	20 (100%)	17 (100%)	5 (100%)	17 (100%)

*p<0.01

Table 3.Four mental and physical functions

Four mental and physical functions		Indoor Construction Sites		Outdoor Construction Sites	
		Number of cases Incidents（Rate）	42(24.4%)	Number of cases Incidents（Rate）	34(26.0%)
Situation awareness	(1) I could not see it.	7 (7.5%)	28 (30.0%)	8 (9.6%)	15 (18.0%)
	(2) I could not notice.	15 (16.1%)		4 (4.8%)	
	(3) I forgot about it.	6 (6.4%)		3 (3.6%)	
Integration of thinking	(4) I did not know.	0 (0.0%)	31 (33.3%)	3 (3.6%)	33 (39.8%)
	(5) I did not think about it.	14 (15.0%)		12 (14.5%)	
	(6) I thought it would be alright	17 (18.3%)		18 (21.7%)	
Feelings・emotions	(7) I was upset.	13 (14.0%)	15 (16.2%)	11 (13.3%)	11 (13.3%)
	(8) I was experiencing stress. (I was stressed.)	0 (0.0%)		0 (0.0%)	
	(9) I was feeling tired. (I was tired.)	2 (2.2%)		0 (0.0%)	
Work behaviors	(10) I moved my hands absent mindedly.	0 (0.0%)	19 (20.5%)	2 (2.4%)	24 (28.9%)
	(11) The work was hard to do for me. (It was difficult.)	6 (6.5%)		8 (9.6%)	
	(12)I accidentally lost my balance	13 (14.0%)		14 (16.9%)	
Total		93 (100%)	93 (100%)	83 (100%)	83 (100%)

Table4. Contents of near-miss incidents in the stepladder work

Item analysis	Construction Site (Number of cases)	Contents of near- miss incident			
		ID No,	Age	Years of Work Experience	Contents
Stepladder work	Indoor (15 Cases)	B167	57	13	Experience: I lost my balance while working on a stepladder.
					work Environment: I knew the work place was so narrow and dim that I had to maintain an awkward posture for work on the stepladder. Having no chance to change the situation, I decided to work there.
	Outdoor (13 Cases)	C35	36	15	Experience: While I was working on a low stepladder, I fell down. Although I did not get injured, there were openings on the ground nearby. It was scary.
					work Environment: We were in a hurry. There was no time to bring another stepladder.

Consideration

At indoor construction sites, the trend analysis of near-miss incidents showed that 63% of the entire indoor incidents took place in the data centre or machine room or inside the office building. Many near-miss incidents cases were the ones that could lead to material accidents. At the plant and construction sites, "falling" and "slipping" incidents that could lead to work-related accidents were reported.

At outdoor construction sites, the trend analysis of near-miss incidents showed many reported near-miss incidents such as "falling", "slipping" and "while driving an automobile" that could lead to work-related accidents.

"Slipping" was recognized as the common item between indoor and outdoor construction work. There were many reports of near-miss incidents during "the stepladder work."

Conclusion

Identifying sources of danger from the experiences at construction sites as this research did and schematizing them to be used in the safety education, are considered effective in preventing accidents.

As for the next step for the accident prevention research, I am planning to investigate effectiveness of the accident prevention educational programs (Takahashi *et al.*, 2013) in the future, wishing that contribute to prevention of accidents in the telecommunications construction work.

References

Cress, U., Vaquero, B., Schwan, S., & Hessen, F.W. (2007). Improving quality and quantity Two models for promoting knowledge exchange with shared databases. *Computers & education, 49,* 423-440.

Fang, D., Chen, Y., & Wong, L. (2006). Safety Climate in Construction Industry: A Case Study in Hong Kong. *Journal of Construction Engineering and Management. 132(6)*, 573–584.

Gherardi, S., Nicolini, D., & Odella, F. (1998). What Do You Mean By Safety? Conflicting Perspectives on Accident Causation and Safety Management in a Construction Firm. *Journal of Contingencies and Crisis Management, 6(4),* 202-213.

Ishikawa, M. (2012). *Root cause analysis* (in Japanese). Tokyo: Igaku-Shoin Ltd.

Kawamura, H. (2004). *Human factors for human error prevention* (in Japanese). Tokyo: Techno system.

Kimura, S. (1997). Excavating latent accidents. Case 2. Gathering accidents accompanied with chill or startle and activity for accident prevention (in Japanese). *Safety, 38(8),* 17-21.

Ministry of Internal Affairs and Communications. (2012). *The accident outbreak situation of the telecommunications* (in Japanese) Retrieved April 10, 2013, from. http://www.soumu.go.jp/main content/000174336.pdf.

Nagasaki Labor Bureau. (2013). *Disaster example in the construction industry* (in Japanese). Retrieved April 10, 2013, from. http://nagasaki-roudoukyoku.jsite.mhlw.go.jp/library/nagasaki-roudoukyoku/lib/tokei/ex-saigai/ex-saigai24-ken.pdf

Nshimura, S. （2007). The review and perspective of the studies on "aseri": The proposal of comprehensive model of aseri (in Japanese). *Tokyo University graduate school pedagogy graduate course bulletin. Tokyo University graduate school pedagogy graduate course, 47,* 251-258.

Takahashi, A., Nakamura, A., Shimazaki, K., & Ishida, T. (2013). Perception and Behavior of Construction Workers at Hazardous Sites. ―Factors Affecting Risk Perception, Coping Behavior and Communication― (in Japanese). *Japanese Journal of Applied Psychology, 38(3)*. 222-230.

The Japan Construction Occupational Safety and Health Association. (2013). *Formulation of an Industrial Accident Prevention monthly* (in Japanese) Retrieved April 4, 2013, from. http://www.kensaibouaichi.jp/endoffiscal/gallery/2012/thepointofendoffiscal.pdf

Tanimura, T. (1995). *Analysis and prevention of the human error* (in Japanese). Tokyo: Nikkagiren shuppan-sha.

Usui, S. (1995). A Study on Human Factors for Accident Prevention by Analysis of Near-Accident Reports(1) (in Japanese). *Research Reports of the National Institute of Industrial Safety, NIIS-RR-94,* 37-44.