

EXAMINING THE DISASTER RESPONSE SYSTEM FOR THE DISABLED IN KOREA

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Abstract

The number of disaster occurrence is increasing every year, and there is an increase in the average annual number of the disabled that have been experiencing damage from disasters. The disabled are exposed to more than 200 disaster situations every year in Seoul. However, existing disaster response system does not include specific instructions that reflect different characteristics of the disabled and is not used efficiently during actual disaster situations.

The objective of this study is to analyze the problems faced by the disabled due to the inefficiency of disaster response system. This study examines the characteristics of the disabled in existing disaster response system using text-mining analysis. To improve the disaster response system for the disabled, measures should be taken such as reinforcing existing disaster response manuals to reflect the characteristics of the disabled, enhancing individualized accessibility to disaster-related information for different types of disabilities, improving evacuation planning that considers different types of mobility constraints and conducting regular evacuation drills along with additional emergency training.

Keywords: Disasters, the disabled, disaster response system, text-mining

Introduction

The average global temperature is continuously increasing, and climate change caused by global warming is increasing the number of disaster occurrence. Along with climate change, the rapid change in socioeconomic structure has increased the risk of disasters among vulnerable groups such as the disabled, children and elderly. Several major incidents like the 2014 Sewol Ferry accident raised social awareness of the importance of disaster response system and various countermeasures have been suggested. The term ‘vulnerable groups in safety affair’s has been included in 「The Framework Act on the Management of Disasters and Safety」 on January 18, 2018 to establish separate safety regulations and policies for vulnerable groups (Korea Legislation Research Institute, 2018). Numerous disaster response manuals for the disabled have been established and continuous research is being conducted about disaster management system for the disabled.

The disabled are exposed to more than 200 disaster situations every year in Seoul. However, existing disaster response system does not include specific instructions that reflect different characteristics of the disabled and is not used efficiently during actual disaster situations. For example, failure to provide sign language translations during emergency broadcasts related to the fire and the unavailability of evacuation guide for wheelchair users made it difficult for the disabled to take quick actions during the evacuation process of 2019 Gangwon Province forest fire in South Korea. According to the National Fire Agency, the number of deaths from fire per 100,000 people (as of 2014) was 4.7 times higher for the disabled (2.8 persons) than the non-disabled (0.6 persons). Moreover, the rate of deaths among casualties from fire was significantly higher for the disabled (43.6%) than the non-disabled (13.7%)

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(Statistics Korea, 2014). Despite various efforts, current legislation lacks the consideration of the behavioral characteristics of the disabled as most of them are designed for the non-disabled; therefore, it can be said that the institutional protection for the disabled is still insufficient. In order to protect and support the safety of the disabled, behavioral characteristics need to be understood during and after the evacuation process and should be reflected in the disaster response system.

Literature Review

The disabled as disaster vulnerable group

Disasters can be experienced by anyone but the ability to cope with disasters differs among people. The term ‘vulnerable groups in safety affairs’ is defined as people who are vulnerable to disasters such as the disabled, children and elderly (Korea Legislation Research Institute, 2018). The damage caused by disasters varies among people, including the vulnerable groups. Among the vulnerable groups, the disabled are more vulnerable to disasters and are less able to respond to disasters (Chang, et al., 2014). Research conducted by the Seoul Metropolitan Fire & Disaster Headquarters and the National Rehabilitation Center mentioned that the disabled are more than twice as vulnerable as the non-disabled (Kweon, et al., 2013). The disabled are more vulnerable than any other people and are more likely to have delayed or impossible response due to psychological and/or physical functional limitations. This will lead to higher risk of accident or casualty and as a result, it is likely that the disabled have a high demand for a proper disaster response system (Kailes and Enders, 2007).

Review of previous studies on disaster management system for the disabled

Even though the necessity of the disaster management system for the disabled has been mentioned in the early 2000s, practical studies have only begun recently. The 2014 Sewol Ferry disaster raised the importance of disaster safety management system as the accident revealed the overall vulnerability of the disaster safety in Korea. After the sinking of the Sewol Ferry, Korea is in the process of reforming the nation’s disaster management system. However, there are no major changes other than reorganizing the functions of the existing Ministry of Security and Public Administration, National Emergency Management Agency and Korea Coast Guard, and there is no organization that has professional knowledge, skills and planning for the disabled (Lee, 2016).

Emergency management can be defined as the process of developing and implementing policies that are concerned with the four phases of mitigation, preparedness, response and recovery, depending on the progress and response activities of the disaster (Petak, 1985). The existing problems and limitations of the current disaster management system in South Korea were identified from previous studies and Table 1 shows the problems and limitations classified according to the four phases of emergency management.

Table 1: Problems of the disaster management system for the disabled in South Korea

Phase	Problems	References
Mitigation	Legislation: Unclearness of the concept of disaster vulnerable group; lack of specific action strategies and measures for the disabled	Byun, et al. (2018), Kim, et al. (2017), Nemoto and Ariga (2014), Lee (2016), Lee (2016), Kim, et al. (2013), Roh and Kim (2016), Kim and Roh (2016), Jung, et al. (2019)
	Policies: Absence of disaster management policies for the disabled	Lee (2016), Kim, et al. (2013), Kim and Roh (2016)
	Building design guidelines: Lack of consideration of the disabled in building design guidelines and evacuation plans	Nemoto and Ariga (2014), Lee (2016)
Preparedness	Manual: Unstructured detailed manuals for the disabled	Lee (2016), Lee (2016), Kim, et al. (2013), Kim, et al. (2016), Kang, et al. (2017), Kweon, et al. (2013), Jung, et al. (2019)
	Education and training: Lack of consideration of the disabled and usually is a one-time planning event	Kim, et al. (2017), Lee (2016)
Response	Information accessibility: Limited	Byun, et al. (2018), Nemoto and

	information about emergency shelters and limited manual distribution methods	Ariga (2014), Kang, et al. (2017)
	Communication: Difficulty in communication with different types of disabilities	Kim, et al. (2017), Kang, et al. (2017)
	Department in charge for the disabled: Absence of disaster management department for the disabled	Lee (2016), Roh and Kim (2016), Kim and Roh (2016)
Recovery	Support plan for the disaster vulnerable group: Limitation in reflecting the characteristics of the disabled	Byun, et al. (2018), Lee (2016), Roh and Kim (2016), Kim and Roh (2016)
	Emergency shelter: Operational problems of emergency shelters during actual disaster situations	Nemoto and Ariga (2014)

The mitigation phase is to implement plans to reduce risks for disaster occurrence and the preparedness phase is to plan for detailed emergency safety measures by providing information such as manuals and training. These two phases can be classified as the pre-disaster management phase. Despite of the amendment of certain articles, legislation related to the disaster management system for the disabled have problems such as the lack of action strategies and measures for the disabled as policies and manuals still tend to focus on the non-disabled.

In Korea, the disaster response manual is mainly focused for the non-disabled, and existing disaster response manual for the disabled does not consider different characteristics of the disabled (Lee, 2016). Even though manuals are trying to provide a comprehensive guide to disasters and the countermeasures, the quantity makes it difficult for the disabled to read all of them and understand. Therefore, it can be said that thick booklets of manuals are realistically inefficient compared to one or two pages of leaflets. The lack of detailed guidelines shows the need to prepare countermeasures for each facility and evacuation behavior for the disabled. Similarly, education and training like evacuation drills lack consideration of different types of disabilities. Since most of the training is usually a one-time planning event, evacuation drills along with additional emergency training need to be arranged constantly and regularly as a long-term event (Kim, et al., 2017).

The response phase is the practical process of responding to disaster situations regardless of the type of disasters. One of the main problems is the lack of standardized disaster response system for the disabled. In terms of information accessibility, the main problem was the limited information about emergency shelters available to the disabled (Byun, et al., 2018; Nemoto and Ariga, 2014). Distributing the disaster response manuals to more than 2.5 million of the disabled is subject to realistic constraints in terms of budget and distribution methods. Difficulty in communication with different types of disabilities leads to emergency rescue communication difficulties by firefighters (Kang, et al., 2017). Low professionalism, lack of understanding for the disabled and the absence of disaster management department for the disabled are problems of disaster response system at the government level (Roh and Kim, 2016; Kim and Roh, 2016). Therefore, communication methods and education need to be conducted in order to make it easier for the firefighters or any other related persons to rescue the disabled. At the recovery phase, the absence of management considering the disabled is the main problem and it needs to be known that the disabled need more assistance than the non-disabled as the recovery phase includes factors that can affect their lives. Due to the lack of consideration of different types of mobility constraints for the disabled, actual emergency shelters have operational problems during disaster situations. For example, architectural or physical barriers such as the absence of ramps and narrow doorways lower the accessibility for wheelchair users.

Characteristics of the disabled that are vulnerable to disasters

Even though all types of disabilities are vulnerable to disasters, the important targets of the disabled who need additional support are people with physical disabilities, developmental disabilities, hearing impairment and visual impairment. These are the representative types of disabilities and any other types of disabilities with similar disaster vulnerable characteristics can be included in these four categories. In analyzing the characteristics of the disabled that are vulnerable to disasters, the constraints faced by the disabled can be categorized into three categories, which are: mobility, communication and

information accessibility (Kang, et al., 2017).

Table 2: Characteristics of the disabled that are vulnerable to disasters (Kang, et al., 2017)

Category	Characteristics	Description	Target
Mobility	Difficulty in horizontal circulation (physical movement)	Restriction of movement in the event of a disaster	People with paralysis, physical disabilities
	Difficulty in vertical circulation (stairs)	Restriction of using stairs for vertical circulation	People with mobility impairment requiring the use of wheelchairs, clutch, etc.
Communication	Difficulty in verbal communication	Oral communication difficulties	People with hearing impairment, brain lesions
	Difficulty in complex communication	Complex communication difficulties (abstract words, etc.)	People with developmental, intellectual disabilities
Information Accessibility	Difficulty in acquiring visual information	Visual recognition difficulties (fire, emergency exit, etc.)	People with visual impairment

Table 2 shows the three characteristics of the disabled that are the behavioral difficulties faced by the disabled in disaster situations. For mobility constraints, some people need assistance in order to move both horizontally and vertically in disaster situations. It is necessary to designate an evacuation officer in advance to assist the disabled during actual disaster situations. Signing an agreement with local volunteer groups and arranging social service agents as evacuation assistants can be considered for emergency evacuation assistance program for the program to be organized in a systematic manner (Shim, et al., 2010). People with hearing impairment face challenges when they are being rescued by firefighters during disaster situations due to communication difficulties (Korea Disabled People’s Development Institute, 2017). Measures such as utilizing video interpretation service as a method to communicate with sign language interpreters and mandatory completion of basic sign language training for firefighters can be taken to improve communication skills during emergency (BeMinor, 2018). People with visual impairment have limited information accessibility compared to any other people as they have difficulty in acquiring visual information such as spotting real fire or smoke by sight, reading emergency text messages and looking at evacuation map to evacuate. Information accessibility can be enhanced by the provision of voice-assisted information along with text messages in the mobile phone. The voice information can provide information about disaster occurrence, emergency evacuation and thus increase the disaster response ability for people with visual impairment (Oh, et al., 2017).

Methodology

Data preprocessing

News articles related to the disabled in disaster situations such as their characteristics, response system, evacuation methodology and refuge were collected using BIGKinds, a news article analysis system launched by the Korea Press Foundation. For accurate search results, search operators were used as “(the disabled OR refuge OR evacuate OR escape) AND (“the disabled” AND “evacuate”)” in order to search news articles that include the two words “the disabled” and “evacuate” and at least one of the words among “the disabled”, “refuge”, “evacuate” and “escape”. News articles were collected from political, economic, social and regional field, excluding the field of cultural, international, sports and science and technology.

Using its integrated database, a total of 2,385 news articles from January 1, 1990 to July 9, 2019 were collected. Out of 2,385 news articles, data were refined by excluding less relevant data such as data about personnel, prime minister, military administration and election. As such, 129 news articles that pointed out the problems were selected for further analysis. For data preprocessing, stop words were removed, compound nouns and abbreviations were unified. Unnecessary data were excluded for news articles on news websites such as the information related to the newspaper company (name of the

reporter, website address, etc.), title of related news articles, advertisement and more. Proper nouns such as the name of institutions and organizations were changed to full names by the standardization of terminologies.

Text-mining and network analysis

Recently, large amounts of unstructured data have been analyzed not only to identify the differences and similarities in words, but also to spatially visualize the text-based network analysis research (Chae, et al., 2016). Text-mining analysis converts unstructured text data to structured text data and extracts information from texts. It is effective and easy to find any type of patterns hidden in the large collection of data; it can analyze specific topic's structural relationship and visualize the network.

Pathfinder network analysis was used for text-mining analysis and visualization as it is effective in visualizing the entire and detailed structure of the network. It simplifies the structure of the network by calculating weights between nodes and removing paths that violate the triangle inequality (Lee, 2006). To determine whether the triangle inequality is violated or not, parameter q (maximum number of links to a node) and parameter r (square of Minkowski distance) is required. If $r=1$, then the sum of W (weighted value) of each link becomes the distance of the path and if $r=\infty$, the maximum weighted value becomes the path distance (Jung, et al., 2011).

$$W(n_i, n_j) \leq \left[\sum_{x=1}^{k-1} W^r(n_x, n_{x+1}) \right]^{1/r} \quad (k = 2, 3, \dots, q) \quad (1)$$

From a total of top 400 words with the highest frequency of occurrence, unrelated words with the least co-occurrence were further deducted. Node centrality measure analysis was conducted, and a network was formed according to the degree centrality of the words. In this study, pathfinder network analysis was used to analyze the text data and a visualization software called UCINET was used to visualize the network formed by the top 320 words.

Results

This study collected news articles related to the disabled's disaster response system to analyze the problems faced by the disabled in disaster situations from January 1, 1990 to July 9, 2019. From the 129 news articles collected, pathfinder network analysis was conducted to visualize the network.

Figure 1 visualizes the network made by the top 320 words and the size of the nodes varies according to the degree centrality of the words. The top 20 words with the highest degree centrality appear in the order of the disabled, calamity, occurrence, fire, safety, earthquake, evacuate, situation, elderly, obstacle, facility, intellectual, wildfire, install, accident, KBS, building, electric wheelchair, support and preparation.

The text data not only includes the disabled as the vulnerable group, but also any other vulnerable group to disasters such as the weak, elderly and patients. The visualized network shows the overall status of the disabled's disaster management system in Korea including the limitation of legislation, policies and problems faced by the disabled due to the inefficiency of the existing disaster response system. Along with the visualization of the overall status, the network also includes major disaster accidents that happened in Korea such as the 2017 Pohang earthquake and 2019 Gangwon Province forest fire to show the inefficiency of disaster safety measures and response system in actual disaster situations. To identify the behavioral patterns of the disabled during disaster situations, clusters of words were shown in different groups of networks. The behavioral patterns of the disabled can be classified into three categories, which are: information accessibility, communication and mobility.

Discussion

From the overall network, groups of words that are related to the behavioral patterns of the disabled in disaster situations were shown in different clusters of words. Various groups of words that show the behavioral patterns of the disabled are shown separately in Figure 2, 3 and 4. Figure 2 shows the network of words that are related to information accessibility, Figure 3 shows the network of words that are related to communication and Figure 4 shows the network of words that are related to mobility.

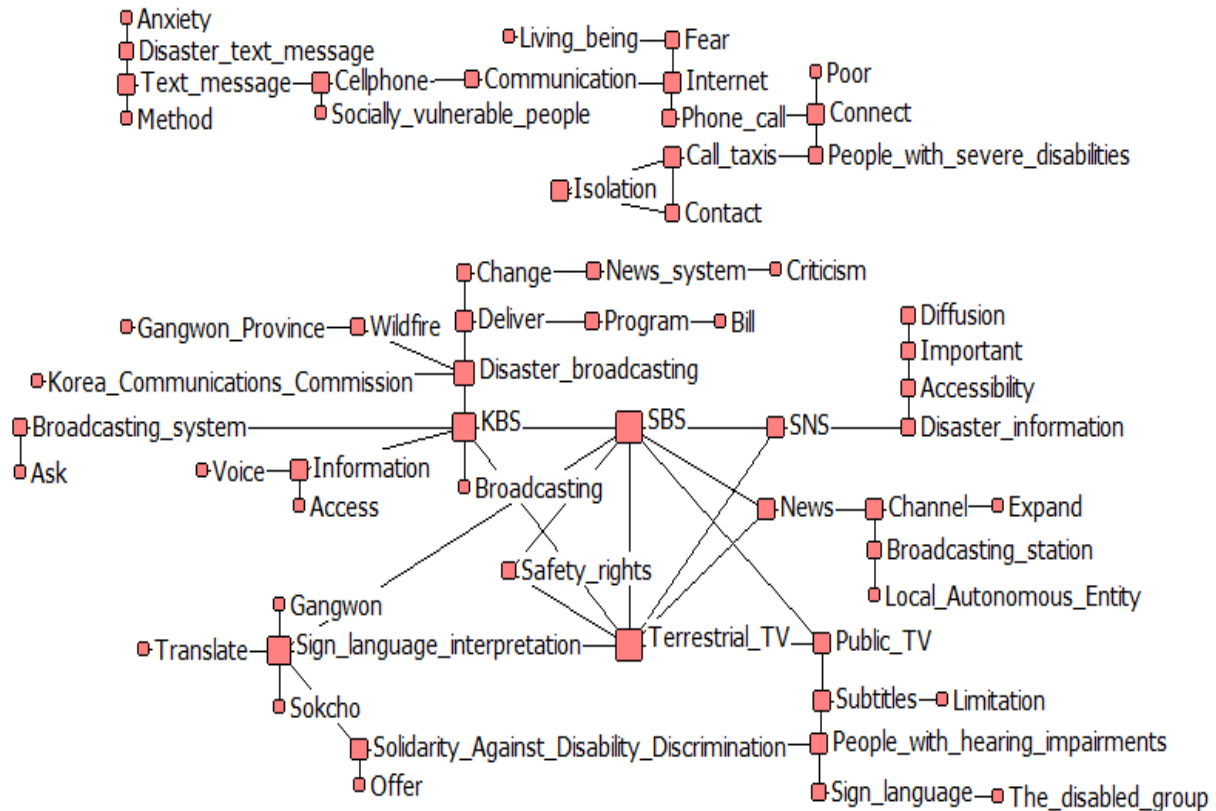


Figure 2: Information accessibility

Figure 2 shows the words related to information accessibility and portrays the behavioral pattern of people with visual impairment and people with hearing impairment. It is relatively easier for the non-disabled to access information related to disaster or any other dangerous situations by text messages; however, people with visual impairment have limited information accessibility due to the lack of service such as the provision of voice service along with text messages in their mobile phones. The lack of advancement in the delivery method of disaster related information makes it difficult for people with visual impairment in the process of evacuating and receiving information related to disaster situations. For people with hearing impairment, the absence or delay of sign language and interpretation service in news media limits the information accessibility in disaster situations. Figure 2 includes words related to Korea's broadcasting system such as SBS, KBS, terrestrial tv and public tv to reflect the delay of sign language interpretation that happened during the 2019 Gangwon Province forest fire. The 2019 Gangwon Province forest fire showed more problems of the reliability and swiftness of disaster broadcasting system as it didn't provide adequate information such as evacuation tips for the disabled in subtitles and sign language.

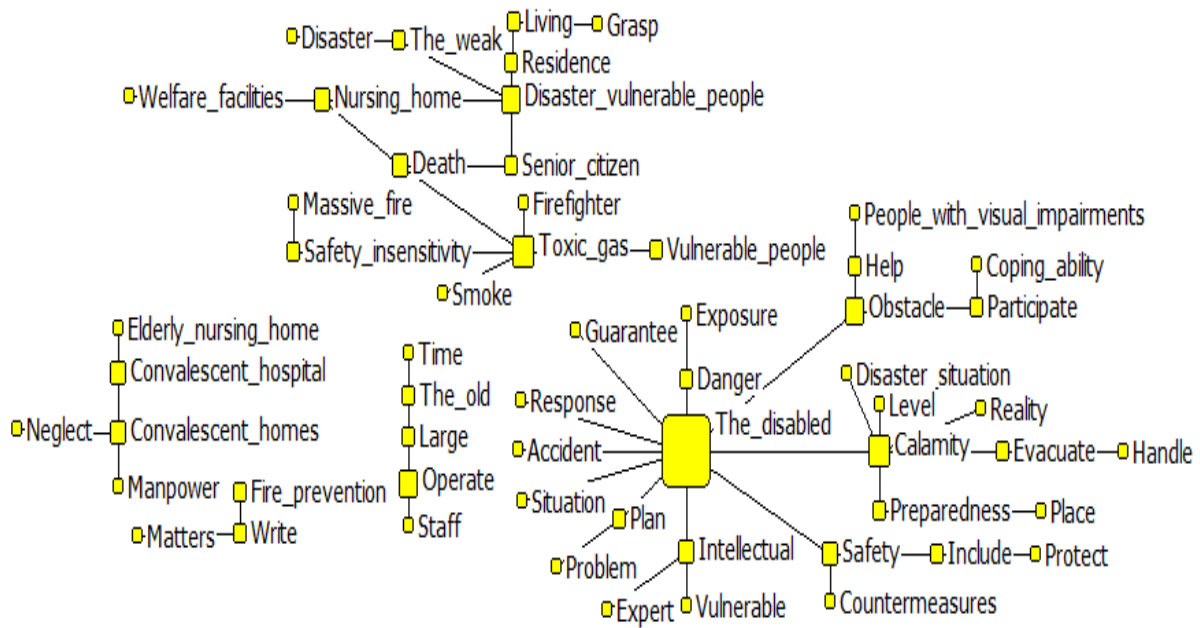


Figure 3: Communication

Figure 3 shows clusters of words that are related to communication barrier problems faced by the disaster vulnerable people in disaster situations. For people with hearing impairment, they face difficulties in oral communication and therefore have communication barriers with firefighters when firefighters can't understand sign language. For people with intellectual disabilities, they are more likely to have communication barriers as they have problems in adaptive functioning that includes communication in daily lives. The figure shows that regardless of location such as residence, welfare facilities, or convalescent facilities, the disabled easily face communication barriers with different types of people such as firefighters, staff, experts, and the problem becomes crucial even more during evacuation and rescue situations.

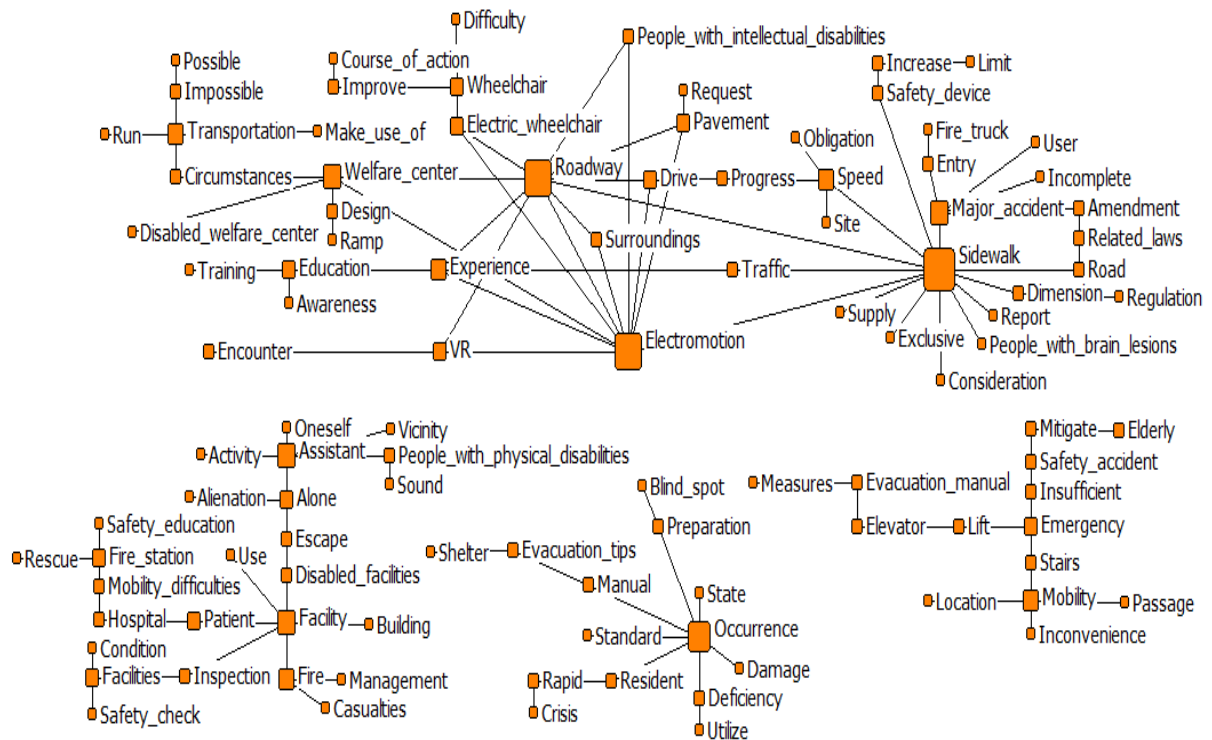


Figure 4: Mobility

Figure 4 shows the words related to mobility constraints faced by the disabled in disaster situations. The

data mainly shows the problems faced by the disabled who use mobility equipment like wheelchairs. Individuals with mobility impairment have mobility constraints during situations like fire emergency as they won't be able to use elevators and need someone's assistance to evacuate. Lack of consideration of the disabled in terms of design guidelines such as the absence of ramps and narrow sidewalks hinder the evacuation process for the disabled and therefore increases the risk for the disabled to be exposed to dangerous situations. The words also mention different types of mobility constraints such as people who need assistance and people who need mobility aids to distinguish different types of mobility constraints according to the different types of disabilities.

Conclusion

The network analysis among the text data extracted from news articles visualized the current problems and limitations of the disabled's existing disaster response system in Korea. The result shows that information accessibility problems are mostly faced by people with severe disabilities and people with hearing impairment. The data shows the limitation of the information accessibility for the disabled by including examples of major accidents like 2019 Gangwon Province forest fire where the disabled couldn't access disaster related information equally and quickly as the non-disabled. To increase the information accessibility for the disabled, safety measures need to be customized and different types of information need to be provided for different type of disabilities. For example, sign language and interpretation service need to be mandatory on breaking news so that the disabled can evacuate along with the non-disabled. Complex disaster text messages with abbreviated words need to be replaced with simpler words for people with developmental and intellectual disabilities.

The visualized network for communication barrier shows problems during evacuation process experienced by people who have disabilities that affect hearing, speaking or understanding. Communication problems arise during rescue process in disaster situations. As such, emergency training needs to be conducted regularly not only for the disabled, but also for related persons who assist the disabled during emergency situations such as firefighters and staff members.

The mobility constraint is mostly faced by people with mobility difficulties such as people with intellectual disabilities, people with brain lesions and people with physical disabilities. They face mobility difficulties in buildings where design guidelines don't consider the design suitable for the disabled with mobility aids and when they don't have assistance in evacuation process inside facilities like disabled welfare facilities. For facilities that the disabled use, design guidelines should provide features such as ramps inside facilities so that people with mobility impairment can use the ramp as an emergency evacuation route. High rise buildings should have emergency evacuation lifts that are available during power outage so that the disabled can use it during evacuation process.

The result of the study shows that the disaster response system for the disabled need better comprehensive measures to support the disabled in disaster situations. There is a need for systematic improvement to increase the efficiency of the existing disaster response system. To improve the disaster response system for the disabled, perfunctory system needs to reflect different type of disabilities' disaster vulnerable characteristics in the system so that the system itself can reflect the needs of the disabled.

This study aimed at discovering behavioral patterns of the disabled in disaster situations to suggest improvement of the existing disaster response system in Korea. In the future, continuous research needs to be conducted to systematically improve the disaster response system with comprehensive measures for the disabled based on their behavioral patterns during disaster situations.

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