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A Comparative Analysis of Occupational Accidents between Indoor and Outdoor Workers in Telecommunications Industry

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Objective: This study aims to analyze the characteristics of occupational accidents and injuries of telecommunications line and cable workers by type of workplace and operational process of cabling service and to provide baseline data in establishing the preventive policies for occupational accidents and injuries.

Background: In order to set up the preventive policies for occupational injuries and illness systematically, the accident analysis by industry should be preceded. To establish more effective policies, it should be done by occupation for persons who work in various kinds of occupation rather than by industry for persons who do in the same occupation.

Method: In this study, the 176 occupational accidents and injuries were classified by type of workplace - indoor (inside building) and outdoor (at the top of utility pole, in a manhole, or in the fields) - and also done by operational process involved at the time of the accident. By analyzing the characteristics of occupational injuries and illness by type of workplace and operational process, respectively, this study can be helpful in establishing the preventative policies for occupational accidents and injuries.

Results: The characteristics of occupational accidents and injuries by type of workplace showed that there were differences in terms of accident rate between indoor and outdoor on age of the injured, while not on employment-size and work experience of the injured. In addition, the characteristics on accident type, agency of accident, parts of body affected, and operational process between indoor and outdoor workplaces were statistically different each other.

Conclusion and Application: The findings of occupational accidents' characteristics can be applied to the establishment of systematic preventative policies for occupational accidents of telecommunications line/equipment workers.

Keywords: Telecommunications line worker, Occupational accidents and injuries, Cabling work process

1. Introduction

An occupational accidents and injuries analysis includes the process of collecting, arranging and summing up the causes and baseline data on various accidents occurring at industrial sites, and that of analyzing and evaluating the data to establish policies for accidents and injuries prevention (Colling, 1990). Through such analysis

processes, more objective and precise causes of occupational accidents and injuries can be identified. Existing studies present general accident preventive measures by accident analysis targeting the industries in which workers performing various jobs are engaged (Jeong, 1998; Jeong, 1999; Lee and Jeong, 2009; Park et al., 2015). Especially, Nicholson (1985), and Mital and Ghahramani (1994) analyzed occupational accidents and injuries in the telecommunications industry. However, there is a need to analyze the characteristics of accidents and injuries by occupation targeting the workers engaged in the same type of occupation in order to establish systematic policies taking into account workers' job characteristics. Davis and Sheppard (1980) analyzed the rates of accidents and injuries by occupation in the telecommunications industry, and the types of accidents and injuries in the high risk occupations. Nicholson et al. (1981) identified the specific occupational factors causing handling accidents and back injuries for telecommunications engineers and verified the correlation between the back injury rate and physical work stresses of different occupational groups.

In Korea, the line and cable workers are classified on the criteria of the Korean Standard Classification of Occupations (KSCO) (Statistics Korea, 2007) and the Korean Employment Classification of Occupations (KECO). KSCO classifies the line and cable workers into technicians and relevant functional workers (large scale classification), installers and repairers of broadcasting and Internet cable (middle scale classification) and telecommunications cable installers and repairers (small scale classification). KECO classifies the line and cable workers into telecommunications broadcasting and internet cable installers and repairers, and telecommunications cable installers and repairers. This study aims to study the characteristics of accidents and injuries targeting occupational accidents and injuries occurring of cable installers and repairers by workplace in and outside of a building (indoor and outdoor).

There exist risks of various accidents and injuries including trips, falls, contacts and vehicle incidents occurring at the outside of workplaces (outdoor vehicle incidents) (Davis and Sheppard, 1980; Shiina, 2013; KOSHA, 2013). Davis and Sheppard (1980) examined the injury distribution model of the telecommunications industry and the rate of accidents and injuries by occupation in that industry, and presented the occupation type having the highest accidents and injuries rate, and the accident and injury type with the highest frequency in the high risk occupations. According to KOSHA (2013), the occurrence rate of outdoor vehicle incidents was higher than that of falls or trips, and death accidents were mainly derived from falls, outdoor vehicle incidents and occupational diseases. Shiina (2013) comparatively analyzed the occurrence frequency and accidents and injuries factors on the near-misses such as falls and slips in and outside of a building at the telecommunications installation sites. Mital (1994) pointed out injuries on hands or back, due to overwork, occurred in the telecommunications industry as well. Nicholson (1985) investigated and compared the prevalence rates of objects handling accidents, waist injuries and lumbago.

In Korea, 51,030 workers are working in 8,575 information and telecommunications installation construction enterprises based on 2015 (Table 1), and individual enterprises and corporations are accounted for 7.7% and 92.3%, respectively (KICA, 2015).

Table 1. Number of enterprises and workers in 2015 (unit: entity, person, %)

Telecom construction industry	Individual	Corporation	Total
Enterprise	660	7,915	8,575
(%)	7.7%	92.3%	100.0%
Worker	*NA	*NA	51,030
(%)	–	–	100.0%

*NA: Not Available

Accidents and injuries risks in cabling work reveal huge differences between indoor work and outdoor work. While outdoor work

is mainly carried out on the top of utility poles, inside of a manhole or on the road, indoor work is performed underground, corridors, indoors and at the rooftop; therefore there can be differences in the factors and risks of accidents and injuries in view of the characteristics of workplaces (Shiina, 2013). Cabling work can be divided into advanced and post work, pulling and service drop operation, cable wiring and installation, and maintenance and checkup.

To establish proper policies for accidents and injuries prevention, it is necessary to systematically analyze and use the characteristics of accidents and injuries occurrence by workplace type or operation process. This study aims to contribute to the prevention of accidents and injuries by analyzing the characteristics of each occupation and each operation process targeting the injured by the accidents occurring indoor and outdoor workplaces of telecommunications cable installers.

2. Methods

2.1 Data collection

This study targets the injured who took a leave of absence from work for four days or more, due to accidents occurring at cabling worksites. The Korean records and guidelines on occupational accidents and injuries classify the information on the work types of the injured on the basis of the Korean Standard Industrial Classification and the Korean Standard Classification of Occupations. Therefore, a process to classify the injured having accidents in workplaces into the injured by indoor work and outdoor work, according to business type, work type, company name and the summary of accidents and incidents, should be preceded so as to classify the cabling workplace type into indoor and outdoor workplaces. This study targeted 176 injured people of which workplace type can be classified among the injured who had accidents during the cabling work for two years from 2010 to 2011. Table 2 shows the distribution of the injured by workplace type during the work for two years (2010~2011). Actually, 47.2% of the injured had accidents in the indoor workplaces, and 52.8% of the injured had accidents in the outdoor workplaces. However, death accidents took place only in the outdoor workplaces.

Table 2. Distribution of the injured by type of workplace (unit: person, %)

Type	Non-fatal		Fatal		Total	
Indoor	83	47.7%	0	0.0%	83	47.2%
Outdoor	91	52.3%	2	100.0%	93	52.8%
Total	174	100.0%	2	100.0%	176	100.0%

This study aims to analyze the characteristics of accidents and injuries by process, based on work performed at the time of accidents. Although there can be differences in the order or content by the type of workplace, the cabling work can be divided into advanced and post work, pulling and service drop/lateral operation, cable wiring and installation, and maintenance and checkup.

2.2 Data analysis

The independent variables in this study were selected as the characteristics of the injured person's enterprise (employment size), the characteristics of the injured (age, work experience), accidents and injuries occurrence characteristics (occurrence type, agency of accident, operation process). The dependent variable was the type of workplace. This study analyzed whether the differences of accidents and injuries occurred during the work by workplace type existed or not, according to enterprise characteristics, the

characteristics of the injured (age, work experience), and accidents and injuries occurrence characteristics (occurrence type, agency of accident, operation process). To check whether the change of the dependent variable is significant according to the change of independent variables, this study tested the independence of two different probabilities distributions using the Chi-square test. In doing so, 0.1 level of significance was used.

3. Results

3.1 Characteristics of the injured by type of workplace

3.1.1 Characteristics by size of employment

Table 3 shows the distribution of the injured by the size of employment and workplace type. Concerning the size of employment, the enterprises having 15 employees and under took up 35.8%, and those with over 50 employees took up 31.3%. According to the χ^2 test result, the accidents and injuries rate by workplace type cannot be different, according to the size of employment (χ^2 = 4.6, p = 0.207). Therefore actions to prevent accidents and injuries need to be taken equally, irrelevant of employment size or workplace type.

Table 3. Distribution of the injured by size of employment (unit: person, %)

Size of employment	15 and under	16~29	30~49	50 and over	Total
Indoor	27	14	19	23	83
	32.5%	16.9%	22.9%	27.7%	100.0%
Outdoor	36	7	18	32	93
	38.7%	7.5%	19.4%	34.4%	100.0%
Total	63	21	37	55	176
	35.8%	11.9%	21.0%	31.3%	100.0%

3.1.2 Characteristics by age

Table 4 shows the distribution of the injured by age. The accidents and injuries rates by age were revealed in the order of in their 30s (38.6%), 40s (32.4%) and 50s (19.9%). Table 4 shows the distribution of age by indoor and outdoor workers (χ^2 = 10.4, p = 0.034). The accidents and injuries of the injured in their 30s were the highest in the indoor workplaces at 47.0%, while those in their 40s were the highest in the outdoor workplaces at 32.3%. Telecommunications installation workers require high technical requirements and hard work postures, and therefore there are many injured in 30s and 40s. Especially, no injured persons occurred,

Table 4. Distribution of the injured by age (unit: person, %)

Age (yrs)	29 and under	30~39	40~49	50~59	60 and over	Total
Indoor	7	39	27	9	1	83
	8.4%	47.0%	32.5%	10.8%	1.2%	100.0%

Table 4. Distribution of the injured by age (unit: person, %) (Continued)

Age (yrs)	29 and under	30~39	40~49	50~59	60 and over	Total
Outdoor	8	29	30	26		93
	8.6%	31.2%	32.3%	28.0%		100.0%
Total	15	68	57	35	1	176
	8.5%	38.6%	32.4%	19.9%	0.6%	100.0%

since workers over 60s retire in the case of outdoor workers. However, the rate of the injured in their 50s was higher in the outdoor workplaces, where work is relatively harder than indoor work. In this regard, customized training by age to prevent accidents and injuries is needed to be executed.

3.1.3 Characteristics by work experience

Table 5 shows the distribution of the injured by work experience. The injured with over ten years of work experience took up 36.4%, and those with under six months of work experience were 22.7%. There was no difference in the distribution of the injured by work experience according to workplace (χ^2 = 7.6, p = 0.183). Therefore, policies for accidents and injuries prevention need to be taken equally, irrelevant of worker's work experience and workplace type.

Table 5. Distribution of the injured by work experience (unit: person, %)

Work experience (yrs)	Under 0.5	0.5~1	1~2	2~5	5~10	Over 10	Total
Indoor	20	6	9	17	8	23	83
	24.1%	7.2%	10.8%	20.5%	9.6%	27.7%	100.0%
Outdoor	20	8	9	9	6	41	93
	21.5%	8.6%	9.7%	9.7%	6.5%	44.1%	100.0%
Total	40	14	18	26	14	64	176
	22.7%	8.0%	10.2%	14.8%	8.0%	36.4%	100.0%

3.2 Characteristics of accidents by type of workplace

3.2.1 Characteristics by event or exposure

Table 6 shows the distribution of the injured by accidents and injuries occurrence type (event or exposure), and the most events or exposures were falls (40.9%), contact with objects or equipment (18.8%), trips (18.2%) and vehicle incidents (9.1%) in the order. While many falls and contact with objects or equipment occurred in the indoor and outdoor workplaces by the type of workplace, the frequency of trips was higher in the indoor workplace. Also, vehicle incidents took place remarkably more in the outdoor workplace (χ^2 = 22.9, p < 0.001). This shows that distribution characteristics by accidents and injuries occurrence type (event and exposure) are not the same according to the type of workplace, and also implies that the policies to prevent accidents and injuries on working environment, used facilities and tools by the type of workplace are required.

Table 6. Distribution of the injured by event or exposure (unit: person, %)

Event or exposure	Falls to lower level	Slips, trips, falls	Vehicle incidents	Work-related illness	Contact with objects or equipment	Overexertion and bodily reaction	Cut and amputation	Others	Total
Indoor	30	21	0	10	8	3	10	1	83
	36.1%	25.3%	0.0%	12.0%	9.6%	3.6%	12.0%	1.2%	100.0%
Outdoor	42	11	16	5	12	3	3	1	93
	45.2%	11.8%	17.2%	5.4%	12.9%	3.2%	3.3%	1.1%	100.0%
Total	72	32	16	15	20	6	13	2	176
	40.9%	18.2%	9.1%	8.5%	11.4%	3.4%	7.4	1.1%	100.0%

3.2.2 Characteristics by agency of accident

Table 7 shows the distribution of the injured by agency of accident providing the sources of injuries or illnesses. Overall, the accidents and injuries rates were the highest in the order of structures and surfaces (34.1%), tools, instruments and equipments (24.4%) and vehicles (13.1%). Concerning the distribution of the agency of accident by workplace, the accidents and injuries rates caused by structures and surfaces, and tools, instruments and equipments were commonly high both in the indoor and outdoor workplaces. When it comes to vehicles, the accidents and injuries rate was higher in the outdoor workplaces, while the rate was higher in the indoor workplaces in the case of containers, furniture and fixtures ($\chi^2 = 36.7$, $p < 0.001$). Therefore the accidents and injuries distribution by agency of accident cannot be said that it would be the same, according to workplace. Because there are common agency of accident and no common agency of accident in the indoor and outdoor workplaces, policies to prevent accidents and injuries by workplace on working environment are implied to be needed.

Table 7. Distribution of the injured by agency of accident (unit: person, %)

Agency of accident	Structures and surfaces	Tools, instruments and equipment	Vehicles	Containers, furniture and fixtures	Parts and materials	Persons and animals	Others	Total
Indoor	27	23	1	16	6	3	7	83
	32.5%	27.7%	1.2%	19.3%	7.2%	3.6%	8.4%	100.0%
Outdoor	33	20	22	1	6	0	11	93
	35.5%	21.5%	23.7%	1.1%	6.5%	.0%	11.8%	100.0%
Total	60	43	23	17	12	3	18	176
	34.1%	24.4%	13.1%	9.7%	6.8%	1.7%	10.2%	100.0%

3.2.3 Characteristics by part of body affected

Table 8 shows the distribution of the injured by part of body affected, due to accidents or injuries. Overall, the highest body parts affected were multiple body parts (43.2%), lower limbs (16.5%), upper limbs (15.9%), trunk (13.1%), and head/neck (8.5%)

in the order. Regarding the part of body affected of the injured by workplace, the accidents and injuries rates on multiple body parts, lower limbs, and upper limbs were high both in the indoor and outdoor workplaces. While the rate on trunk was higher in the outdoor workplaces than the indoor workplaces, the rate on the head/neck was higher in the indoor workplaces (χ^2 = 9.5, p = 0.090). The distribution of the injured by part of body affected cannot be said to be the same by workplace, which means that policies for accidents and injuries prevention by workplace are needed.

Table 8. Distribution of the injured by part of body (unit: person, %)

Part of body	Head / neck	Trunk	Upper extremities	Lower extremities	Multiple body parts	All others	Total
Indoor	9	10	19	15	28	2	83
	10.8%	12.0%	22.9%	18.1%	33.7%	.0%	100.0%
Outdoor	6	13	9	14	48	3	93
	6.5%	14.0%	9.7%	15.1%	51.6%	1.1%	100.0%
Total	15	23	28	29	76	5	176
	8.5%	13.1%	15.9%	16.5%	43.2%	.6%	100.0%

3.2.4 Characteristics by operation process

Table 9 shows the distribution of the injured by operation process in which the injured were undertaking at the time of accidents. Overall, the highest operation process was maintenance and checkup (31.3%), followed by advanced and post work (30.1%), pulling and service drop operation (22.2%), and cable wiring and installation (17.0%) in the order. Looking at the distribution of the injured by operation process by the type of workplace, the accidents and injuries occurrence rates of maintenance and checkup, and advanced and post work were high both in the indoor and outdoor workplaces. The rate of cable wiring and installation was relatively higher in the indoor workplaces, and that of puling and service drop operation was higher in the outdoor workplaces (χ^2 = 20.1, p = 0.003 < 0.05). The accidents and injuries distribution by operation process according to workplace cannot be said to be the same. Therefore policies for accidents and injuries prevention should be established by operation process, according to workplace type.

Table 9. Distribution of the injured by operation process (unit: person, %)

Process	Advanced / post work	Pulling & service drop / lateral	Cable wiring & installation	Maintenance and checkup	Total
Indoor	19	13	24	27	83
	22.9%	15.7%	28.9%	32.5%	100.0%
Outdoor	34	26	5	28	93
	36.6%	28.0%	5.4%	30.1%	100.0%
Total	53	39	30	55	176
	30.1%	22.2%	17.0%	31.3%	100.0%

4. Conclusion and Discussion

From 2008 to 2013, the high speed Internet subscribers nationwide increased from 15.48 million to 18.74 million people (KOSIS, 2014), and the number of households subscribing paid broadcast including cable and satellite broadcasting was 14.44 million, based on the end of 2013 (MSIP, 2015). Among the 8,570 registered information and telecommunications installation enterprises, based on August 2015, individual enterprises were 660, which were relatively small businesses (KICA, 2015). Because the work in the outdoor workplaces frequently deal with utility poles, ladders and terminal boxes, the accidents and injuries rate, due to handling objects, which was pointed out by Davis and Sheppard, was higher than the accidents and injuries by other agencies of accidents (Davis and Sheppard, 1980). Namely, tools, instruments and equipments took up 24.4%, containers, furnitures and fixtures 9.7%, and parts and materials 6.8%, and the accidents and injuries rate of handling objects was 40.9%. Concerning accidents and injuries type, the accidents and injuries risk of cable installers' falls, trips and contact with objects or equipment was commonly high in both indoor and outdoor works. Such a phenomenon can be observed in KOSHA (2013) as well. However, the rate of falls was relatively higher. This can be derived from the business type characteristics having high place work a lot.

This study analyzed whether the characteristics distribution of accidents and injuries was different according to the type of workplace using the accidents and injuries data from 2010 to 2011. As for the results of this study, the distribution of the injured by age was different according to the type of workplace. Also, the characteristics distribution of accidents and injuries, such as occurrence type, agency of accident and operation process, was different according to the type of workplace. However, the accidents and injuries occurrence distribution according to the employment size and work experience of the injured was not different according to the type of workplace.

Because two death accidents taking up 52.8% of 176 total injured in the cable installation work occurred only in the outdoor workplaces, the accidents occurring in the outdoor workplaces are more fatal than those in the indoor workplaces. According to the 2014 accidents and injuries analysis data released by the Ministry of Employment and Labor, the number of deaths was seven among 68,053 injured people in the telecommunications industry, and the rate of death per 10,000 population was 1.03 (KOSIS, 2014). The rate of death per 10,000 population of cable installers was 113.6, far higher than that of the communications industry. This implies that cable installation work risk is very high in the telecommunications industry.

As for the age of workers with high accidents and injuries rate at the cable installation sites, the injured in their 30s and 40s accounted for 38.6% and 32.4%, respectively, irrelevant of the work experience of the injured. Concerning the accidents and injuries occurrence type, the highest types were falls (40.9%), contact with objects or equipment (18.8%) and trips (18.2%) in the order. Concerning the agency of accident, the highest agency of accident was structures and surfaces (34.1%), followed by tools, instruments and equipment (24.4%), and vehicles (13.1%). The highest part of body affected was multiple body parts (43.2%), followed by lower limbs (16.5%) and upper limbs (15.9%). By operation process, maintenance and checkup (31.3%), advanced and post work (30.1%), and pulling and service drop operation (22.2%) were the highest in the order.

The occupation of a cable installer belongs to the U.S. occupational codes 49-2022 (Telecommunications Equipment Installers and Repairers except Line Installers) and 49-9052 (Telecommunications Line Installers and Repairers). Concerning the characteristics of accidents and injuries occurred to the U.S. cable installers in 2013, overexertion and bodily reaction (47.3%), contact with objects or equipment (18.0%) and trips (15.5%) were the highest in the order. Therefore, overexertion and bodily reaction was higher than Korea, but falls were lower than Korea (BLS, 2013). As for the agency of accident at the time of accidents, persons injured or ill workers took up 42.4%, parts and materials 13.3%, structures and surfaces 9.5%, and therefore there were huge differences form Korea (BLS, 2013). Here, a person injured means the person, who was injured by his/her own physical conditions, such as fainting, heart attack and job stress, and who was injured by the automatically occurred motions of the person (BLS, 2012). Concerning the part of body affected, trunk (32.0%), lower limbs (27.5%) and upper limbs (20.1%) were the highest in the order. This means that

the accidents and injuries on trunk are high, and those on the multiple body parts are low, unlike Korea.

Regarding the age brackets of the injured in the outdoor workplaces, the injured in their 40s took up 32.3%, and 30s accounted for 31.2%, irrelevant of work experience. Looking at accidents and injuries occurrence type, falls (45.2%), vehicle incidents (17.2%) and contact with objects or equipment (16.1%) were the highest in the order. As for the agency of accident at the time of accidents, structures and surfaces (35.5%), transporting means including vehicles (23.7%), tools, instruments and equipment (21.5%) were the highest in the order. Concerning the part of body affected, multiple body parts (51.6%), lower limbs (15.1%) and trunk (14.0%) were the highest in the order. Regarding operation process, advanced and post work (36.6%), maintenance and checkup (30.1%) and pulling and service drop operation (28.0%) were the highest in the order.

Looking at the age of the injured in the indoor workplaces, those in their 30s were 47.0%, and those in 40s were 32.5%, higher than other age brackets, irrelevant of work experience. Concerning the accidents and injuries occurrence type, falls (36.1%), trips (25.3%) and contact with objects or equipment (21.7%) were the highest in the order. Regarding the agency of accident at the time of accidents, structures and surfaces (32.5%), tools, instruments and equipment (27.7%), and containers, furniture and fixtures (19.3%) were the highest in the order. As for part of body affected, multiple body parts (33.7%), upper limbs (22.9%) and lower limbs (18.1%) were the highest in the order. As for operation process, maintenance and checkup (32.5%), cable wiring and installation (28.9%) and advanced and post work (22.9%) took up the highest in the order in terms of accidents and injuries.

This study implies that customized policies for accidents and injuries prevention by workplace are needed, because differences in the distribution of the injured and accidents and injuries occurrence are revealed according to workplace. In other words, although overall characteristics show comprehensive aspects on the accidents and injuries occurred during the cable installation in the indoor and outdoor workplaces, differences by characteristics according to indoor and outdoor workplaces exist, even though workers perform work under similar environment and conditions. To establish more practical and effective policies for accidents and injuries prevention, there is a need to sufficiently use such individual characteristics. Therefore an analysis on accidents and injuries targeting more segmented characteristic operation process or occupation is required.

This study examined and analyzed the characteristics of the injured by workplace, where the injured took a leave of absence from work for four days or more during the telecommunications line and cable installation work, and by operation process. In this regard, the study results can be applied to the establishment of policies for accidents and injuries prevention or guidelines according to the type of workplace and operation process.

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