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Improving Accessible Mobility for Visually Impaired Travelers: An IPA Analysis of the Sightseeing Verbal Map in Shanghai

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ABSTRACT

This study conducts an Importance-Performance Analysis (IPA) of the Sightseeing Verbal Map, an auditory assistive system, to guide accessible-mobility improvements for visually impaired travellers in Shanghai. Building on prior qualitative work that adapted the system from Japan to Chinese users, we move from descriptive validation to quantitative prioritization. A structured questionnaire was administered to 306 visually impaired respondents, who rated nine attributes across three functions (route guidance, the map of words, and environmental sounds) on both importance and satisfaction. Plotting these means against grand-mean crosshairs yields a four-quadrant priority matrix. Real-time location awareness emerges as the clearest improvement target, with the narrow-sense map of words as a borderline case in the same quadrant; start- and end-of-route guidance and walking instructions are strengths to maintain, and the soundscape is already adequately provided. The findings translate diffuse feedback into a data-driven improvement map and advance cross-cultural localization of assistive mobility technologies.

Keywords: Visually impaired individuals, Mobility accessibility, Voice guidance, Universal design, Importance-performance analysis

INTRODUCTION

Globally, at least 2.2 billion people live with some form of near or distance vision impairment (World Health Organization, 2019), and for those whose impairment is severe, visiting an unfamiliar city is one of the situations in which the gap with sighted people becomes most apparent. The information a sighted tourist briefly—where the path bends, what stands on either side, which building is worth stopping for—must instead be obtained through hearing, touch, and spoken explanation. Studies of tourists with vision impairment have shown that access to information and the experience of wayfinding strongly shape whether a trip feels inclusive or exclusionary, and that many tourism spaces remain difficult to navigate (Richards et al., 2010; Small et al., 2012).

Audio-based support tools attempt to close this gap by converting spatial and cultural information into sound and language. Learning a route before the trip is a particularly promising approach: blind people can

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build a step-by-step representation of an unfamiliar route through virtual navigation (Guerreiro et al., 2017) and later draw on this knowledge to complete unassisted navigation tasks in the real environment (Guerreiro et al., 2020). The Sightseeing Verbal Map, developed in Japan through a series of studies on walking support for visually impaired people (Takahashi et al., 2013; Matsumoto et al., 2018; Ishii et al., 2022), is a tool of this kind: it combines spoken route information, verbal descriptions of the surroundings, and recorded environmental sounds so that users can become acquainted with a walking route before setting out. Its components, however, were designed around Japanese streets and Japanese users, and there is no guarantee that each will be valued, or delivered, equally well in a different urban and cultural setting.

In an earlier qualitative stage of this project (Li and Uchida, 2025), the system was adapted to a sightseeing route in Shanghai and examined with Chinese users through in-depth interviews, which identified navigation accuracy, cultural engagement, and sound design as recurring themes. Interview findings of this kind reveal what users care about, but not how the individual components compare with one another when development resources are limited. Taking an exploratory, quantitative step, the present paper uses responses from 306 visually impaired people in China to examine how important users consider each of nine attributes of the system and how satisfied they are with each and applies Importance-Performance Analysis (IPA; Martilla and James, 1977) to turn these paired ratings into improvement priorities. All respondents are analysed as one population to obtain a system-level picture; differences among visual-impairment profiles are left to separate work.

THE SIGHTSEEING VERBAL MAP

The Sightseeing Verbal Map is a set of narrated walking videos through which a visually impaired person can learn a sightseeing route by listening before visiting it. Each video follows the route at walking pace and layers three kinds of audio content onto the recorded scene: spoken instructions on how to proceed, verbal descriptions of the surroundings, and sounds either captured on site or added for effect. Figure 1 shows how these contents are organized, together with the nine attributes evaluated in this study. Rather than issuing commands during the trip, the system helps users form a picture of the route in advance, so that on the day of travel the place already feels partly familiar.

Route guidance provides the information needed simply to reach the destination (Matsumoto et al., 2018): where the walk begins and ends, when to go straight, turn, or turn back at each decision point, and which walkways, crossings, and transit connections are encountered. Because the narration reports the user's position and heading as the video progresses, it also helps the listener keep track of where they are. This function was evaluated through three attributes (A1–A3 in Figure 1): guidance at the start and end of the route, instructions for walking straight and turning, and real-time awareness of one's current location.

The map of words in the broad sense goes beyond wayfinding to convey what the surroundings are like (Adachi et al., 2017) and consists of three layers. The wide-area edition gives an overview of the larger district. The map of words in the narrow sense describes the immediate environment through geo-information, which reports physical features that can be confirmed with a cane or through sound and smell (e.g., walkway layout, adjacent facilities, and surface materials), and sketching words, which express in everyday language the sensory impressions a person would gain at that spot, including those specific to a season or time of day. The wayside guide encourages the user to linger and explore by presenting shops and landmarks as a sighted visitor might notice them in passing, including where each shop's entrance is. Each layer was evaluated as one attribute (B1–B3 in Figure 1).

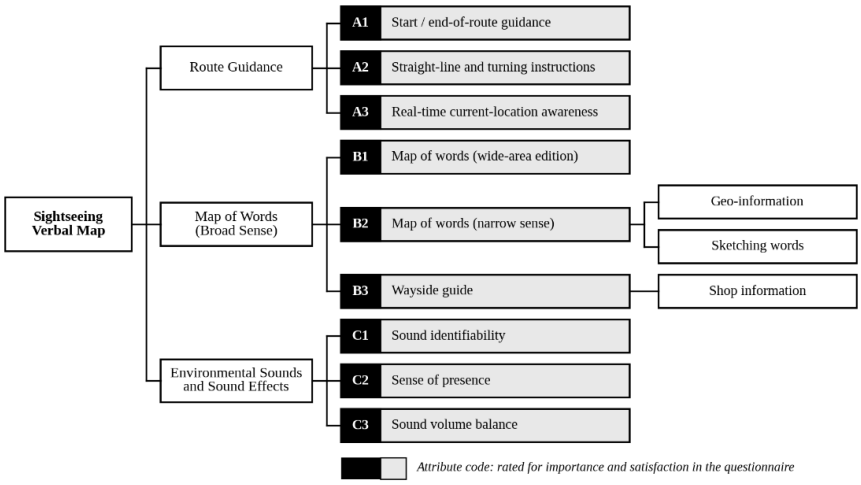


Figure 1: Structure of the sightseeing verbal map and the nine evaluated attributes.

Environmental sounds and sound effects form the third function (Takahashi et al., 2013). Environmental sounds are the ambient sounds heard along the route. They were recorded while walking at about 3 km/h, a pace typical of visually impaired pedestrians, with a pause of about 20 seconds facing the direction of travel at crossings and other decision points, mirroring how a sighted walker might stop to check a map. Sound effects, by contrast, are inserted deliberately to mark the character of a place, stimulate the listener's imagination, and strengthen the sense of being there. This function was evaluated through three attributes (C1–C3 in Figure 1): how easily the sounds can be identified, the sense of presence they create, and the balance of sound volume. The nine attributes shown in Figure 1 are the units analysed in the IPA.

METHODOLOGY

Figure 2 shows where the present study sits within the wider research program. After a sightseeing route in Shanghai was recorded with its ambient sound and localized as a Chinese-language Sightseeing Verbal Map, a qualitative

stage explored users' experiences through interviews (Li and Uchida, 2025). The present quantitative stage presented the same content to a large sample of visually impaired respondents and analysed their importance and satisfaction ratings of the nine attributes with IPA.

The study route in central Shanghai, a major destination for domestic and international visitors with a varied urban soundscape, is summarized in Table 1 and Figure 3. Its course of roughly 2.8 km links natural, commercial, and historical settings, from People's Park through Nanjing Road to the Bund waterfront.

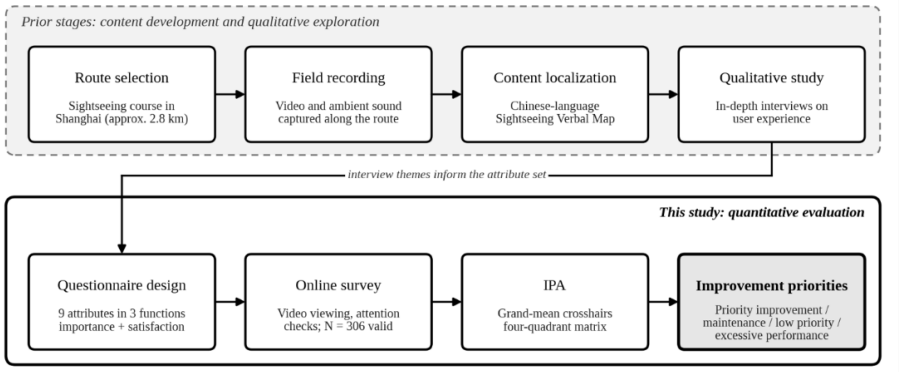


Figure 2: Position of the present study within the research program.

Table 1: Overview of the walking course.

Location	The Bund Area, Central Shanghai, China
Start / End	People's Square Metro Station (Exit 9) / Bund Historical Memorial Hall; approx. 2.8 km
Main Settings	People's Park, Nanjing Road Pedestrian Street, the Bund waterfront
Visitors	All age groups, from young people to older adults
Signature Sound	Whistle of the sightseeing tram on Nanjing Road

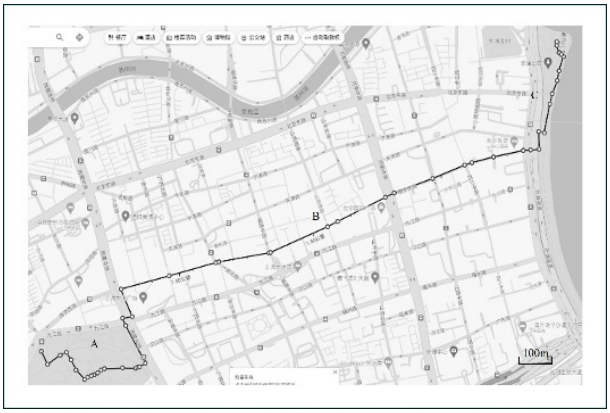


Figure 3: Walking course (Li and Uchida, 2025; modified map of Shanghai based on Google Maps with study-area boundaries added).

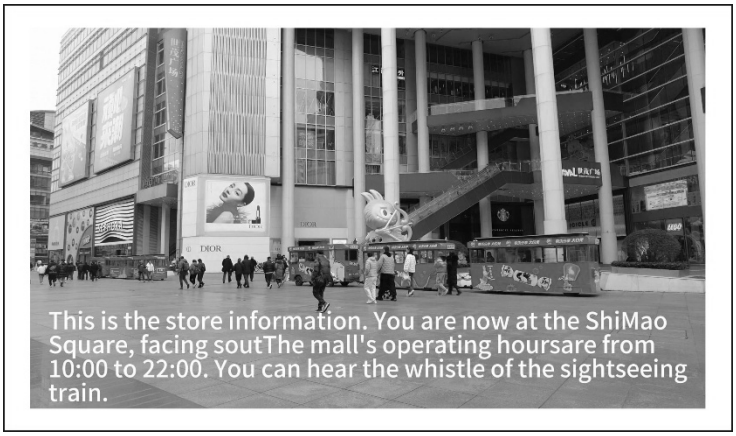


Figure 4: Screenshot of the sightseeing verbal map presented to respondents (Li and Uchida, 2025).

QUESTIONNAIRE SURVEY

Data were collected through a structured online questionnaire distributed to visually impaired people in China. Before answering, each respondent experienced the Shanghai Sightseeing Verbal Map (Figure 4). The questionnaire consisted of three parts (Table 2): Part 1 collected the respondent's profile, Part 2 asked for an evaluation of the nine attributes shown in Figure 1, and Part 3 asked about willingness to pay for the service, which lies outside the scope of this paper. An attention-check item was placed at the end of Parts 1 and 3, and only responses that passed both checks were retained, yielding 306 valid responses.

Table 2: Content of the questionnaire.

Part	Items	Response Format
Part 1 Respondent profile	Degree of visual impairment (congenitally blind, adventitiously blind, low vision); age; gender; frequency of independent outings; assistive tools used; prior sightseeing travel; attention check	Multiple choice (single answer; multiple answers for assistive tools)
Part 2 Attribute evaluation	Importance and satisfaction for each of the nine attributes: route guidance (A1–A3), map of words (B1–B3), and environmental sounds and sound effects (C1–C3); see Figure 1	Five-point scale 1 = strongly disagree 5 = strongly agree
Part 3 Willingness to pay	Willingness to pay for the service, acceptance of charging schemes, acceptable price range, and preferred cost-sharing; attention check	Five-point scale (not analysed in this paper)

In Part 2, each attribute was rated twice—for its importance to the respondent's travel experience and for satisfaction with its performance as experienced in the verbal map—on a five-point scale from 1 (strongly

disagree) to 5 (strongly agree). These matched ratings provide the two coordinates required for the IPA.

Table 3 summarizes the composition of the 306 valid respondents. The sample was balanced by gender, spread across age bands and independent-outing frequencies, and included congenitally blind, adventitiously blind, and low-vision individuals. Navigation applications, companions, and the white cane were the most used travel aids. The study adhered to the ethical guidelines of the Research Ethics Review Committee, Graduate School of Engineering, Osaka Metropolitan University; respondents were informed that participation was anonymous and voluntary and that the data would be used solely for academic research.

Table 3: Composition of respondents (N = 306).

Attribute	Categories (Count)
Gender	Male 157; Female 149
Degree of visual impairment	Congenitally blind 94; adventitiously blind 71; low vision 141
Age	Under 20: 12; 20s: 76; 30s: 70; 40s: 68; 50+: 80
Independent-outing frequency	Rarely 68; occasionally 64; sometimes 79; often 58; very often 37
Assistive tools used (multiple)	White cane 215; navigation app 276; companion 217; guide dog 59
Prior sightseeing travel	Yes, frequent to none, across four levels (62/104/88/52)

IMPORTANCE-PERFORMANCE ANALYSIS

Importance-Performance Analysis, introduced by Martilla and James (1977), evaluates service attributes by considering together how important each attribute is to users and how well it is currently delivered. The mean importance and mean performance of each attribute are plotted on a two-dimensional grid, which a pair of crosshairs divides into four quadrants (see Figure 5). Attributes in Priority Improvement (termed Concentrate Here by Martilla and James) are important but under-delivered and are the first candidates for improvement; those in Priority Maintenance (Keep Up the Good Work) are important and well delivered and should be maintained; those in Low Priority score low on both dimensions and call for no urgent action; and those in Excessive Performance (Possible Overkill) receive more effort than their importance justifies, so resources may be redirected elsewhere. Because its output is a single, easily interpreted chart, IPA has been widely adopted in service management and tourism research (Azzopardi and Nash, 2013) and suits the setting of development priorities for an assistive system whose functions compete for limited resources.

In this study, satisfaction ratings serve as the measure of performance, and mean importance and mean satisfaction were calculated for each attribute across all 306 valid responses. The crosshairs can be placed at the midpoint of the rating scale (scale-centred) or at the observed means of the data (data-centred) (Bacon, 2003). Because all importance means were close to

4 and all satisfaction means exceeded the scale midpoint, a scale-centred grid would place every attribute in the same quadrant and fail to distinguish among them. The grand means of importance and satisfaction across the nine attributes were therefore used as the crosshairs, so that an attribute's quadrant indicates its priority relative to the other attributes of the same system rather than an absolute level of adequacy.

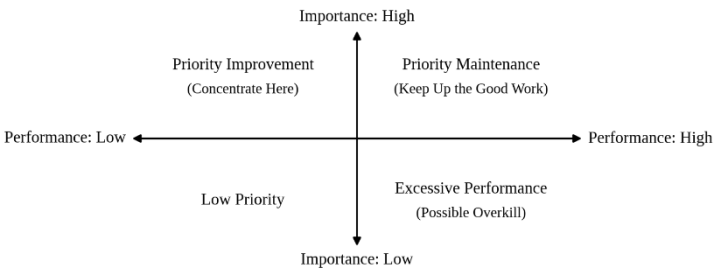


Figure 5: Four-quadrant framework of Importance-Performance Analysis (Inuzuka, 2021).

RESULTS

Table 4 reports the mean importance and mean satisfaction for each of the nine attributes, together with the grand means used as the IPA crosshairs. Across all attributes, importance (grand mean 4.11) consistently exceeded satisfaction (grand mean 3.53), indicating that respondents value the functions but see room for improvement in their current realization.

Table 4: Importance and satisfaction mean by attribute (N = 306).

Code	Item	Function	Import.	Satisf.
A1	Start / end-of-route guidance	Route Guidance	4.25	3.58
A2	Straight line and turning instructions	Route Guidance	4.25	3.60
A3	Real-time location awareness	Route Guidance	4.24	3.41
B1	Map of words (wide-area edition)	Map of Words	4.13	3.55
B2	Map of words (narrow sense)	Map of Words	4.12	3.46
B3	Wayside guide	Map of Words	4.05	3.44
C1	Sound identifiability	Env. Sounds	4.02	3.62
C2	Sense of presence	Env. Sounds	3.99	3.56
C3	Sound volume balance	Env. Sounds	3.96	3.53
	Grand mean		4.11	3.53

Figure 6 plots the nine attributes on the importance–performance plane. Two attributes fall in the "Priority Improvement" quadrant. Real-time location awareness (A3) combines above-average importance with the lowest satisfaction of any attribute and lies well away from both crosshairs; it therefore represents the system's foremost improvement target. The narrow-sense map of words (B2) also falls in this quadrant, but its importance (4.12) exceeds the grand mean (4.11) only marginally, so it is better regarded as a

borderline case than as a priority on a par with A3. In contrast, start- and end-of-route guidance (A1) and walking instructions (A2) fall in the "Priority Maintenance" quadrant, pairing high importance with high satisfaction and indicating strengths to be preserved.

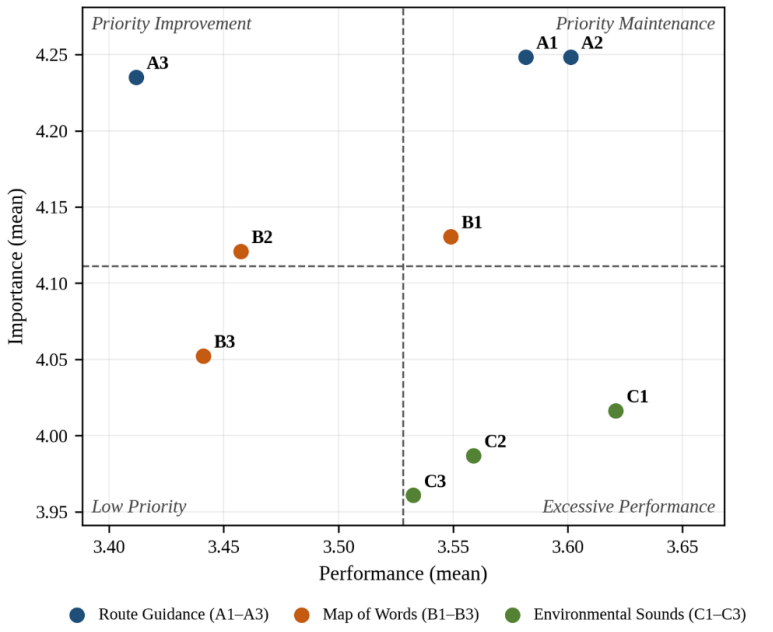


Figure 6: Importance-performance analysis of the nine service attributes (N = 306).

The map-of-words attributes are spread across three quadrants. The wide-area edition (B1) lies in the "Priority Maintenance" quadrant, close to both crosshairs; the narrow sense (B2), as noted above, lies just inside "Priority Improvement"; and the wayside guide (B3) falls in the "Low Priority" quadrant, where both importance and satisfaction are below average. Within this function, the district overview is regarded as adequate, the descriptions of the immediate surroundings leave users less satisfied, and the wayside guide is considered least pressing.

The three environmental-sound attributes (C1–C3) lie below the importance crosshair and at or above the satisfaction crosshair (C3 almost on it), placing them in the "Excessive Performance" quadrant. Respondents are relatively satisfied with the soundscape but regard it as less important than route guidance and the map of words, indicating that further investment here would yield limited returns compared with route-guidance improvements.

DISCUSSION

The IPA results convert the qualitative determinants identified in earlier work into an ordered set of development priorities. Navigation accuracy, previously described as a central concern, is here shown to concentrate specifically in real-time location awareness rather than in route guidance

as a whole: start- and end-of-route guidance and walking instructions already satisfy users, whereas the ability to know one's position continuously along the route is the weakest link. This finding aligns with the difficulty of maintaining orientation in dense and acoustically complex environments such as Shanghai, where important audio cues can be masked by background noise.

For environmental sound, the design objective should shift from adding immersion toward balancing it so that it supports, rather than competes with, route guidance. Within the map of words, the wayside guide can be treated as a lower priority, whereas the narrow-sense descriptions, lying on the border of the Priority Improvement quadrant, deserve monitoring; such enrichment, while valued, should not displace investment in positional accuracy.

Two limitations qualify these conclusions. First, IPA establishes relative priorities within the current attribute set and does not by itself reveal absolute thresholds of acceptability. Second, treating the respondents as a single population is appropriate for system-level prioritization but conceals potential differences among visual-impairment profiles; congenitally blind, adventitiously blind, and low-vision users may weigh the same attributes differently, a question left to subsequent analysis. The findings are also tied to the Shanghai context and should be tested in other urban environments.

CONCLUSION

This study applied Importance-Performance Analysis to a culturally adapted Sightseeing Verbal Map, using responses from 306 visually impaired users in China. The analysis identifies real-time location awareness as the attribute most clearly demanding improvement, with the narrow-sense map of words as a borderline candidate; it confirms start- and end-of-route guidance and walking instructions as strengths to maintain, positions the wayside guide as a lower priority, and indicates that the environmental soundscape is already adequately provided. By translating diffuse user feedback into an explicit priority map, the analysis complements the earlier qualitative validation and gives developers a data-driven basis for allocating limited resources. Future work will compare priorities across congenitally blind, adventitiously blind, and low-vision subgroups and examine users' willingness to pay for the service.

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