Representing Retail Wayfinding: A Requirement-Driven Study Design for Non-Visual Supermarket Navigation

Xiang Zhou
Geoinformatics Group, Institute of Geography, University of Augsburg, Germany

Sabine Timpf
Geoinformatics Group, Institute of Geography, University of Augsburg, Germany

Abstract

First-visit supermarket shopping is a demanding case of non-visual indoor wayfinding. Blind and low-vision shoppers must make sense of functional zones, work through repetitive aisles, and confirm shelf areas while also dealing with queues and checkout. We use retail wayfinding to describe how movement, in-store search, and shelf-level confirmation are coupled. Retailer-held 2D layouts and product placement data can support verbal guidance, but many dynamic, sensory, and social conditions remain outside these data. We outline a requirement-driven mixed-methods study with 52 blind and low-vision participants: 30 in Study A, 30 in Study B, with eight participants taking part in both. Audio-recorded dialogue, verbal route descriptions, observer-coded event traces, and post-task interviews will be used to examine how shoppers request spatial information, confirm progress, and manage uncertainty from store-level orientation to shelf-level confirmation. The expected output is an initial coding matrix showing what needs to be represented, at what scale, and when confirmation or assistance becomes necessary in non-visual retail wayfinding.

2012 ACM Subject Classification Information systems → Spatial-temporal systems; Human-centered computing → Ubiquitous and mobile computing; Human-centered computing → Accessibility

Keywords and phrases retail wayfinding, blind and low-vision shoppers, indoor wayfinding, verbal route descriptions, requirements modelling

Digital Object Identifier 10.4230/LIPIcs.COSIT.2026.27

Category Short Paper

1 Introduction

Large indoor environments are difficult to navigate without vision because spatial information has to be selected, timed, and confirmed while the traveller is moving. Classic work describes non-visual wayfinding as problem solving around decision points, route knowledge, and uncertainty [18, 15], while guidance studies show that the form of spatial information affects cognitive load [7]. For blind and low-vision travellers, being on the correct path is therefore only part of the problem. Guidance also has to be understandable, confirmable, and able to support re-orientation when the perceived environment no longer matches the expected route [20, 6]. This paper focuses on first-visit supermarket shopping as a specific case of non-visual indoor wayfinding. A shopper enters with a list, moves between functional zones, searches within aisles, narrows down relevant shelf areas, and eventually reaches checkout.

As Figure 1 suggests, this recurrent task-chain can describe shopping more generally. The non-visual problem lies in how shoppers understand each stage, confirm progress, and re-establish orientation when expected cues are missing or unclear. Supermarkets make this harder because repetitive aisles and changing shelf displays make orientation unstable, while other customers affect where it is safe to stop, search, or ask for help.

17th International Conference on Spatial Information Theory (COSIT 2026).
Editors: Sabine Timpf, Gabriele Filomena, Armand Kapaj, Rui Zhu, Nicholas Giudice, and Ed Manley; Article No. 27; pp. 27:1–27:7
Leibniz International Proceedings in Informatics
LIPICS Schloss Dagstuhl – Leibniz-Zentrum für Informatik, Dagstuhl Publishing, Germany

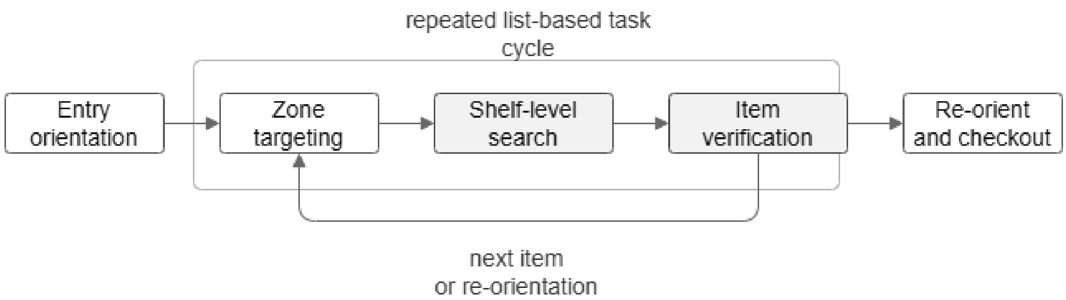

Figure 1 Recurrent shopping process and scale transitions during a first-visit supermarket task. The cycle is not unique to blind and low-vision shoppers; the paper focuses on the non-visual representation requirements that arise when this cycle has to be completed without visual access.

We use *retail wayfinding* to denote wayfinding in retail spaces where navigation is tightly coupled with in-store search and shelf-level confirmation. This definition builds on non-visual wayfinding and verbal route description research [18, 2], and responds to recent studies of grocery navigation, product descriptions, and shopping support for visually impaired people [14, 12, 3, 11]. In this setting, decision points are not only geometric locations such as aisle entrances. They also occur at functional moments in the shopping task: deciding whether an aisle is relevant, where to begin shelf-level search, or how to confirm that the relevant category area has been reached. Recent indoor navigation systems have made progress in positioning, semantic guidance, infrastructure-light interaction, and floor-plan-based support [21, 5, 10, 8]. Yet many still frame success as reaching a destination or point of interest. Supermarket guidance raises a more specific GIScience question: how can store structure and retailer-held spatial data be translated into information that supports non-visual shopping decisions?

Rather than presenting a completed navigation system, this paper asks which retail elements need to be represented, at which scale, and for which stage of a non-visual shopping task. We expect uncertainty to become especially visible at scale transitions, such as from store-level orientation to aisle-level travel, and from aisle-level travel to shelf-level confirmation. Some requirements may be represented from 2D layout and product placement data, while others require dynamic sensing, human knowledge, or interaction. The contribution is a requirements-focused study design with an initial coding matrix linking task stage, information need, spatial representation, and likely data source.

2 Background and Related Work

2.1 Wayfinding without vision

Research on wayfinding without vision shows that visually impaired travellers can acquire spatial knowledge, but the process depends strongly on how information is structured and timed. Passini and Proulx conceptualise wayfinding as problem solving around decision points, while Loomis, Klatzky, and Golledge connect non-visual navigation to route knowledge, landmarks, and spatial language [18, 15]. Montello's account of spatial knowledge acquisition is also useful here, because it distinguishes procedural route knowledge from broader configurational understanding [16]. In the orientation and mobility sense, support should therefore do more than compute a path: it should help the traveller maintain position, heading, relevant cues, upcoming decisions, and ways to re-establish orientation when an expected cue is not found [22, 23, 4].

2.2 Verbal route descriptions and non-visual guidance

Verbal route descriptions (VRDs) are valuable because they reveal how spatial information is selected and structured for action. They can include landmarks, distances, surfaces, sounds, object relations, and re-orientation cues. Balata's work on verbal route descriptions for non-visual navigation shows that such descriptions are richer than simple turn-by-turn commands and often contain information that supports orientation and confidence [2]. Recent work on dynamic indoor environments further suggests that verbal descriptions need to respond to movable objects, people, and changing local conditions [1].

In supermarkets, this matters because a useful instruction may need to explain why an aisle is relevant, where local search should begin, and which cue can confirm the right shelf segment. VRDs therefore offer not only a guidance modality, but also an empirical window into shopping-relevant spatial cognition.

2.3 Assistive indoor navigation and grocery shopping

Accessible indoor navigation systems have improved considerably, especially in positioning, semantic features, infrastructure-light interaction, and smartphone-based map interpretation [21, 5, 10, 8]. Studies of real-world use further show that visually impaired travellers adapt common navigation technologies to situated needs, rather than simply following pre-computed routes [6]. Yet many systems still treat success mainly as reaching a destination or a point of interest. This framing is only partly adequate for supermarket shopping. A shopper may reach the correct department and still struggle at the shelf, because category boundaries, shelf organisation, prices, and packaging cues remain uncertain.

Recent work on grocery navigation, product descriptions, and wearable shopping assistance addresses this gap from complementary directions [14, 12, 3]. Grocery navigation studies show how mobile guidance can support store movement, product-description work clarifies what information is needed to distinguish similar items, and wearable assistance highlights the difficulty of shelf-level recognition in dense scenes. The last-few-metres problem is relevant because uncertainty often appears close to the target, where local confirmation and object interaction become necessary [20]. What remains open is how blind and low-vision shoppers connect store layout, functional zones, sensory cues, and product search during an unfamiliar trip. We address this as a representation problem rather than another positioning or product-recognition system.

3 Retail Wayfinding as a Distinct Problem

Supermarket retail wayfinding is not reducible to indoor wayfinding plus product identification. Instead of following one route to one destination, the shopper completes a list through repeated cycles of moving, searching, confirming, and re-orienting. Reaching the right zone is useful, but it is not enough if the shopper cannot decide where to begin searching, how to confirm the relevant category or shelf area, or how to re-establish orientation when the expected shelf arrangement is not found [14, 12, 3]. Retail wayfinding is therefore used here as a spatial representation problem, not just a task label. The difficulty comes from doing list-based shopping in repetitive shelf spaces, where product categories can be ambiguous and conditions change with carts, displays, restocking, and crowding [17].

Retailer-held spatial data make this distinction concrete. A 2D floor plan can represent entrances, checkout areas, aisles, cross-aisles, and broad functional zones, while product placement data indicate where categories or items are expected to be. Together, these data can support store overviews, zone-level routing, and some aisle-level guidance. However, they rarely capture shelf-level accessibility, temporary obstacles, crowding, sound masking, or local confirmation cues. The research problem is therefore to determine which parts of the shopping task can be represented from stable spatial data, and where non-visual guidance needs sensing, human knowledge, or interaction.

4 A Requirements-Oriented Framework for Retail Wayfinding

We use a requirements-oriented framework to translate supermarket shopping episodes into spatial representation requirements. It links shoppers' needs to supermarket structure and verbal guidance implications, while keeping the focus on representation rather than system architecture. When a shopper asks a question, hesitates, requests confirmation, or reconstructs a route after the task, this mapping helps identify what spatial knowledge was needed and whether it could plausibly be derived from retailer-held data. The framework is an initial coding lens to be refined through the empirical study.

Supermarkets are treated as functional spatial systems, from entrances and checkout areas to aisles, shelf segments, and points where shoppers confirm progress. These elements operate across store, zone, aisle, and shelf scales. Uncertainty often increases when shoppers move from travelling to searching or from searching to confirming.

Table 1 summarises this mapping as an initial coding matrix. The four requirements provide a working lens derived from prior work on non-visual wayfinding, verbal guidance, cognitive load, in-situ navigation technology, last-few-metres wayfinding, and remote sighted assistance [18, 7, 2, 6, 20, 13]. In the empirical study, the table will be refined into a task-stage by need matrix linking each episode to the spatial representation required at that moment.

5 Planned Study and Coding Approach

Subject to ethical approval, the study will be conducted in June–July 2026 in unfamiliar supermarkets with 52 blind and low-vision adults. Study A will involve 30 participants in an in-situ shopping task, while Study B will involve 30 participants in a complementary verbal description and post-task reconstruction task; eight participants will take part in both. This partial overlap connects the two components without treating them as one repeated-measures experiment.

In Study A, participants will locate predefined product categories from different functional zones and then move toward checkout. The store will be checked in advance only to ensure that these target categories are present and can be encountered in plausible shelf areas; no exact product choice is prescribed. A human guide will act as a proxy for future non-visual guidance, prioritising participant requests and safety-critical interventions over unsolicited route planning. The guide may confirm that a participant has reached the relevant category area or intervene for safety, but will not identify a specific product as the correct purchase. Guide-initiated statements and participant-initiated requests will be coded separately. The aim is not to test product recognition or exact item selection, but to identify what spatial and semantic information becomes necessary from store-level orientation to category-level search and shelf-level confirmation.

The study will combine audio-recorded in-situ dialogue with verbal route descriptions, observer-coded event traces, and short post-task interviews. Event traces will be logged as time-stamped episodes, covering the main transition points from entry orientation to checkout. These traces do not evaluate route optimality; instead, they show where participants moved

Table 1 Initial coding matrix linking non-visual needs, spatial knowledge, representational basis, and verbal guidance implications in supermarket shopping.

Need	Spatial knowledge needed	Representational basis / likely data source	Verbal guidance implications
Safety	Safe corridors, reliable boundaries, safe stopping points near search locations [18, 7, 6]	2D geometry + optional dynamic updates	Edge-following cues, clearance cues, safe pause points before search [2, 6, 14]
Control	Preferred pacing; available clarifications per task stage [9, 6, 13]	Task-stage model + dialogue state + user preferences	User-driven queries; progressive disclosure; repeat/rewind; transition cues for local search [9, 6, 13]
Understanding	Zones and relations; anchors relevant to shopping (checkout, entrance, service counter) [16, 21, 8]	2D plan + semantic zoning	Short store overview; anchor references; boundary references between adjacent zones [21, 8, 19]
Confidence and re-orientation	Confirmation cues at aisle entrances, shelf ends, and category boundaries under aisle ambiguity [20, 2, 1, 14]	Topology + decision-point model + cue hierarchy from VRDs	Confirmation checks; conditional return cues; aisle-identity confirmation [20, 2, 1, 13]

smoothly and where uncertainty or assistance became visible. Interviews will ask participants to reconstruct the trip and identify trusted cues, moments of uncertainty, and situations where assistance became necessary.

The analytical unit will be an event episode: a bounded segment of dialogue or movement around a task-relevant spatial action. Each episode will be coded by task stage, need type, cue type, spatial scale, decision context, assistance source, and likely data source. Task stages include entry orientation, zone targeting, aisle traversal, shelf-level search, shelf-area confirmation, re-orientation, and checkout. Cue types include structural, semantic, tactile, auditory, olfactory, and social cues. Decision contexts distinguish geometric decision points from functional ones, such as choosing where to begin a shelf search. The resulting matrix will compare what participants asked for in situ, what they reconstructed after the task, and which environmental features were represented by 2D layout or product placement data. The main analytical task is to move from recorded interaction to representation requirements: identifying stable coding categories, overlaps, and cases where sensing, human knowledge, or interaction remains necessary.

6 Conclusion

Retail wayfinding frames first-visit supermarket shopping as more than destination-based indoor navigation. The shopping cycle itself is not unique to blind and low-vision shoppers. What is specific is the need to represent movement, in-store search, shelf-level confirmation, and re-orientation in forms that can be understood and confirmed without visual access. The framework developed here relates shoppers' needs to supermarket structure and to the limits of retailer-held 2D layout and product placement data. The planned mixed-methods study with 52 participants provides the empirical basis for refining this framework. Its main analytical task is to turn the recorded dialogue, route descriptions, event traces, and post-task reconstruction into a coding matrix for task stages, spatial scale, assistance, and confirmation. This matrix makes the data comparable across what participants request in situ, what they remember after the task, what can be represented from stable retailer-held data, and what depends on dynamic sensing or human knowledge. By focusing on this transition from observed shopping behaviour to representation requirements, the paper supports later work on verbal guidance, spatial data modelling, and non-visual supermarket navigation support.

References

1 Abdulaziz Alrashidi, Peter Cudd, Charith Abhayaratne, and Yoshihiko Gotoh. Exploration of verbal descriptions and dynamic indoors environments for people with sight loss. In *Extended Abstracts of the 2023 CHI Conference on Human Factors in Computing Systems*, pages 110:1–110:6. ACM, 2023. doi:10.1145/3544549.3585883.

2 Jan Balata. *Verbal Route Descriptions in Navigation of People with Visual Impairments*. PhD thesis, Czech Technical University, August 2018.

3 Roger Boldu, Denys J. C. Matthies, Haimo Zhang, and Suranga Nanayakkara. AiSee: An assistive wearable device to support visually impaired grocery shoppers. *Proc. ACM Interact. Mob. Wearable Ubiquitous Technol.*, 4(4):119:1–119:25, 2020. doi:10.1145/3432196.

4 Nicholas A. Giudice and Richard G. Long. Establishing and maintaining orientation: Tools, techniques, and technologies. In Robert S. Wall Emerson, Bruce B. Blasch, and William R. Wiener, editors, *Foundations of Orientation and Mobility: Vol. I, History and Theory*, pages 18–54. APH Press, 4 edition, 2024. URL: https://www.researchgate.net/publication/385852439_Establishing_and_Maintaining_Orientation_Tools_Techniques_and_Technologies.

5 Nicholas A Giudice, William E Whalen, Timothy H Riehle, Shane M Anderson, and Stacy A Doore. Evaluation of an accessible, real-time, and infrastructure-free indoor navigation system by users who are blind in the Mall of America. *Journal of Visual Impairment & Blindness*, 113(2):140–155, 2019. doi:10.1177/0145482X19840918.

6 Vaishnav Kameswaran, Alexander J. Fiannaca, Melanie Kneisel, Amy Karlson, Edward Cutrell, and Meredith Ringel Morris. Understanding in-situ use of commonly available navigation technologies by people with visual impairments. In *Proceedings of the 22nd International ACM SIGACCESS Conference on Computers and Accessibility*, pages 28:1–28:12. ACM, 2020. doi:10.1145/3373625.3416995.

7 Roberta L Klatzky, James R Marston, Nicholas A Giudice, Reginald G Golledge, and Jack M Loomis. Cognitive load of navigating without vision when guided by virtual sound versus spatial language. *Journal of Experimental Psychology: Applied*, 12(4):223–232, 2006. doi:10.1037/1076-898X.12.4.223.

8 Masaya Kubota, Masaki Kuribayashi, Seita Kayukawa, Hironobu Takagi, Chieko Asakawa, and Shigeo Morishima. Snap&Nav: Smartphone-based indoor navigation system for blind people via floor map analysis and intersection detection. *Proc. ACM Hum. Comput. Interact.*, 8(MHCI):1–22, 2024. doi:10.1145/3676522.

9 Bineeth Kuriakose, Ida Marie Ness, Maja Åskov Tengstedt, Jannicke Merete Svendsen, Terese Bjørseth, Bijay Lal Pradhan, and Raju Shrestha. *Turn Left Turn Right* - delving type and modality of instructions in navigation assistant systems for people with visual impairments. *Int. J. Hum. Comput. Stud.*, 179:103098, 2023. doi:10.1016/j.ijhcs.2023.103098.

10 Masaki Kuribayashi, Tatsuya Ishihara, Daisuke Sato, Jayakorn Vongkulbhisal, Karnik Ram, Seita Kayukawa, Hironobu Takagi, Shigeo Morishima, and Chieko Asakawa. PathFinder: Designing a map-less navigation system for blind people in unfamiliar buildings. In *Proceedings of the 2023 CHI Conference on Human Factors in Computing Systems*, pages 41:1–41:16. ACM, 2023. doi:10.1145/3544548.3580687.

11 Jihyun Lee, Jinsol Kim, and Hyunggu Jung. Challenges and design opportunities for easy, economical, and accessible offline shoppers with visual impairments. In *Proceedings of AsianCHI 2020*, pages 69–72. ACM, 2020. doi:10.1145/3391203.3391223.

12 Kyungyeon Lee, Sohyeon Park, and Uran Oh. Designing product descriptions for supporting independent grocery shopping of people with visual impairments. In *Extended Abstracts of the 2021 CHI Conference on Human Factors in Computing Systems*, pages 425:1–425:6. ACM, 2021. doi:10.1145/3411763.3451806.

13 Sooyeon Lee, Madison Reddie, Chun-Hua Tsai, Jordan Beck, Mary Beth Rosson, and John M. Carroll. The emerging professional practice of remote sighted assistance for people with visual impairments. In *Proceedings of the 2020 CHI Conference on Human Factors in Computing Systems*, pages 1–12. ACM, 2020. doi:10.1145/3313831.3376591.

14 Chengpu Liao, Xingpan Jin, and EunJeong Cheon. EasyGO: A field study of grocery store navigation application design for the visually impaired. In *Companion Publication of the 2024 ACM Designing Interactive Systems Conference*. ACM, 2024. doi:10.1145/3656156.3663719.

15 Jack M Loomis, Roberta L Klatzky, Reginald G Golledge, et al. Navigating without vision: basic and applied research. *Optometry and Vision Science*, 78(5):282–289, 2001. doi:10.1097/00006324-200105000-00011.

16 Daniel R Montello. A new framework for understanding the acquisition of spatial knowledge in large-scale environments. *Spatial and temporal reasoning in geographic information systems*, pages 143–154, 1998. doi:10.1093/oso/9780195103427.003.0011.

17 Soobeen Park and Shaoqing Zhang. A pilot study of circulation layout based on perceived retail crowding. *Journal of Retailing and Consumer Services*, 49:305–315, 2019. doi:10.1016/j.jretconser.2019.04.008.

18 Romedi Passini and Guyltne Proulx. Wayfinding without vision: An experiment with congenitally totally blind people. *Environment and Behavior*, 20(2):227–252, 1988. doi:10.1177/0013916588202006.

19 Sebastian Rottmann, Claudia Loitsch, and Gerhard Weber. Accessible mobile map application and interaction for people with visual or mobility impairments. In *Proceedings of Mensch und Computer 2022*, pages 119–127. ACM, 2022. doi:10.1145/3543758.3543780.

20 Manaswi Saha, Alexander J. Fiannaca, Melanie Kneisel, Edward Cutrell, and Meredith Ringel Morris. Closing the gap: Designing for the last-few-meters wayfinding problem for people with visual impairments. In *Proceedings of the 21st International ACM SIGACCESS Conference on Computers and Accessibility*, pages 222–235. ACM, 2019. doi:10.1145/3308561.3353776.

21 Daisuke Sato, Uran Oh, João Guerreiro, Dragan Ahmetovic, Kakuya Naito, Hironobu Takagi, Kris M. Kitani, and Chieko Asakawa. NavCog3 in the wild: Large-scale blind indoor navigation assistant with semantic features. *ACM Trans. Access. Comput.*, 12(3):14:1–14:30, 2019. doi:10.1145/3340319.

22 Victor R Schinazi, Tyler Thrash, and Daniel-Robert Chebat. Spatial navigation by congenitally blind individuals. *Wiley Interdisciplinary Reviews: Cognitive Science*, 7(1):37–58, 2016. doi:10.1002/wcs.1375.

23 Catherine Thinus-Blanc and Florence Gaunet. Representation of space in blind persons: vision as a spatial sense? *Psychological bulletin*, 121(1):20, 1997. doi:10.1037/0033-2909.121.1.20.