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Study of the Use of Walkway Facilities for the Vulnerable and Non-vulnerable through AHP

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Abstract

Pedestrians have been exposed to dangerous traffic environments because the ever increasing cars in cities have reduced the space for them and the road facilities for them have not improved. Such poor walking environments are dangerous to the non-vulnerable and even more dangerous or deadly to the vulnerable. Therefore, this study identified the quantitative and qualitative elements and analyzed the waking characteristics to quantify them, and revealed the walking difference between the vulnerable and non-vulnerable. The vulnerable and non-vulnerable were questioned regarding the quantitative and qualitative issues that they encountered using the existing walkways, and the analytic hierarchy process (AHP), which considered all quantitative and qualitative variables, was used based on the answers. The results of this study, at Level 2, all the vulnerable and non-vulnerable that participated in the survey responded in the order of environmental variable, being on walkways, crosswalk facilities, and walkway edges, showing that the order did not change according to the pedestrian type. The vulnerable and non-vulnerable at Level 3 were found to have different use of road facilities. AHP explained that the vulnerable gave high priorities to the items related to safety compared to the non-vulnerable because they have less cognitive and responding capacity than the non-vulnerable, thus concerning more about factors that can influence the walk safety.

Keywords: Vulnerable, AHP, Walkway Facility, Pedestrian, Traffic Safety

1 Introduction

Pedestrians are exposed to dangerous traffic environments because the ever increasing cars in cities have decreased the space for them and road facilities for them have not improved. Such poor walking environments are dangerous to the non-vulnerable and even more dangerous or even deadly to the vulnerable.

The interest in the socially vulnerable has increased recently and consideration of the vulnerable in transportation areas is attracting growing attention. Everyone experiences vulnerability at some time of their life as they go through childhood and senescence even if they do not have any disability.

Therefore, Korea revised its ROAD ACT and implemented the ACT ON PROMOTION OF THE TRANSPORTATION CONVENIENCE OF MOBILITY DISADVANTAGED PERSONS for the vulnerable to promote transportation convenience and ensure safety. Nevertheless, different standards from the same provision between the two acts or qualitative descriptions make it difficult to judge a precise standard. In addition, the ROAD ACT provides a range of standards on facilities for the vulnerable but fails to fully consider the vulnerable by having a human ellipsoid, i.e., the non-vulnerable as a pedestrian standard.

This study broke down the pedestrian types and analyzed the walking characteristics of each type to improve both pedestrian safety and walking environment for the vulnerable. The quantified satisfaction of pedestrians on the standard for walking facilities that include qualitative variables is expected to greatly improve the road facilities which will promote pedestrian traffic safety and convenience. Therefore, it identified the quantitative and qualitative elements and analyzed the waking characteristics to quantify them and found the walking difference between the vulnerable and non-vulnerable.

This study involved the vulnerable and non-vulnerable living in Daegu city, Korea. The vulnerable require large spaces to move or turn around and feel difficulty in vertical movement or with slight road bumps and steps. The non-vulnerable in this study were classified into traffic professionals and public people. This study questioned the vulnerable and non-vulnerable regarding the quantitative and qualitative issues that they encountered when using the existing walkways. The analytic hierarchy process (AHP), which took all quantitative and qualitative variables into account, was used based on the answers.

2 Review on previous studies

Previous studies related to this study can be classified into studies of the vulnerable and about AHP. Jo & Han (2009) suggested ways for the vulnerable, such as the disabled, weak and pregnant, to have safer and more convenient mobility than before. Lee (2009) proposed methods to improve the accessibility of the vulnerable to transportation facilities, and Jang et al. (2013) presented the ITS service model for the

vulnerable. From previous studies about AHP, Kim (2008) developed a new pedestrian level of service evaluation index with AHP whereas Lee (2013) suggested the children's pedestrian satisfaction model. Choi (2014) examined ways of improving the transportation facilities and decide the investment priority that considered all elements affecting the transportation facilities service and the usage satisfaction for the vulnerable.

Many of the previous studies considered only the quantitative variables of road facility-related acts. Even when they considered the qualitative variables, they failed to perform an effective satisfaction survey due to the lack of a detailed classification of the evaluation factors. They were also unable to represent all the vulnerable because they analyzed the walk of certain types of vulnerable people.

3 Survey

3.1 Establishing hierarchical structure

This study used the AHP to analyze the characteristics of the vulnerable and non-vulnerable focusing on the use of pedestrian facilities. The AHP requires a hierarchical structure reflecting the features of goal description. Therefore, this study collected the evaluation elements related to the walk based on various previous studies, such as Korea highway capacity manual, regulation on road structure and facility, guidelines on crosswalk installation and management, and manual on the installation and management of transportation facilities for the vulnerable, to develop a range of items for a hierarchical structure. A hierarchical structure, which encompasses quantitative and qualitative variables, was also established by reflecting the opinions of this study's participants.

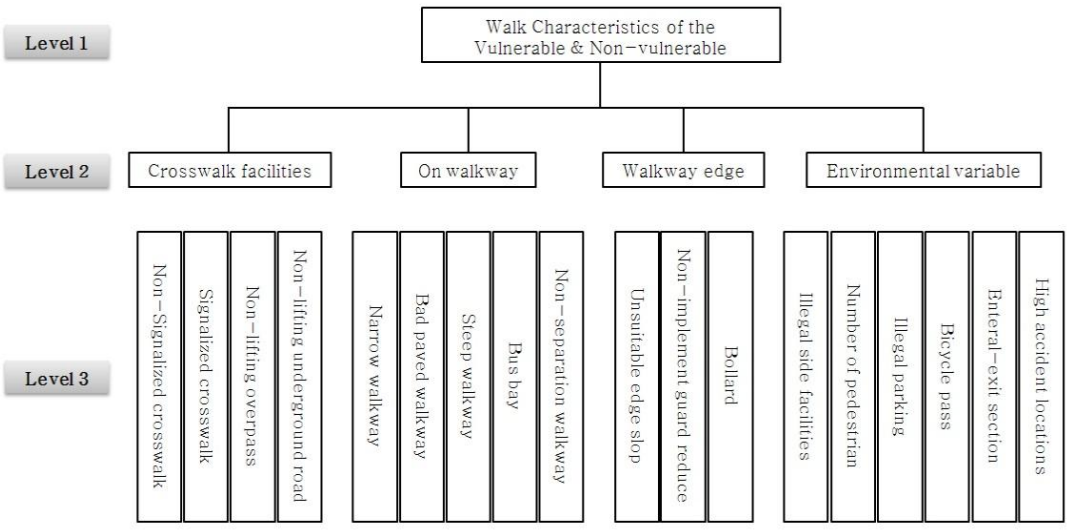


Fig 1. Hierarchical structure

The goal description was established as pedestrian facilities use characteristics of the vulnerable. Level 2 was classified into the walkway edge, walkway, crossing facilities and environmental variables with reference to walk behavioral analysis.

Level 3 was classified by grouping the elements that were related to Level 2 based on 18 evaluation items. The walkway edge included bollards, non-implemented guard and unsuitable edge slope. The walkway included narrow walkways, poorly paved walkways, steep walkways, bus bays, and non-separation walkway. The crossing facilities were classified into non-signalized crosswalks, signalized crosswalks, non-lifting overpasses, and non-lifting under walkway. The environmental variables were classified into illegal side facilities, number of pedestrians, illegal parking, bicycle pass, enteral-exit section, and high accident locations. Fig 1 shows this structure.

3.2 Result of survey

The questionnaire used the items decided by the hierarchical structure for the AHP. The vulnerable and non-vulnerable living in Daegu had a 1:1 interview from June 6 to June 17, 2014. The vulnerable were classified into people with children and/or infants using a stroller, the elderly using an electric scooter and the disabled using a wheelchair. The non-vulnerable were traffic professionals and public people.

According to the survey, the total number of vulnerable was 84, which was comprised of 27 people with children and/or infants, 22 disabled, 35 elderly, whereas the number of non-vulnerable was 77, which was made up of 14 professionals and 63 public people. Among them, 62 vulnerable and 56 non-vulnerable whose Consistency Index (CI) conformed to the reference (CI≤0.1) were sampled for the study.

4 Analysis on use of road facilities

4.1 Analysis of use of road facilities according to the type of vulnerable

Fig 2, 3 show the orders of the elements as a result of analyzing the use of road facilities according to the type of vulnerable with a focus on walking. The element orders differed somewhat according to type of the vulnerable. People with children and/or infants produced different results from those of the elderly or disabled, both of whom showed similar results at Level 3.

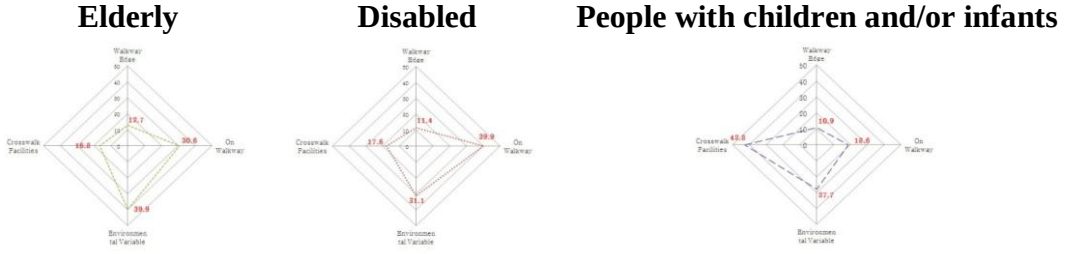
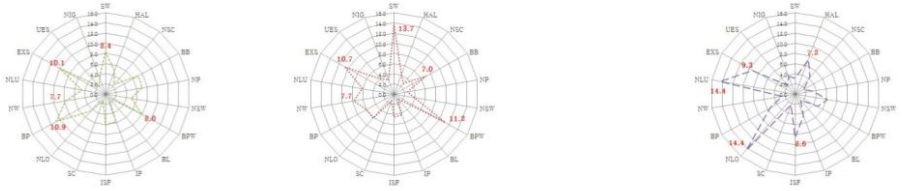


Fig 2. Analysis result of vulnerable (Level 2)

Elderly **Disabled** **People with children and/or infants**



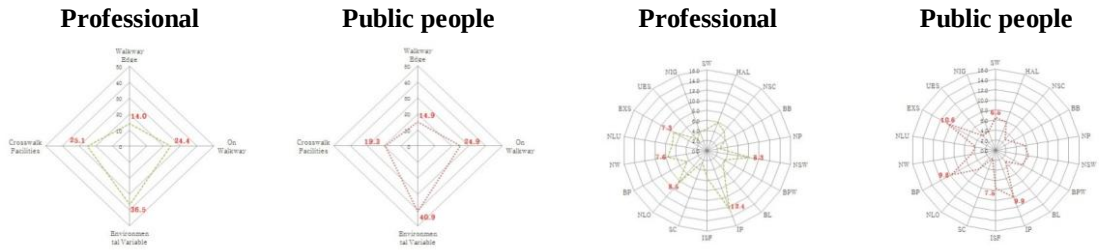
annotate) NSC : non-signalized crosswalk, SC : Signalized crosswalk, NLO : Non-lifting overpass, NLU : Non-lifting under walkway, NW : Narrow walkway, BPW : Bad paved walkway , SW : Steep walkway, BB : Bus bay, NSW : Non-separation walkway , UES : Unsuitable edge slop, NIG : Non-implement guard reduce, BL : Bollard, ISF : Illegal side facilities, NP : Number of pedestrian, IP : Illegal parking, BP : Bicycle pass, EXS : Enteral-exit section, HAL : High accident locations

Fig 3. Analysis result of vulnerable (Level 3)

According to an analysis of Level 2, 39.9% of the elderly felt the environmental variable to be the most inconvenient followed by being on walkways at 30.6%. At Level 3, bicycle passes and enteral-exit section topped the list at 10.9% and 10.1%, respectively, followed in order by steep walkways at 8.4%, poorly paved walkways at 8.0% and narrow walkways at 7.7%. The disabled of Level 2 highlighted being on walkways as the most inconvenient factor at 39.9%, and leaving environmental variables behind at 31.1%. At level 3, 13.7% of them chose steep walkways with 11.2% and 10.7% selected poorly paved walkways and enteral-exit section. Among the people with children and/or infants of Level 2, crosswalk facilities were felt to be the most inconvenient by 42.8%, preceding environmental variable at 27.7%. At Level 3, both non-lifting overpasses and non-lifting under walkways accounted for 14.4% on top followed in order by enteral-exit sections at 9.3%.

4.2 Analysis on use of road facilities by type of the non-vulnerable

As a result of analyzing the use of road facilities according to type of the non-vulnerable with a focus on walking, Fig 4 presents the orders by each element. Professional and public people out of the non-vulnerable at Level 2 produced similar results regarding the orders though the Level 3 generated difference according to the type.



(a) Level 2 (b) Level 3

Fig 4. Analysis result of the non-vulnerable

Professionals at Level 2 reported the environmental variable to be the most inconvenient at 36.5% and crosswalk facilities as the second most inconvenient at 25.1%. At Level 3, 12.4% of them chose illegal parking with non-lifting overpass at 8.5% and non-separation walkways at 8.3%.

40.9% of public people at Level 2 selected the environmental variable as the most inconvenient while 24.9% selected walkways. Level 3 showed that the enteral-exit section accounted for 10.6% with illegal parking and bicycle pass taking up 9.9% and 9.8%, respectively.

The difference between the professional and public people was found to occur as the former chose inconvenience that causes social and economic problems or affects all users of walk facilities in the perspective of traffic welfare over the inconvenience of their own in using walk facilities.

4.3 Comparing use of road facilities by the vulnerable and non-vulnerable

At Level 2, all the vulnerable and non-vulnerable who participated in the survey responded in the order of environmental variable, being on walkways, crosswalk facilities, and walkway edge, showing that the order did not change according to pedestrian type. All the pedestrians reported relatively greater dissatisfaction with the environmental variable than the walkway edge.

The vulnerable and non-vulnerable at Level 3 had different use of road facilities. For the vulnerable, enteral-exit section marked 10.3%, poorly paved walkways was 9.1% and steep walkways was 9.0%. For the non-vulnerable, however, illegal parking was 10.5%, enteral-exit section was 10.2% and bicycle passes was 8.7%. The vulnerable reported that fast moving vehicles or bicycles posed a huge threat.

The AHP explained that the vulnerable gave higher priorities to items related to safety than the non-vulnerable because they have less cognitive and responding capacity than the non-vulnerable, thus having more concern regarding the factors that can influence walking safety.

(a) Level 2 (b) Level 3

Fig 5. Comparison result for the vulnerable and non-vulnerable

5 Conclusion

This study established the elements that make people feel inconvenient using road facilities with a focus on walking using the AHP based on a survey and researched the use of road facilities by the vulnerable and non-vulnerable.

The AHP showed that the elderly at Level 2 selected the environmental variable and being on walkways as the first and second inconvenience, respectively, while the disabled chose being on walkways and environmental variable as the first and second, respectively, suggesting similar characteristics at this level. The people with children and/or infants pointed out crosswalk facilities as the most inconvenient factor, which was different from the elderly and disabled.

At Level 3, the elderly and disabled presented partial similarity, with the enteral-exit section, steep walkway and bad paved walkway making the top of the list of inconveniences because they have less cognitive and responding ability than public people and they depend on machines, such as scooters or wheelchairs, emphasizing safety and mobility. Non-lifting overpass and non-lifting under walkways were the first inconvenience for people with children and/or infants, showing a difference from the elderly and disabled.

According to the AHP, the professionals placed illegal parking, non-separation walkways and non-lifting overpasses on the top of the list. The public people, however, chose the order of enteral-exit section, illegal parking and bicycle passes on their list. The difference between the professional and public people was found to occur as the former chose inconvenience that causes social and economic problems or affects all users of walk facilities in the perspective of traffic welfare over inconvenience of their own in using walk facilities.

At Level 2, all the vulnerable and non-vulnerable that participated in the survey responded in the order of environmental variable, being on walkways, crosswalk facilities, and walkway edges, showing that the order did not change according to the pedestrian type. The vulnerable and non-vulnerable at Level 3 were found to have different use of road facilities. For the vulnerable, the enteral-exit section, poorly paved walkways and steep walkways marked 10.3%, 9.1% and 9.0%, respectively. For the non-vulnerable, however, 10.5%, 10.2% and 8.7% marked illegal parking enteral-exit section and bicycle passes, respectively.

AHP explained that the vulnerable gave high priorities to the items related to safety compared to the non-vulnerable because they have less cognitive and responding capacity than the non-vulnerable, thus concerning more about factors that can influence the walk safety.

This was a basic study that analyzed the use characteristics of road facilities by the vulnerable and non-vulnerable to improve their installation and management. Future studies will analyze the relationships among the road facility installation standard, current road facility and elements that generate inconvenience for the vulnerable to strengthen or improve the road facility installation standard rights for the vulnerable.

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