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Hierarchical analysis of barrier-free ramp scoring criteria

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Abstract

When building an accessible facility, there will be a series of projects to be evaluated. Therefore, through the World Health Organization's " Global Aging-friendly Cities: A Guide " released by the World Health Organization in 2007, this study is based on eight aspects and serves as a reference for cities to promote age-friendly cities. In addition, the importance weights are obtained through interviews with experts and scholars. At the same time, when setting up accessible ramps, special attention should be paid to protective measures, guardrails, and handrails.

Subject Classification: *62P25.*

Keywords: *Supplier selection, Analytical hierarchy process, Accessible ramp.*

1. Introduction

Suppliers play an important role at all times and are essential in the trading of materials, in the production process, and in the upstream, midstream, and downstream of the value chain. Therefore, the attitude of

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suppliers will determine the business performance and whether they have a competitive partner.

Selecting suppliers is one of the most important functions of the purchasing department (Hruška, Průša, & Babić, 2014). Supplier selection is a complex problem, involving multiple qualitative and quantitative criteria. By selecting the most suitable supplier, the company can not only save material costs but also improve its competitive advantage. When selecting the best supplier, it is very important to balance these tangible and intangible factors.

This is one of the key indicators for building an advanced city. Many countries are working to build cities that are accessible to everyone, including the elderly, the poor, the physically and mentally challenged, children, and women. In 2007, the World Health Organization (WHO) released the " Global Aging-friendly Cities: A Guide ". As a reference for communities to promote older friendly cities, and promote the relevant foundation based on eight standards (Tsay, Huang, Hung, & Ho, 2014). Therefore, the purpose of this study is to conduct a stratified analysis of scoring items through literature analysis to study the evaluation criteria for access ramps.

2. Literature review

2.1 *Analytic Hierarchy Process*

Analytic Hierarchy Process (AHP) is about the tools for decision-makers and researchers. Tahriri, Osman, Ali, Yusuff, & Esfandiary (2008) proposed that the application of AHP research methods in different fields includes planning, selecting the best solution, resource allocation, conflict resolution, and optimization. Bruno, Esposito, Genovese, & Passaro (2012) it is proposed that the Analytic Hierarchy Process (AHP) is a multi-objective decision-making method, which is applicable to management science, society and the economy. AHP is a systematic method for selecting suppliers or solutions. When dealing with complex decisions, AHP can confirm and decide a decision, as shown in Figure 1.

AHP was developed by Saaty (1980). It is used to prioritize alternatives in the case of multiple criteria. When multiple criteria must be considered, AHP is a decision-making method that allows decision-makers to structure complex problems. Generally, AHP has at least three levels: target level, standard level and alternatives. The composition standard includes quality, price, service, delivery and other relevant conditions (Hruška *et*

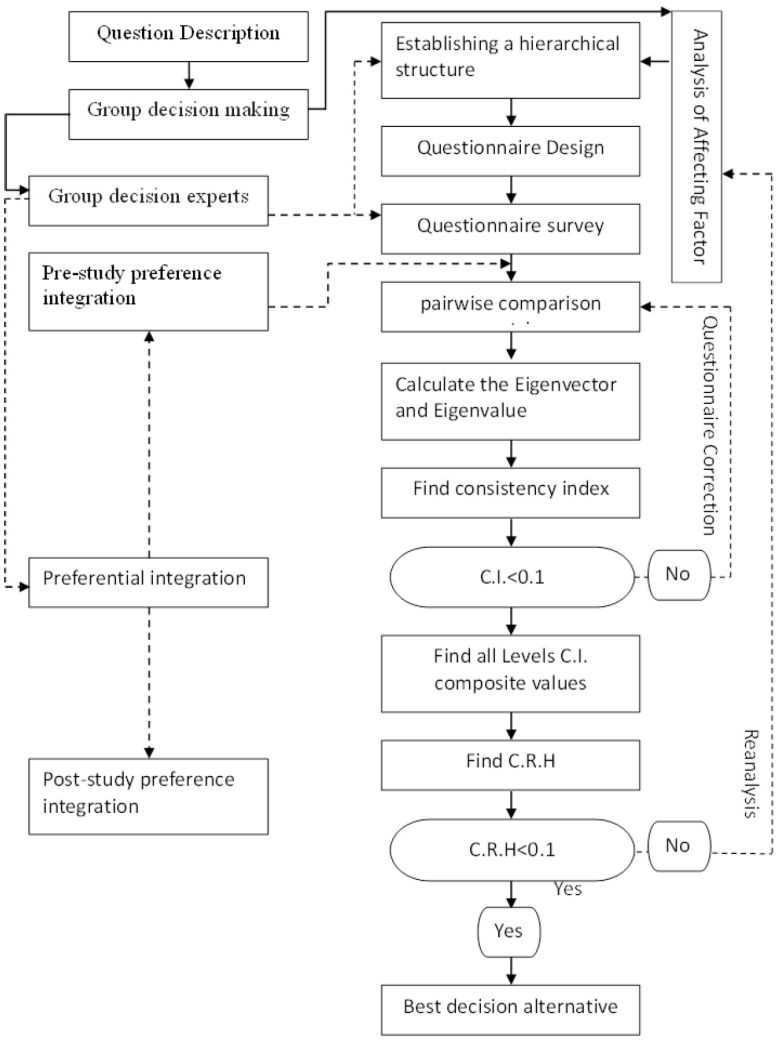

Figure 1

The research process of Analytic Hierarchy Process

al., 2014). Ayhan (2013), Tahriri *et al.* (2008), Kahraman, Cebeci, & Ulukan (2003) established an appropriate evaluation framework based on expert consultation and pre-testing questionnaires based on supplier evaluation indicators proposed by earlier researchers. Finally, the hierarchical process analysis questionnaire is used to determine the most important components and weights of supplier evaluation under the consignment system.

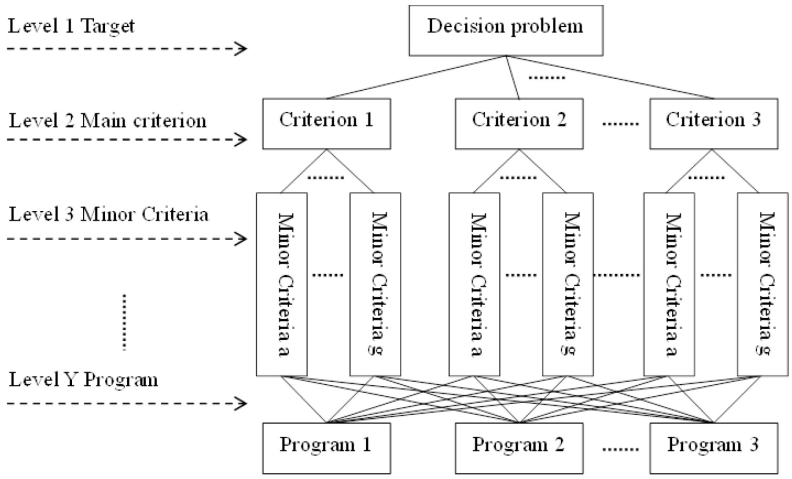

Figure 2

AHP hierarchy diagram

2.2 *Accessible ramp Facility project*

Since the people-oriented policy concept has been accepted and actively implemented by the traffic concept, the establishment of a dignified, safe and comfortable barrier-free pedestrian environment has now become the primary concern of the road. The central road authority also pays special attention to the pedestrian environment of urban roads, and the concept of road construction and maintenance gradually extends to the pedestrian environment (Lin, Sung, Yueh, & Zhuang, 2013), as shown in Table 1.

Table 1

Ramp facilities items

Ramp Facility Categories	Facility Item	
Ramp design	Ramp guidance signs	Ramp width
	Ground	
Platform	Endpoint platform	Intermediate platform
	Turning platform	
Protective facilities	Ramp edge protection	Guardrails
Handrail	Handrail height	Handrail height

2.3 *Accessible Environment*

While the word "free" means freedom, openness, and solution, the phrase "barrier" describes an obstacle that is exploited as a roadblock. Combining the two means "removing barriers", which refers to making homes and other living spaces accessible to the elderly and other physically disabled, while also being safe and slim (Tang, 2002). Cooper & Hasselkus, (1992) it points out that accessibility is the main focus of barrier free environment so that users can easily move and use various facilities and equipment in their daily living environment. Tzeng (1995) believes that in the design of a barrier-free environment, consideration must be given to the physical environment and equipment so that there is no social disadvantage for people with functional or disability impairments.

3. Research methods

Analytic hierarchy process proposed by Saaty (1980). AHP is a measurement tool that provides the ability to incorporate both qualitative and quantitative in the decision-making process. It also uses perception, sensation, judgment and memory to form a multi-level hierarchy of comparisons and to demonstrate the power to influence decisions, thereby facilitating decision-making. Generally, these forces and data are arranged and combined from more general factors to more specific factors. AHP provides a check on the interaction of objectives, standards, sub-standards and alternatives in the whole system. For this reason, both absolute and relative measures are used in the application of AHP. Absolute comparisons are often used when criteria need to be developed to rank independent alternatives based on expert experience (Saaty, 1980). However, relative comparisons require a systematic approach to the prioritization of hierarchical objectives through pairwise comparisons (Gass, 1986).

3.1 *Research steps*

- Build the Hierarchical Model

In problem analysis, the relevant assessment items, are assigned in a hierarchical manner from top to bottom. The top layer is the target layer, and there is only one factor. The bottom layer is usually the scheme or object layer, and there may be one or several levels of multiple criteria in between. When there are more than 7 evaluation criteria, it needs to be decomposed, as shown in Figure 2.

• Build the pairwise comparison matrix

Starting from the second layer of the hierarchical structure model, for the factors in the same layer that are subordinate to each factor in the upper layer, the paired comparison matrix is constructed by using the paired comparison method and the 1-9 comparison ruler until the lowest layer. The analysis method is to first establish a pair comparison matrix. The relationship between the matrices is the upper triangle and the lower triangle, and their relative positions are reciprocal.

When evaluators make paired comparisons to evaluate whether the results are valid or not, the consistency index value is used to check the consistency of weighted judgments among evaluation criteria. When establishing the matrix for comparison, C.I. and C.R. must be less than 0.1, which can not only prove the consistency but also show that the decision makers' differences in weighted judgments between the standards are within an acceptable range.

3.2 *Questionnaire Levels Created*

According to the literature review, this study is integrated into the following aspects, as shown in Figure 3.

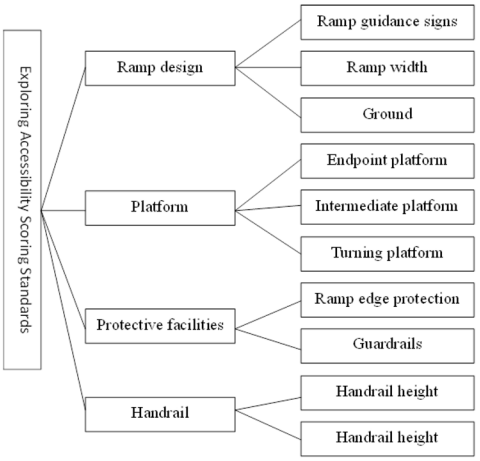

Figure 3

Hierarchical analysis for this study

3.3 *Questionnaire Survey*

The following questionnaires are designed according to the layers of the analytic hierarchy process in Figure 3, as shown in Table 2:

Table 2

Schematic diagram of questionnaire design

Intensity	Options A is more important than Options B									Options B is more important than Options A								Intensity
Options A	Extremely		Very strongly		Strongly		Moderately		Equally		Moderately		Strongly		Very strongly		Extremely	Options B
	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	
Ramp design																		Platform

4. Empirical analysis

This section describes the expert results from the questionnaire using AHP hierarchical analysis.

4.1 *Basic information from experts in the hierarchical analysis questionnaire*

The respondents to the AHP questionnaire were experts and scholars with more than six years of work experience. A total of eight questionnaires were distributed, and the recovery rate was 100%. There are eight experts in this study, and they are introduced in Table 3 below.

Table 3

Basic information from experts in the hierarchical analysis questionnaire

Number	Job position	Job tenure
1	Construction industry	12
2	Construction industry	15
3	Construction industry	14
4	Construction industry	10
5	Government officials	7
6	Government officials	11
7	Government officials	9
8	Government officials	10

4.2 *Overall criteria weighting analysis*

In the weight ranking of the overall selection criteria, as shown in Table 4, "protective measures" is the first, and its overall weight value is 0.4123; "Guardrail" is the second, and its overall weight is 0.2881; Take "handrail" as the third, and its overall weight value is 0.2878; "Strong" is the fourth, and its overall weight value is 0.2319; "Platform" is the fifth, and its overall weight value is 0.1609; "Ramp design" is the sixth, and its overall weight value is 0.1390; "Slope edge protection" is the seventh, and its overall weight value is 0.1243; "Turning platform" is the eighth, and its overall weight is 0.0699; Take "handrail height" as the ninth, and its overall weight value is 0.0559; Take "ramp width" as the tenth, and its overall weight value is 0.0546; "Endpoint Platform" is the eleventh, and its overall weight value is 0.0517; The "ramp guide sign" is the twelfth, and its overall weight value is 0.0448; "Ground" is the thirteenth, and its overall weight value is 0.0396; The "middle platform" is the fourteenth, and its overall weight is 0.0393.

Table 4

Weighted ranking of overall criteria

Dimension	Criterion	Partial weighting	Weighting	Ranking
Accessible ramp scoring criteria	Protective facilities	0.41235	0.41235	1
Protective facilities	Guardrails	0.698649	0.288088	2
Accessible ramp scoring criteria	Handrail	0.287752	0.287752	3
Handrail	Handrail height	0.805791	0.231868	4
Accessible ramp scoring criteria	Platform	0.16088	0.16088	5
Accessible ramp scoring criteria	Ramp design	0.139018	0.139018	6
Protective facilities	Ramp edge protection	0.301351	0.124262	7
Platform	Turning platform	0.434782	0.069948	8
Handrail	Handrail height	0.194209	0.055884	9

Contd...

Ramp design	Ramp width	0.392635	0.054583	10
Platform	Endpoint platform	0.321125	0.051663	11
Ramp design	Ramp guidance signs	0.322287	0.044804	12
Ramp design	Ground	0.285078	0.039631	13
Platform	Intermediate platform	0.244094	0.03927	14

Based on the above, it can be seen that the weight of protective measures in this study is extremely important, followed by guardrails, and the lowest is the intermediate platform.

5. Conclusions

The results of the empirical analysis of this study lead to the following conclusions.

- The experts in this study are management-level personnel with at least six years' of experience in the industry. After the questionnaire is obtained through the interview results, it is analyzed.
- In this study of barrier-free ramp scoring criteria, the importance of protective measures is extremely important, followed by guardrails etc.
- Through the analytic hierarchy process, we get the opinions of experts and scholars, hoping that this research can contribute to the purchasers who plan to build barrier free ramps.

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