



Mapping information uncertainty in hospital wayfinding through patient journey maps

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DOI: <https://doi.org/10.47989/ir31ISIC65290>

Abstract

Introduction. This study proposes a replicable framework to detect, code, and visualise information uncertainty during hospital wayfinding across digital and physical touchpoints, treating wayfinding as a distributed information behaviour.

Method. A seven-stage patient journey model (pre-arrival to exit) structures data collection. The unit of analysis is a stage-bounded interaction with a touchpoint.

Analysis. Events are coded with a codebook. Coded units are aggregated into a Stage–Touchpoint–Uncertainty matrix and transformed into heatmaps and patient journeys that display uncertainty peaks.

Results. The framework operationalises uncertainty with observable, time-stamped indicators and supports triangulation.

Conclusion. Journey-based, behaviour-proximal coding makes information uncertainty measurable and comparable across sites. The approach enables evidence-based prioritisation of wayfinding interventions while accommodating variability in hospital contexts and patient needs.

Introduction

Wayfinding is a key part of the patient experience. It is twofold in nature, representing both a design element and a medical problem. Well-designed wayfinding systems in hospitals offer numerous benefits, including reduced stress and anxiety for patients and visitors (Morag et al., 2016; Petermans & Mattiello, 2022). Effective wayfinding can save costs by decreasing missed appointments, minimising staff time spent giving directions, improving overall efficiency (Morag et al., 2016; Potter, 2017), and reducing complaints (Kaya et al., 2016). Implementing clear signage with symbols and pictograms can enhance patient outcomes and staff satisfaction (Potter, 2017). Digital wayfinding systems can further improve user experience by providing interactive guidance and reducing task complexity (Harper et al., 2018; Morag & Pintelon, 2020). A holistic approach to wayfinding design, incorporating multiple communication channels, and considering the broader healthcare journey can empower health seekers and improve their overall experience (Short et al., 2017; Giraldi et al., 2018). Ultimately, well-designed wayfinding systems contribute to a more comfortable and user-friendly hospital environment (Mackenzie & Krusberg, 1996). Studies point out that part of supporting wayfinding also involves paying attention to digital tools such as information on hospital websites, digital navigation systems, and other specialised applications (Geng et al., 2024; Lo et al., 2017; Short et al., 2019; Morag & Pintelon, 2020). Similar to information seeking, healthcare wayfinding involves patients' adoption of adaptive behavioural strategies including the use of environmental cues and the development of coping mechanisms that accord with information-seeking frameworks.

Information uncertainty in wayfinding

Previous studies conceptualised wayfinding as spatial problem-solving, involving information processing, decision-making, and plan execution (Passini, 1981). Uncertainty in wayfinding can arise from multiple factors, such as environmental complexity, the legibility and effectiveness of navigational aids, and individual differences in spatial cognition. Information uncertainty may result from the information gap that patients experience in a hospital setting (Gualandi et al., 2019). Uncertainty significantly influences wayfinding by impacting both cognitive processes and navigational behaviours (Chien et al., 2016; Yang & Kalantari, 2022). A thorough understanding of information uncertainty sources and how they influence both cognitive and behavioural navigation aspects is essential for designing effective wayfinding systems and built environments.

Patient journeys as a method for mapping patients' experience

Patient journey mapping is an emerging method for understanding and improving patient experiences in healthcare systems (Bulto et al., 2024). It provides valuable insights into wayfinding challenges in complex hospital environments (Short et al., 2019). This approach can inform clinic placement, signage design, and resource allocation to enhance patient experience and operational efficiency (Cheng & White, 2018) and optimise signage placement (Guo & He, 2022). Studies have shown that when experiencing wayfinding tasks, patients benefit from simple building structures, nature projections during diagnostics, and varied social spaces during treatments (Zijlstra et al., 2020).

The aim of the article is to provide a replicable method framework to detect, code, and visualise information uncertainty during hospital wayfinding across digital and physical touchpoints, using patient journey mapping as the integrating frame.

Various patient journey mapping projects use qualitative, quantitative, and mixed methods. Some rely on traditional data collection like interviews, focus groups, and observations, while others use specialised journey mapping tools (Bulto et al., 2024). Patient journey mapping often involves visual, narrative, and descriptive maps or tables (Davies et al., 2021). However, the traditional methods, such as surveys and static observations, may not be sufficient to fully understand the patient experience (Gualandi et al., 2019). On the contrary, behavioural methods, such as mobile eye-

tracking, has proven effective in evaluating and improving wayfinding systems. The methodological framework is designed for wayfinding research that combines various research techniques within mixed research, allowing for the selection of appropriate indicators and metrics for analysing patient journeys.

Patient journeys provide a structured analytic lens for examining wayfinding as a temporally and cross-channel distributed information behaviour process rather than as an isolated interaction at a single point in space. Within complex hospital environments, breakdowns rarely stem from one touchpoint (e.g., a lobby directory) in isolation; instead, they accumulate through sequences of actions, decisions, and information cues across digital and physical contexts (Short et al., 2019; Gualandi et al., 2019, Kynoch et al., 2019). To keep analysis explicit and reproducible, the researcher operationalised a seven-stage journey model that spans digital and physical contexts:

1. **Pre-arrival (digital orientation):** hospital website, department page, route planning tools.
2. **Arrival (site entry):** transport drop-off/parking, approach paths, entrances.
3. **Entry and initial orientation:** vestibule/lobby, reception/volunteer desk, first decision node.
4. **En-route navigation:** corridors, junctions, vertical circulation (stairs/elevators), confirmation cues.
5. **Destination interface:** department front-of-house (doors, counters, check-in).
6. **In-visit circulation:** sub-routes to diagnostics, temporary wayfinding during tests.
7. **Exit & post-visit:** return path, payment/administration, discharge paperwork, follow-up info.

This seven-stage model serves as an analytical scaffold rather than a prescriptive sequence. In practice, patient journeys exhibit considerable variability: stages may be truncated, reordered, or omitted entirely (Rosenbaum et al., 2023) depending on visit type, patient familiarity, and care pathway. For instance, emergency department patients typically bypass the pre-arrival digital orientation stage altogether, while patients attending follow-up appointments may skip initial orientation if they have developed cognitive maps from prior visits (Hölscher et al., 2006). Conversely, patients undergoing complex diagnostic sequences often experience recursive loops through the in-visit circulation stage, returning multiple times to waiting areas between tests (Gualandi et al., 2019).

The model accommodates this variability by treating stages as analytical categories that structure data collection and comparison rather than as mandatory sequential steps. This approach aligns with journey mapping methodologies in service design where idealised models function as heuristic frameworks against which actual user experiences can be mapped and deviations identified as potential intervention points (Stickdorn et al., 2018). Documenting which stages are emphasised, abbreviated, or absent in specific patient cohorts can itself yield actionable insights—for example, revealing that repeat visitors encounter wayfinding difficulties primarily at the en-route navigation stage rather than at initial orientation, suggesting different design priorities for signage placement.

For each stage, the analysis enumerates possible touchpoint classes: digital (e.g. web pages, map widgets, PDF maps, contact info, accessibility notes), physical (exterior totems, building identifiers, colour/number zoning, directories, directional signs, confirmation signs, landmarks, floor graphics, elevator call panels, door labels), and social and organisational touchpoints (reception desks, ad-hoc staff guidance).

Proposal for a research framework for investigating information uncertainty in hospital wayfinding

The proposed framework integrates three complementary theoretical perspectives. First, it draws on Passini's (1981) conceptualisation of wayfinding as spatial problem-solving, which frames navigation as an iterative cycle of information uptake, decision-making, and plan execution. This perspective foregrounds the cognitive demands of wayfinding and provides the basis for the task state coding (orient → decide → move → confirm).

Second, the framework incorporates Dervin's sense-making methodology (Dervin & Foreman-Wernet, 2003), particularly the concept of 'micro-moments' in which individuals encounter gaps between their current situation and desired outcome. In wayfinding contexts, these gaps manifest as *information uncertainty moments* when available cues prove insufficient for confident navigation. The uncertainty markers in the codebook (hesitation, backtracking, help seeking) operationalise these gap-bridging behaviours as observable indicators.

Third, the framework adopts a distributed cognition perspective (Hutchins, 1995), treating wayfinding as an activity distributed across persons, artefacts, and environments. This lens aligns with journey mapping methodologies, which similarly trace how experience flows across channels and moments rather than analysing isolated touchpoints (Kalbach, 2016). The Stage-Touchpoint-Uncertainty matrix operationalises this perspective by making visible the temporal and cross-channel distribution of breakdowns.

Together, these perspectives position information uncertainty as a systemic property emerging from the interaction between navigating individuals and their information environment—consistent with ecological approaches to human-information interaction (Fidel, 2012).

The unit of analysis is defined as a stage-bounded interaction with a wayfinding touchpoint, that is, an observable episode in which a participant engages with a digital, physical, or social cue during a specific patient-journey stage (e.g., *Entry & Initial Orientation*: 'reads lobby directory for 18 s and selects elevator A'). Conceptualising wayfinding as a procedural problem-solving activity (information uptake → decision → action → feedback) aligns with established models of navigational cognition (Passini, 1981) and supports process-oriented analysis of breakdowns across stages (Short et al., 2019; Morag & Pintelon, 2020).

Each unit can be coded along five indicator families to enable triangulation across data sources (video, mobile eye-tracking, think-aloud/interviews, artefact review):

1. **Task state** (*orient → decide → move → confirm*).
Inspired by Dervin's micro/moments (Dervin & Foreman-Wernet, 2003), this sequence operationalises the micro-process of wayfinding and anchors events to journey stages, allowing temporal localisation of error and recovery (Passini, 1981; Short et al., 2019).
2. **Uncertainty markers** (e.g., hesitation, backtracking, verbalised doubt, repeated scanning, asking for help). These behavioural signatures are theoretically tied to information uncertainty and degraded navigational performance and are directly observable and time-stampable in ET/video streams (Chien et al., 2016; Yang & Kalantari, 2022).
3. **Touchpoints qualities** (*visibility, legibility, consistency, redundancy, semantic clarity*).
These properties translate environmental communication principles into codable variables affecting discoverability and decoding of signage and digital content (Potter, 2017; Guo & He, 2022; Morag & Pintelon, 2020).

4. **Accessibility factors** (*screen-reader compatibility, tactile availability, language/symbol comprehensibility*). Because journeys bridge digital and physical channels, upstream accessibility barriers propagate to on-site breakdowns; coding these factors surfaces equity-relevant issues for users with specific needs (Lo et al., 2017; Jeamwathanachai et al., 2019; Short et al., 2019; Geng et al., 2024).
5. **Context modifiers** (*noise/crowding, lighting, competing signage, temporary signs*). Contextual conditions systematically modulate cue effectiveness and search cost; coding them reduces attribution error when failures are driven by the environment rather than by the cue itself (Mackenzie & Krusberg, 1996; Kaya et al., 2016; Harper et al., 2018; Morag & Pintelon, 2020).

Family	Definition	Include when... (examples)	Examples of measures
Task state	Participant scans environment to form an initial mental model	First entry to lobby; first view of department page	ET shows wide/regressive saccades; think-aloud: 'Where is radiology?'
Task state	Participant commits to a route/choice	Points to elevator A; clicks 'Parking' link	Hand/foot turn; click; verbal 'Let's go left'
Task state	Physical relocation toward goal	Walks corridor toward sign	Footfall movement; ET focused ahead
Task state	Checks that choice was correct	Checks room number	ET dwell on confirmation signage; verbal 'This is it'.
Uncertainty	Pause with continued scanning	Stops at junction scanning multiple cues	Timer on video ≥ 2 s; ET oscillates across cues
Uncertainty	Retraces or returns to prior node	Returns to last junction	Path trace; verbal 'Wrong way'.
Uncertainty	Repeated sequential scans of ≥ 2 cues	Alternates between map and signs	ET shows alternates
Uncertainty	Initiates help-seeking, describes doubts	Asks for directions	Audio captures request
Touchpoint quality	View of cue unobstructed at task distance	Directory readable at 5 m	Photo shows obstructed line of sight
Touchpoint quality	Text/icon meets size/contrast norms	Pictogram $\geq$ recommended size	Measured size vs. viewing distance
Touchpoint quality	Style/terminology matches prior cues	'Radiology' vs. 'Imaging'	Terminology table check
Context	Illumination impairs visibility	Backlit glare on directory	Lux reading/observer note
Context	Temporary or competing signage	Construction detour	Photo of temporary A-frame
Accessibility	Screen-reader compatibility verified	Proper labels on page	Screen-reader output log
Accessibility	Meets contrast ratios	Text/background clarity	Measurement/screenshot
Accessibility	Pictogram/text comprehensibility	Cross-language clarity	Focus-group confusion noted

Table 1. Codebook and units of analysis.

Steps of analysis

For each participant and route, coded units are organised into a Stage-Touchpoint-Uncertainty matrix that overlays task states with evidence summaries (e.g., time-to-first-fixation on target cue,

doubts expressions, reaching wrong destination). Aggregation proceeds by stage to identify uncertainty “peaks” and recurrent breakdown patterns, supporting requirement derivation and cross-site comparison (Guo & He, 2022).

ID	Stage	Touchpoints	State	Markers	Quality	Context modifiers	Access	Evidence
P01	2	Directory (interior → lobby)	Orient → Decide	Hesitate; Re_scan	Legibility↓; Semantics ↓	Lightning↑	—	ET dwell 6s; ‘Where’s X?’
P01	3	Directional sign (interior → corridor)	Move → Confirm	—	Visibility↓	Temp Sign detour	—	Video shows blurred sign

Table 2. Stage-Touchpoint-Uncertainty matrix.

Visualisation

As a first step of visualisation, the Table 3 (filled with test data) functions as a compact specification for wayfinding issues across the patient journey: each cell encodes the frequency of uncertainty events for a qualities of touchpoints (e.g., visibility, legibility, consistency, accessibility) within a journey phase, enabling construction of a heatmap in which colour intensity reflects either counts or exposure-normalised rates (per participant or per touchpoint). Context modifiers (notes) should be coded to discrete tags and overlaid as annotations to qualify hotspots (e.g., ‘temporary signage present’, ‘helpful staff’), thereby separating situational from systemic problems. Interpreted together, the heatmap, composition, and contextual overlays provide an evidence-based visual narrative that prioritises design interventions without overextending inference.

Touchpoint qualities	Pre-arrival	Arrival	Entry	En-route	Destination	In-visit	Exit
VISIBILITY issues	1	0	3	2	0	1	0
LEGIBILITY issues	0	0	4	1	0	0	0
CONSISTENCY issues	1	0	3	2	1	2	0
ACCESSIBILITY gaps	2	0	2	1	0	1	0
Counts	4	0	12	6	1	4	0
CONTEXT modifiers	(notes)	(notes)	(notes)	(notes)	(notes)	(notes)	(notes)

Table 3. Example of quantitative analysis and visualisation of wayfinding issues.

A pilot application of the framework was conducted at [anonymised hospital] with 12 participants navigating to specific departments. Preliminary findings indicated that uncertainty markers clustered at the Entry and En-route stages, with semantic inconsistency and missing signage emerging as primary quality issues. Full results will be reported separately.

Experience mapping in practice

Experience cannot be evaluated solely on the basis of objective indicators. Referring to Dervin's theory of sense-making, the experience of any information behavior is also created individually as a combination of achieving goals, overcoming information barriers, and making sense of reality (Dervin & Foreman-Wernet, 2003). In practice, customer experience and user experience maps are used today in the areas of user experience and customer experience, which are often based primarily on users' evaluations of a journey through a selected information service (Lallemant et al., 2022; Pumpurs, 2022; Shang & Shao, 2023). Using the research framework presented here could help to better describe the objective difficulties and challenges involved in wayfinding. And vice versa—when describing and evaluating wayfinding, it is necessary to carefully interpret all context modifiers and the individual experience of the patient. Figure 1 shows a form of a patient journey

map that will convey findings from wayfinding research in a specific hospital environment to interested stakeholders.

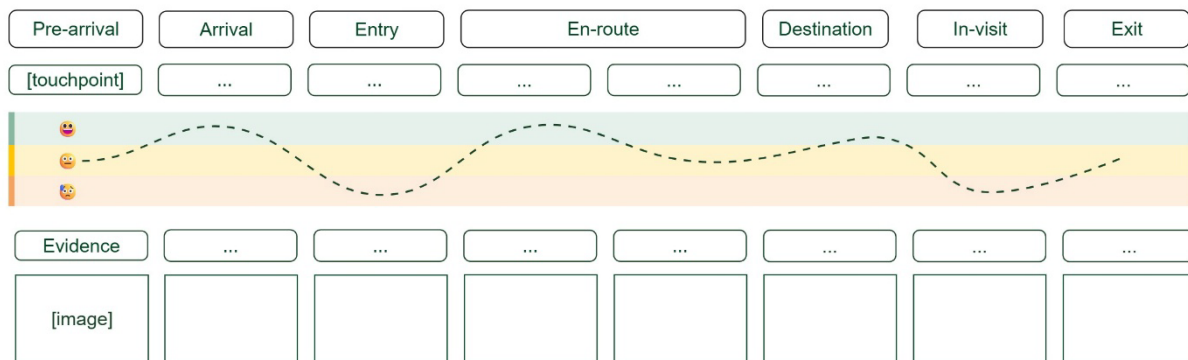


Figure 1. Patient Journey Map.

Discussion

The mapping method provides a structured, behaviour-proximal way to locate and characterise wayfinding uncertainty across the patient journey. Its main strengths are triangulation, temporal localisation of uncertainty issues, and an explicit codebook. One of the major challenges in implementing the method in practice will likely be the variability of contexts in different hospital environments and patient types, and in particular balancing behavioural and attitudinal indicators when evaluating the quality of individual touchpoints and the whole patient journey.

About the author

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