

NEEDS ASSESSMENT FOR INDOOR NAVIGATION: QUANTITATIVE INSIGHTS FROM STAKEHOLDERS IN A TERTIARY CARE FACILITY

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in

Hospital and Health Management

by

Tanmay Sharma

Under the Supervision and Guidance of

Dr. Vidya Bhushan Tripathi

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BOOTWAY INAAS PRIVATE LIMITED

JAGATPURA, JAIPUR (302017)

BootWay

CIN - U63999RJ2024PTC097270

CERTIFICATE

This is to certify that **Mr. Tanmay Sharma**, has successfully completed his internship at **BootWay iNaaS Pvt. Ltd.** The internship was undertaken during the period from **10th March to 7th June 2025**. During this time, Mr. Sharma demonstrated a sincere commitment to his responsibilities and contributed meaningfully to the organization's ongoing projects.

We acknowledge his efforts in market research and wish him success in all his future professional endeavors.

Bharat
Bharat Mangal
Director
15/06/2025



www.bootway.in



support@bootway.in



+91-7976866822

CERTIFICATE FROM FACULTY GUIDE AND SCHOOL DEAN

This is to certify that dissertation titled '**Needs Assessment for Indoor Navigation: Quantitative Insights from Stakeholders in a Tertiary Care Facility,**' is the record of the research work undertaken by **Tanmay Sharma** in partial fulfillment of the requirements for the award of the degree of M.B.A. (**Hospital and Health Management**) from the IIHMR University, Jaipur, my guidance and supervision and his approach to the research study has been sincere, scientific and analytical.


Vidya Bhushan Tripathi

Assistant Professor

IIHMR University, Jaipur

Date: 16-06-2025


Dr. Sanjay Gupta

Dean and Professor

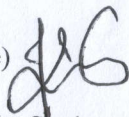
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DECLARATION BY THE STUDENT

I hereby declare that this dissertation, titled '**Needs Assessment for Indoor Navigation: Quantitative Insights from Stakeholders in a Tertiary Care Facility,**' is the bona fide record of my original research work. I declare that it has not been submitted to any other university or institution for the award of any or diploma. Information derived from the published or unpublished work of others has been duly acknowledged in the text.

(Signature)



Name of the Student: Tanmay Sharma

Date: 16 June 2025

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ABSTRACT

Navigating large multispecialty hospitals can be a stressful and time-consuming experience for patients, attendants, and even hospital staff. Confusing layouts, lack of clear signage, and limited support often lead to delays, dissatisfaction, and inefficiencies. With increasing digitization in healthcare, indoor navigation technologies offer a promising solution to these challenges. BootWay's Indoor Navigation-as-a-Service (iNaaS) aims to address this gap by providing a smart, user-friendly wayfinding tool. However, the success of such a system depends on how well it aligns with the actual needs and expectations of its end users.

This study presents a structured, quantitative assessment of stakeholder perceptions related to hospital navigation and the potential adoption of BootWay iNaaS. A cross-sectional survey was conducted among 100 respondents, including patients, attendants, and hospital staff in a tertiary care facility. Data were collected using a structured questionnaire and analyzed using descriptive statistics to identify common navigation challenges, perceived usefulness of indoor navigation systems, and readiness for digital adoption.

The findings highlight significant wayfinding difficulties across all user groups, along with a strong interest in digital navigation tools. Preferences for key features such as real-time directions, department locators, and multilingual support were identified. The study concludes that a user-centered, evidence-based approach is critical for successful adoption of indoor navigation systems in Indian hospitals. Recommendations are provided for system design, stakeholder engagement, and phased implementation to maximize utility and acceptance. This research offers actionable insights for hospital administrators and technology providers seeking to enhance patient experience and operational efficiency through digital innovation.

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ABBREVIATIONS

iNaaS	Indoor Navigation-as-a-Service
OPD	Outpatient Department
ICU	Intensive Care Unit
OT	Operation Theatre
MRI	Magnetic Resonance Imaging
QR	Quick Response (Code)
IPS	Indoor Positioning System
NABH	National Accreditation Board for Hospitals and Healthcare Providers
NHM	National Health Mission
ABDM	Ayushman Bharat Digital Mission
UI/UX	User Interface / User Experience
SEM	Structural Equation Modeling
SPSS	Statistical Package for the Social Sciences

CHAPTER 1

INTRODUCTION

1.1. Background

Modern multispecialty hospitals have evolved into complex ecosystems that accommodate a wide range of departments, diagnostic centers, outpatient services, critical care units, and administrative functions. While these institutions are designed to offer comprehensive medical care under one roof, their physical complexity often presents significant navigational challenges. Patients, attendants, and even staff members frequently struggle to locate various service areas, leading to frustration, missed appointments, and inefficiencies in care delivery. For first-time visitors, especially the elderly or those unfamiliar with the hospital layout, navigating such large premises can be overwhelming.

The demand for seamless patient experiences and operational efficiency has intensified with the growing emphasis on patient-centered care. In this context, the ability to easily find one's way within hospital premises is not merely a logistical concern but a key component of overall service quality.

1.2 The Role of Digital Solutions in Hospital Navigation

Digital indoor navigation systems, such as BootWay's Indoor Navigation-as-a-Service (iNaaS), represent a promising innovation aimed at simplifying hospital wayfinding. These solutions leverage mobile technology, real-time location services, and digital mapping to guide users efficiently through complex spaces. iNaaS, in particular, offers a scalable and customizable platform that can be adapted to different hospital layouts and user needs. When effectively implemented, such systems can reduce staff burden, improve time management, and significantly enhance patient satisfaction.

Despite the technological feasibility of indoor navigation systems, their success largely depends on understanding the real-world challenges and expectations of end users. Adoption rates are often hindered by poor alignment between technology design and user needs, making it essential to conduct needs assessments before implementation.

1.3 Problem Statement

While healthcare systems are rapidly embracing digitization, indoor navigation remains an underexplored domain, particularly in Indian tertiary care settings. Hospital visitors routinely face confusion when trying to locate departments, consultation rooms, or service counters. These challenges not only compromise the patient experience but also interrupt staff workflows, as employees are often required to assist with directions. Introducing an indoor navigation system without first understanding the requirements of key stakeholders risks poor adoption and underutilization. Therefore, there is a pressing need to assess the navigation challenges, expectations, and feature preferences of hospital users to inform the development and deployment of BootWay iNaaS.

1.4 Objectives of the Study

- To identify common wayfinding challenges encountered by patients, attendants, and staff in a tertiary care hospital.
- To assess stakeholder perceptions of the usefulness and usability of a digital indoor navigation system.
- To evaluate preferred features and functionalities of BootWay iNaaS from a user perspective.
- To measure stakeholder readiness and openness toward adopting a digital navigation tool.

1.5 Research Questions

1. What are the common navigation difficulties reported by patients, attendants, and staff?
2. How do users perceive the usefulness of a hospital-based digital indoor navigation system?
3. What specific features are most valued by potential users of BootWay iNaaS?
4. What is the level of user readiness for adopting such a system in a tertiary care hospital?

1.6 Significance of the Study

This study contributes to the growing body of knowledge on smart hospital infrastructure by providing quantitative insights into the navigation needs of key hospital stakeholders. The findings will inform developers like BootWay on how to design a system that aligns with user expectations, ensuring higher adoption and satisfaction rates. For hospital administrators, the research offers data-driven guidance on integrating indoor navigation tools into existing workflows to enhance patient engagement and operational efficiency. Moreover, this study addresses a notable gap in the Indian healthcare context, where structured assessments of digital wayfinding solutions are limited.

1.7 Scope and Limitations

This study is limited to a quantitative research framework and is based exclusively on structured data collected through a close-ended questionnaire. The scope includes stakeholders—patients, attendants, and hospital staff—across multiple tertiary care hospitals, enhancing the generalizability of the findings within similar institutional settings.

However, the study does not incorporate qualitative data such as in-depth interviews or open-ended responses, which could have provided richer insights into user behavior and preferences. The reliance on structured responses may also limit the exploration of nuanced opinions or unexpected barriers. Despite these limitations, the study offers valuable, data-driven insights into the expectations and readiness of hospital stakeholders for adopting an indoor navigation system like BootWay iNaaS.

CHAPTER 2
REVIEW OF LITERATURE

S.NO.	Author s (Year)	Study Location	Sample Size	Sampling Technique	Salient Features/Key Findings
1.	Kalyan et al. (2024)	Govt. Gen. Hospital, Kakinada (India)	970 outpatient s	Cross- sectional survey (questionn aire)	Patients reported moderate satisfaction with existing multilingual signage. More-educated, younger, and repeat visitors were significantly more satisfied. Signage's visibility and readability were highlighted as crucial, and inclusion of local language signs was viewed positively (though some clarity issues remain)
2.	Sahoo et al. (2024)	960-bed tertiary care hospital, Odisha (India)	507 (patients/ attendant s/ visitors)	Quality improvement project survey (questionn aire)	After installing color- coded trilingual signs, 98% of respondents eventually reached their destination (most found ICU, OT, and labs hardest to locate) but almost all (98%) needed to double-check with staff. Nearly 84% of participants expressed a

					need for digital wayfinding aids (e.g. interactive signs or apps)
3.	Wichmann & Leyer (2021)	Major German hospitals (multisite survey)	323 visitors, 304 employees	Cross-sectional survey (convenience sample; SEM analysis)	Using the reasoned action model, attitude toward technology and subjective norms strongly predicted IPS adoption. For patients/visitors, attitude ($\beta=0.536$) and norms ($\beta=0.236$) significantly predicted intention to use a navigation app. For employees, attitude ($\beta=0.283$), norms ($\beta=0.301$), and perceived behavioral control ($\beta=0.178$) were significant predictors
4.	Ženka et al. (2021a)	Vítkovice Hospital, Ostrava (Czechia)	928 patients/visitors	Cross-sectional survey (questionnaire)	Technology acceptance of a hospital smartphone navigation app increased with education level and decreased with age; no significant difference was found by gender. In other words, better-

					educated and younger patients/visitors were more willing to use a digital navigation app
5.	Ženka et al. (2021b)	Vítkovice Hospital, Ostrava (Czechia)	928 patients/visitors	Cross-sectional survey (questionnaire)	Older adults (60+) showed less interest in new wayfinding solutions and were less willing to use mobile apps, whereas the 41–60 age group were the strongest proponents of change. Demand for improved navigation (including a mobile app) was positively correlated with education
6.	Anagnostopoulos et al. (2017)	Geneva University Hospitals (Switzerland)	111 staff (primary care)	Questionnaire based survey	Nearly all staff (97.3%) reported that finding destinations in the hospital caused stress. The majority of respondents suggested improving existing signage (81/111) and landmarks, and many favored adding digital aids: about half supported creating a mobile navigation app (54/111). These findings

					underscored pervasive wayfinding problems and interest in tech solutions.
7.	Zhang et al. (2024)	Three tertiary hospitals in Guangzhou (China)	762 elderly patients	Questionnaire survey	Most elderly patients got lost in the hospital and typically asked others for directions before relying on signs. Overall they had positive attitudes toward existing signage, but stressed that clear graphics, text, and colors are essential. Older and female participants understood signage worse than younger/male patients; more-educated seniors understood signs better but were more critical of their adequacy

CHAPTER 3

RESEARCH METHODOLOGY

3.1 Introduction

This chapter outlines the methodological framework used to conduct the study on assessing stakeholder needs for a hospital-based indoor navigation system—BootWay iNaaS. It presents the research design, study setting, population characteristics, sampling methods, data collection tools, and analysis techniques. The approach is fully quantitative and based on structured data collected from patients, attendants, and staff across multiple tertiary care hospitals.

3.2 Research Design

The study adopted a **descriptive cross-sectional design** to explore navigation challenges and preferences for indoor navigation systems among different hospital stakeholders. This design was appropriate for capturing a snapshot of perceptions and experiences at a single point in time, across various hospital environments.

3.3 Study Setting

The research was carried out across **multiple tertiary care hospitals** located in urban settings of India. These institutions typically experience high patient footfall, feature complex physical layouts, and currently offer limited structured indoor navigation support—making them ideal settings for evaluating the feasibility of deploying systems like BootWay iNaaS.

3.4 Study Population

The study focused on three primary stakeholder groups:

- **Patients:** Individuals visiting the outpatient department or admitted for care.
- **Attendants:** Family members or caregivers accompanying patients.
- **Hospital Staff:** Clinical (e.g., nurses, doctors) and non-clinical (e.g., reception, housekeeping, security) personnel.

3.5 Sample Size and Sampling Technique

The final sample included 100 respondents, divided across stakeholder categories as follows:

- Patients: 41
- Attendants: 30
- Hospital Staff: 29

Stratified random sampling was employed to ensure proportional representation of each group. This approach helped in drawing meaningful comparisons between categories and capturing diverse perspectives on indoor navigation issues and expectations.

3.6 Inclusion and Exclusion Criteria

Inclusion Criteria:

- Individuals aged 18 years and above.
- Patients, attendants, and hospital staff present at the hospital during the data collection period.
- Willingness to voluntarily participate in the study.

Exclusion Criteria:

- Critically ill patients or those unable to respond.
- Visitors below 18 years of age.
- Staff with less than 6 months of experience.
- Incomplete or duplicate responses.

3.7 Data Collection Tool

A structured questionnaire was developed based on a review of existing literature and validated by academic and clinical experts. The tool was designed to capture:

- Demographic details (age, gender, education, stakeholder type).
- Navigation experiences (difficulty finding locations, ease of navigation, frequently confusing areas).
- Assistance-seeking behavior (whether participants asked for directions and from whom).
- Technology use (smartphone ownership, comfort with digital maps, use of QR codes/kiosks).

- Attitudes toward BootWay iNaaS (perceived usefulness, likelihood of use, preferred features, and perceived barriers).
- User suggestions for improving hospital navigation.

The questionnaire was pilot-tested and refined for clarity. It was distributed via QR code posters and direct links, with assistance provided for non-digital respondents where necessary.

3.8 Data Analysis

Collected data were compiled and cleaned in **Microsoft Excel**. The analysis included:

- **Descriptive Statistics:**
 - Frequencies and percentages for categorical variables (e.g., gender, stakeholder group, smartphone use)
- **Cross-tabulations:**
 - Used to explore relationships between variables (e.g., stakeholder type vs. likelihood of using digital navigation)
- **Graphical Representation:**
 - Bar graphs, pie charts, and histograms were used to visually present findings on digital readiness, perceived usefulness, and feature preferences.

3.9 Ethical Considerations

- **Informed Consent:** A consent statement was included at the beginning of the Google Form, and verbal consent was obtained from offline participants.
- **Voluntary Participation:** Participation is voluntary, with no penalties for non-participation.
- **Data Security and Confidentiality:** Ensuring that patient data is anonymized and protected throughout the research process.

3.10 Summary

This chapter detailed the quantitative methodology employed to assess stakeholder needs and expectations for a hospital-based indoor navigation solution. The use of both digital and direct data collection modes allowed broad participation across multiple user groups. The structured nature of the tool and systematic sampling ensured reliability and validity of the findings. The next chapter presents the analysis and interpretation of the collected data.

CHAPTER 4

RESULTS

This chapter presents the findings from the structured data collected from 100 respondents, comprising patients (N = 41), attendants (N = 30), and hospital staff (N = 29) across multiple tertiary care hospitals. The results have been analyzed using descriptive statistics and align with the study objectives: navigation experience, digital familiarity, perception of BootWay iNaaS, and perceived barriers.

Table 4.1 - Age Distribution of Hospital Stakeholders (N=100)

Age Range	Patients	Attendants	Staff	Total
20-29	11	4	9	24
30-39	10	9	16	35
40-49	7	9	4	20
50-59	7	6	0	13
60+	6	2	0	8

A cumulative 66% (N=55) of the respondents belong to the younger adult age groups (20-39 years), of which 31% (N=26) are in the 20-29 age group and 35% (N=29) are in the 30-39 age group. Approximately 24% (N=20) of the respondents fall in the 40-49 age group, while only 13% (N=11) are in the 50-59 age group, and another 13% (N=11) are in the 60+ age group.

Table 4.2 - Gender Distribution of Hospital Stakeholders (N=100)

Gender	Patients	Attendants	Staff	Total
Female	23	14	14	51
Male	18	16	15	49

A cumulative 51% (N=51) of respondents are female, with 45% (N=23) being patients, 27% (N=14) attendants, and 27% (N=14) staff. Males constitute 49% (N=49), with 37% (N=18) as patients, 33% (N=16) as attendants, and 31% (N=15) as staff.

Table 4.3 - Level of Education Distribution (N=100)

Education Level	Frequency	Percent (%)
Below 10th	15	15
10th-12th	19	19
Graduate	47	47
Postgraduate	19	19

A total of 66% (N=66) of respondents have higher education, with 47% (N=47) holding a Graduate degree and 19% (N=19) a Postgraduate degree. Meanwhile, 19% (N=19) have a 10th-12th education, and 15% (N=15) have Below 10th education, showing most hospital stakeholders are well-educated.

Table 4.4 - Distribution of Stakeholders in Difficulty Finding (N=100)

Stakeholder Category	Yes (Frequency)	Yes (%)	No (Frequency)	No (%)	Total
Patient	38	92.7	3	7.3	41
Attendant	22	73.3	8	26.7	30
Staff	0	0	29	100	29

Among stakeholders, 92.7% (N=38) of Patients and 73.3% (N=22) of Attendants reported difficulty finding their way, while 0% (N=0) of Staff faced this issue, highlighting significant navigation challenges for Patients and Attendants.

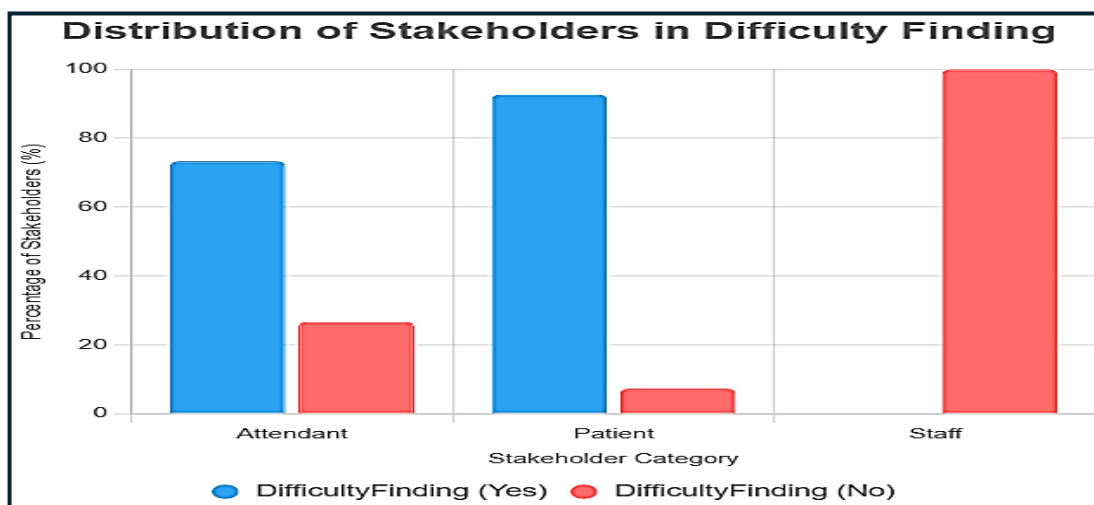
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Table 4.5 - Overall Ease of Navigation Distribution (N=100)

Ease of Navigation	Frequency	Percent (%)
Very Easy	9	9
Easy	25	25
Neutral	21	21
Difficult	33	33
Very Difficult	12	12

A total of 45% (N=45) of respondents found navigation challenging, with 33% (N=33) rating it Difficult and 12% (N=12) Very Difficult. Meanwhile, 34% (N=34) found it easy, with 25% (N=25) rating it Easy and 9% (N=9) Very Easy, while 21% (N=21) were neutral, indicating a significant navigation challenge for many stakeholders.

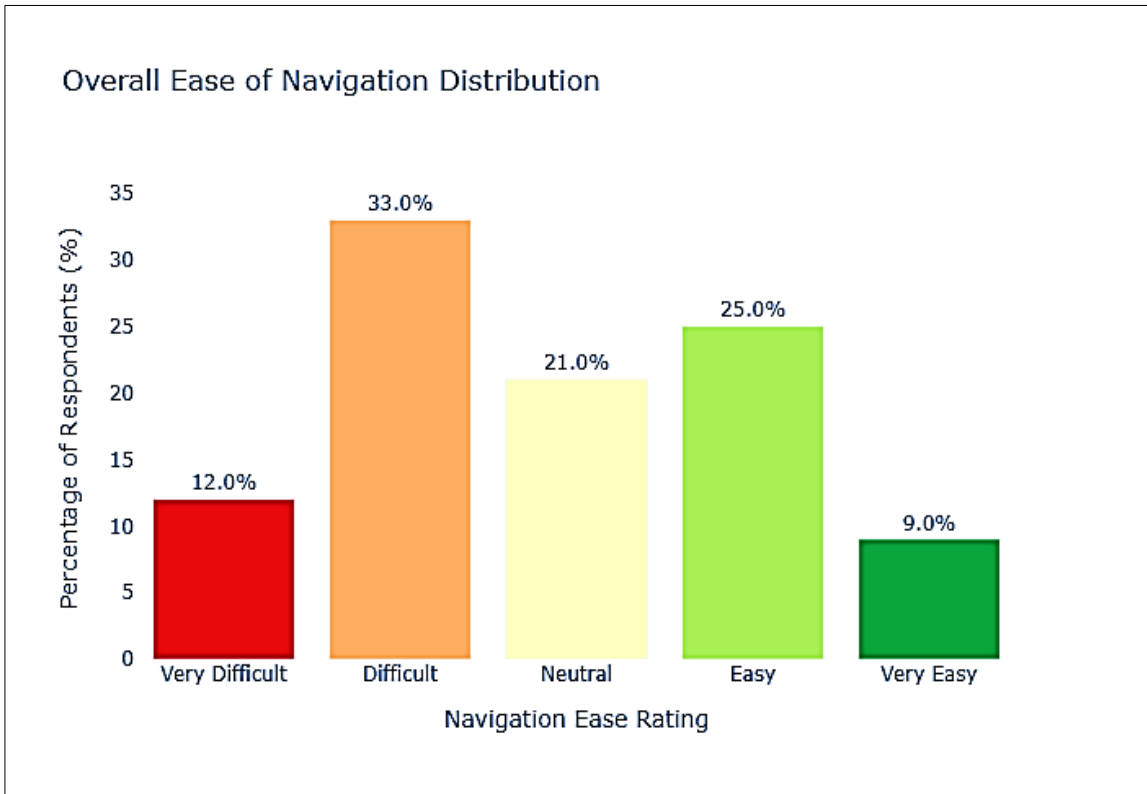


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Table 4.6 - Digital Literacy Metrics by Stakeholder Group

Stakeholder Category	Smartphone Users (%)	Comfortable with Digital Maps (%)
Patient	63%	24%
Attendant	80%	43%
Staff	100%	100%

The chart shows that while most patients (63.4%) and attendants (80%) use smartphones, far fewer are comfortable with digital maps (24.4% and 43.3% respectively). In contrast, all staff (100%) are digitally literate in both areas. This indicates a digital gap among patients and attendants, suggesting the need for training, support, or simplified tools to ensure effective adoption of indoor navigation systems.

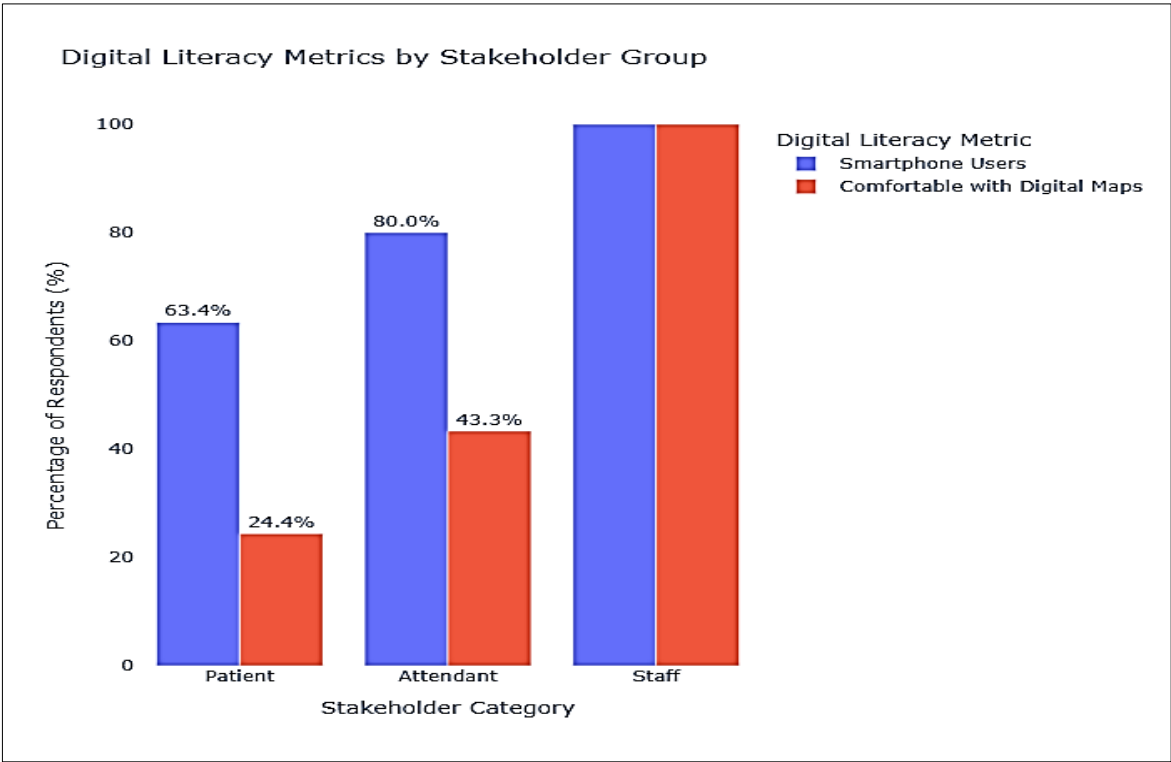


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Most Commonly Reported Difficult Navigation Areas

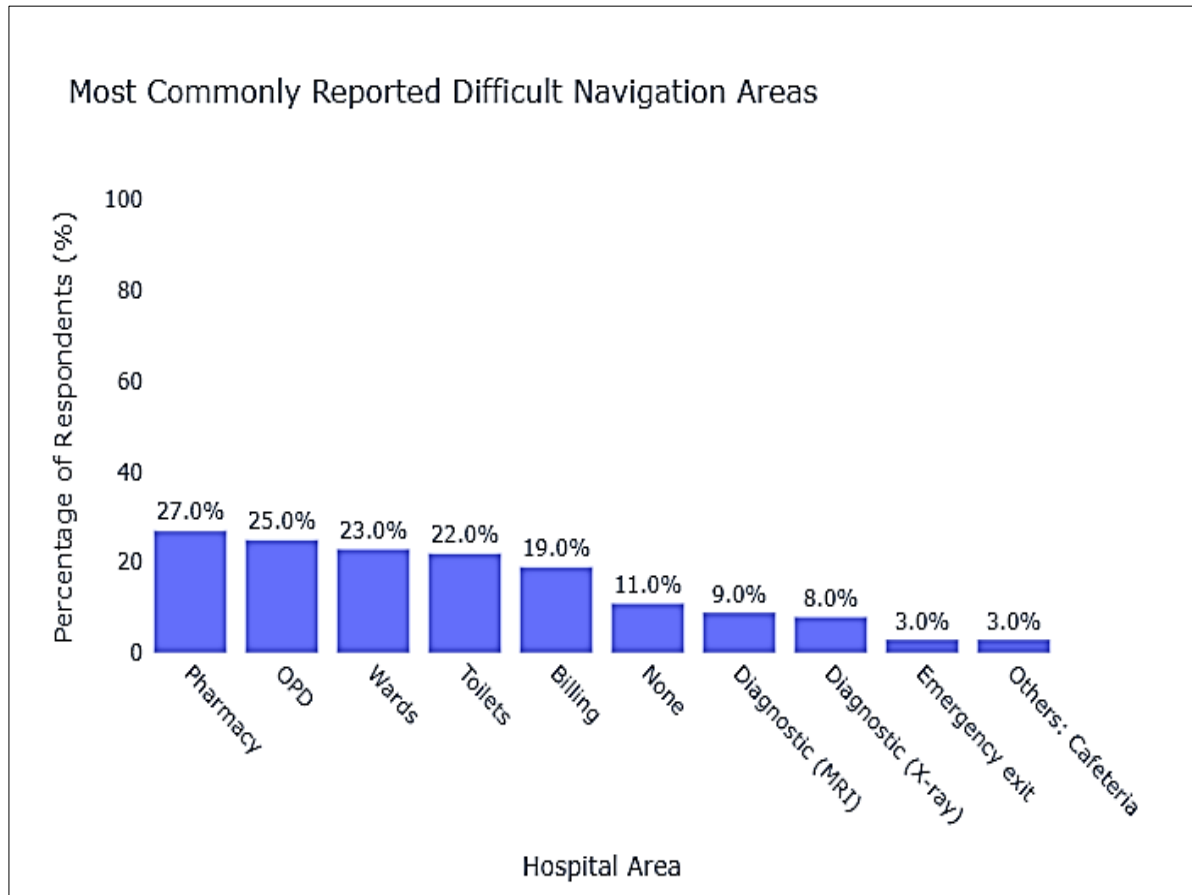


Fig: 4.4

A total of 89% (N=57) of respondents who faced navigation challenges identified specific hospital areas as difficult, with 27% (N=17) reporting the Pharmacy as the most challenging, followed by 25% (N=16) for the OPD, 23% (N=15) for Wards, and 22% (N=14) for Toilets. Billing was noted by 19% (N=12), while 11% (N=7) reported no specific difficult areas. Diagnostic areas, such as MRI (9%, N=6) and X-ray (8%, N=5), along with Emergency exits (3%, N=2) and the cafeteria (3%, N=2), were less frequently mentioned. This highlights that Pharmacy, OPD, Wards, and Toilets are the primary areas needing improved navigation solutions, such as better signage or digital aids.

Table 4.7 - Mobile Navigation Usefulness and Likelihood to Use by Stakeholder Group Table

Stakeholder Category	Total Respondents	"Yes" Responses	Percent Finding Mobile Navigation Useful (%)	Average Likelihood to Use Score (1-5)
Attendant	30	24	80	3.6
Patient	41	29	70.7	3.61
Staff	29	29	100	4.59

A total of 100% (N=29) of Staff found mobile navigation useful, with a high likelihood to use score of 4.59, showing strong adoption. Attendants had 80% (N=24) finding it useful, with a moderate likelihood score of 3.6, while 70.7% (N=29) of patients found it useful, with a slightly higher likelihood score of 3.61. This indicates mobile navigation tools are most valued by Staff, with Attendants and Patients showing moderate acceptance, suggesting potential for improved usability to increase adoption among non-staff stakeholders.

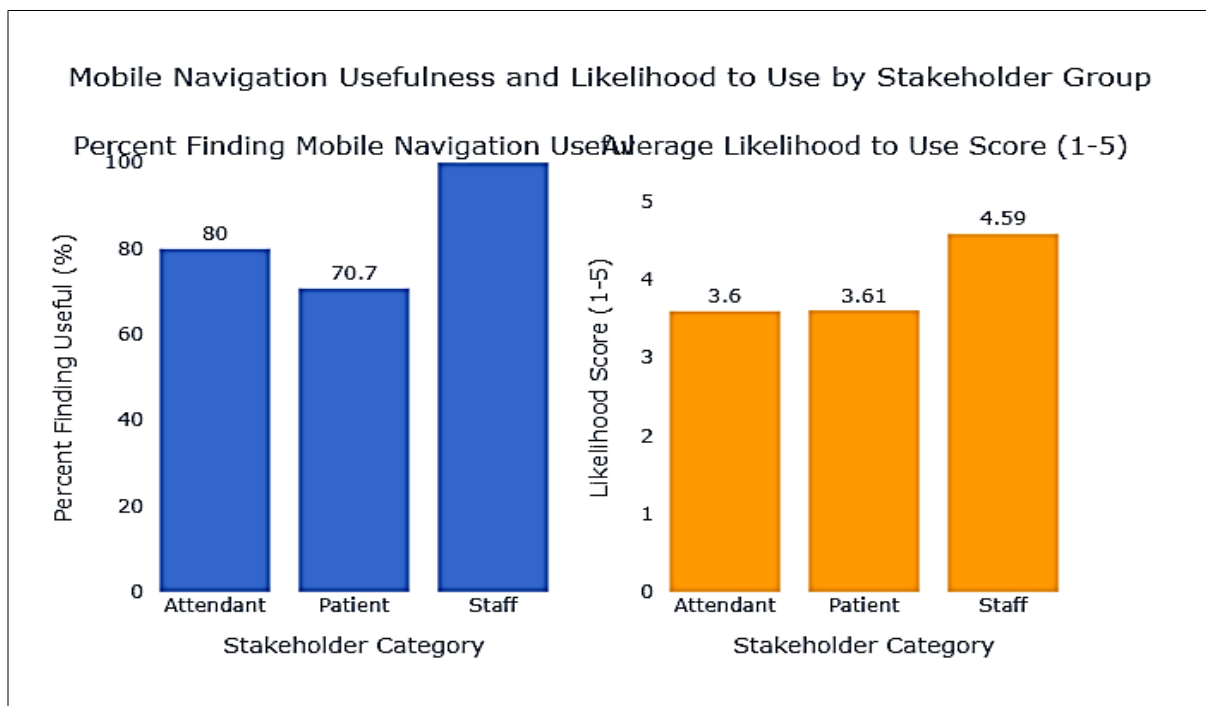


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Table 4.8 - Preferred Navigation Features by Stakeholder Group

Feature	Patients (n=41)	Attendants (n=30)	Staff (n=29)
Voice-guided directions	34 (82.9%)	23 (76.7%)	13 (44.8%)
Departmental search	29 (70.7%)	23 (76.7%)	29 (100%)
Real-time location updates	25 (61.0%)	19 (63.3%)	22 (75.9%)
Multilingual support	15 (36.6%)	10 (33.3%)	2 (6.9%)
Emergency exit locator	8 (19.5%)	15 (50.0%)	25 (86.2%)
Wheelchair-accessible route info	8 (19.5%)	10 (33.3%)	5 (17.2%)
Integration with OPD/appointment system	6 (14.6%)	8 (26.7%)	22 (75.9%)

This table shows the frequency and percentage of respondents in each stakeholder group (Patients, Attendants, Staff) who selected specific navigation features as helpful. Percentages are calculated based on the total number of respondents in each group (Patients: 41, Attendants: 30, Staff: 29)

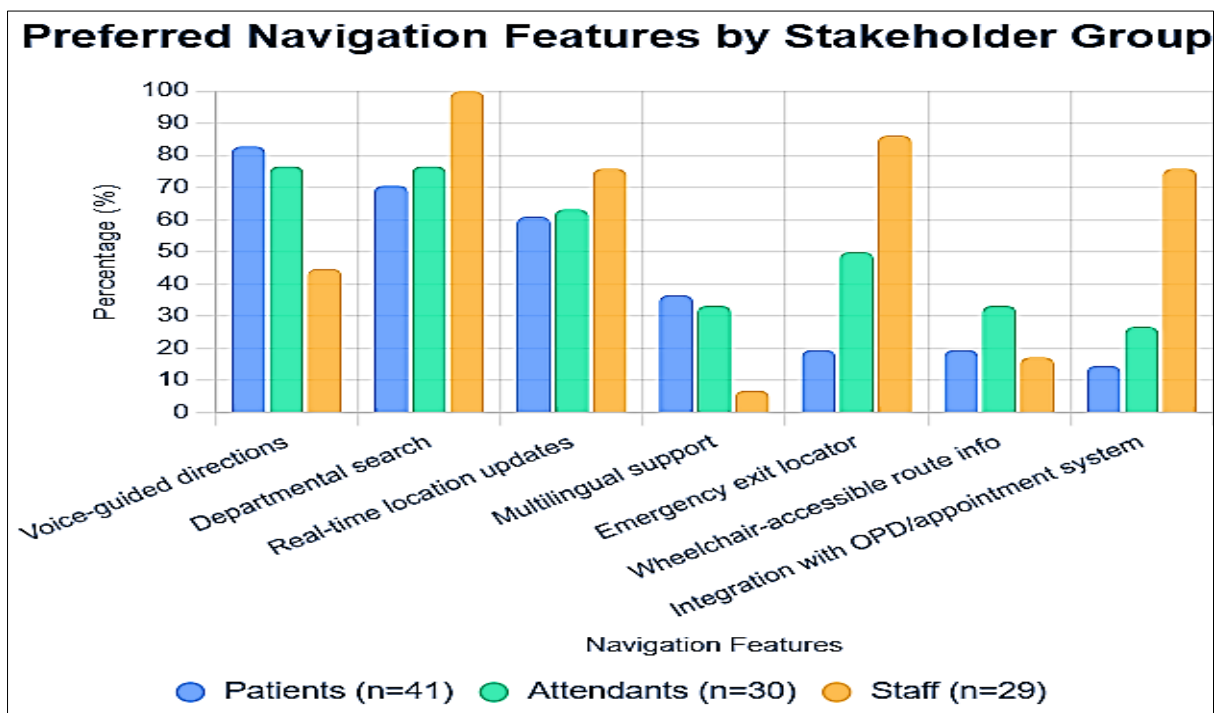


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Key Findings

- **Voice-guided Directions:** Highly preferred by patients (82.9%) and Attendants (76.7%), less by Staff (44.8%), indicating non-staff need intuitive guidance.
- **Departmental Search:** Universal for Staff (100%), high for Attendants (76.7%) and Patients (70.7%), showing broad demand.
- **Real-time Location Updates:** Popular across Staff (75.9%), Attendants (63.3%), and Patients (61.0%), useful for dynamic navigation.
- **Multilingual Support:** Moderate for Patients (36.6%) and Attendants (33.3%), low for Staff (6.9%), reflecting language barriers for non-staff.
- **Emergency Exit Locator:** Critical for Staff (86.2%), moderate for Attendants (50.0%), low for patients (19.5%), highlighting staff's safety focus.
- **Wheelchair-accessible Route Info:** Moderate for Attendants (33.3%), lower for patients (19.5%) and Staff (17.2%), indicating accessibility needs.
- **OPD/Appointment Integration:** High for Staff (75.9%), less for Attendants (26.7%) and Patients (14.6%), showing staff's efficiency needs.

Table 4.9 - Distribution of Barriers to Indoor Navigation Implementation by Stakeholder Group

Barrier	Patients (n=41)	Attendants (n=30)	Staff (n=29)
Technical complexity	16 (39.0%)	10 (33.3%)	3 (10.3%)
Lack of smartphone/internet	12 (29.3%)	5 (16.7%)	0 (0.0%)
No need for it	1 (2.4%)	8 (26.7%)	3 (10.3%)
Language issues	6 (14.6%)	4 (13.3%)	0 (0.0%)
Trust issues with digital tools	3 (7.3%)	3 (10.0%)	0 (0.0%)
None	3 (7.3%)	0 (0.0%)	23 (79.3%)

This table shows the frequency and percentage of respondents in each stakeholder group (Patients, Attendants, Staff) who identified specific barriers to indoor navigation implementation. Percentages are calculated based on the total number of respondents in each group (Patients: 41, Attendants: 30, Staff: 29).

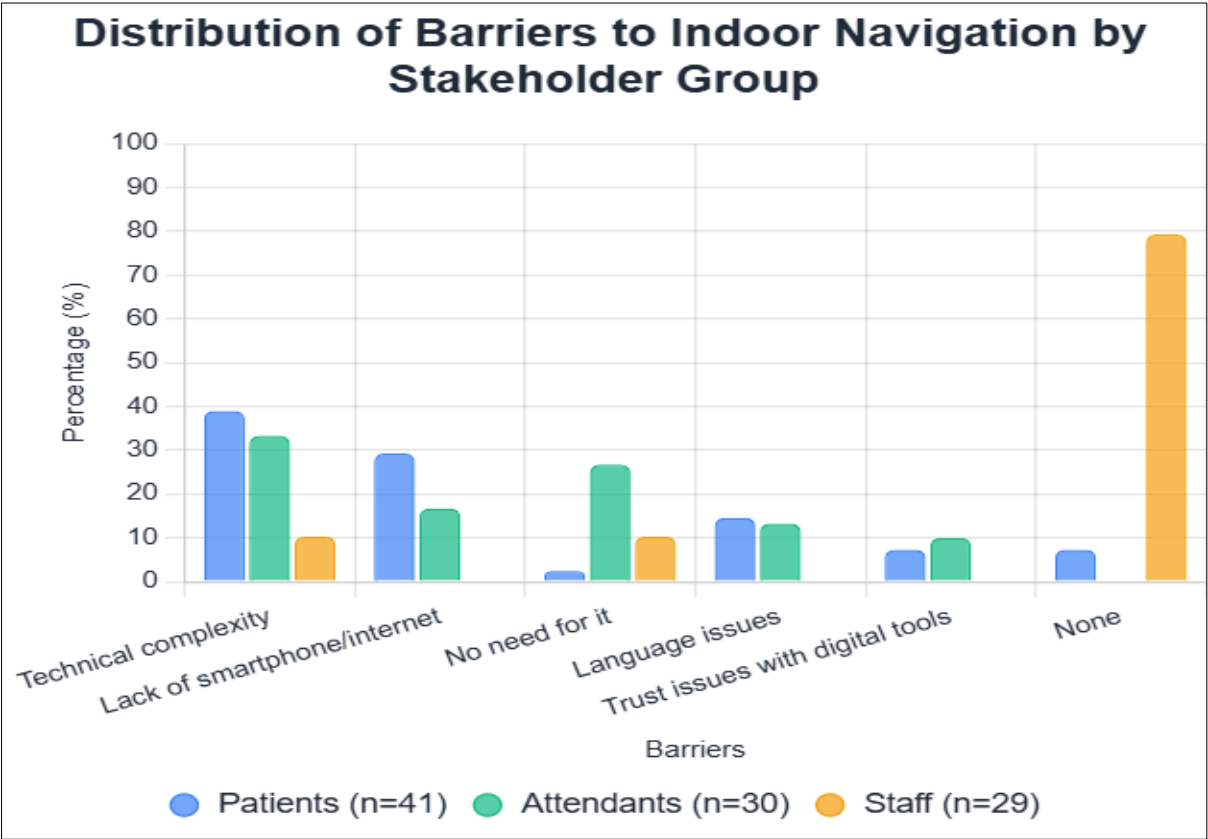


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Key Findings

- Technical Complexity:** Most significant for patients (39.0%) and Attendants (33.3%), less for Staff (10.3%), indicating non-staff struggle with digital navigation tools.
- Lack of Smartphone/Internet:** Notable for Patients (29.3%) and Attendants (16.7%), absent for Staff (0.0%), reflecting Staff’s universal smartphone access (100% per dataset).
- No Need for It:** Highest among Attendants (26.7%), low for patients (2.4%) and Staff (10.3%), suggesting some Attendants see navigation tools as unnecessary.
- Language Issues:** Moderate for Patients (14.6%) and Attendants (13.3%), absent for Staff (0.0%), highlighting language barriers for non-staff.

- **Trust Issues with Digital Tools:** Low for Patients (7.3%) and Attendants (10.0%), absent for Staff (0.0%), showing minor distrust among non-staff.
- **None:** Dominant for Staff (79.3%), low for patients (7.3%), and absent for Attendants (0.0%), indicating Staff face fewer barriers due to familiarity and digital comfort.

CHAPTER 5

DISCUSSION

5.1 Introduction

This chapter interprets and contextualizes the findings presented in Chapter 4, linking them with the study's objectives and existing literature. The aim is to critically analyze the significance of stakeholder feedback related to hospital navigation, digital literacy, and preferences for BootWay iNaaS—a mobile-based indoor navigation system. By comparing the results with national and international studies, this discussion offers a comprehensive understanding of user needs and practical implications for healthcare institutions and technology developers.

5.2 Interpretation of Key Findings

5.2.1 Navigation Challenges and Wayfinding Difficulty

The study revealed that a significant proportion of patients (92.7%) and attendants (73.3%) had trouble navigating hospital spaces, while none of the hospital staff reported such challenges. These findings suggest that unfamiliarity with hospital layouts is a substantial barrier to efficient healthcare access for visitors. The areas most frequently reported as difficult to locate included the pharmacy, OPD, wards, toilets, and billing counters—indicating a consistent pattern of spatial confusion in both clinical and non-clinical service zones.

These findings closely align with those of **Sahoo et al. (2024)**, who reported that even after trilingual signage improvements, 98% of visitors still needed to verify directions with staff. **Kalyan et al. (2024)** similarly found moderate satisfaction with hospital signage, particularly among repeat and more educated visitors, but emphasized a lack of clarity for first-time patients. This reinforces the idea that signage alone may not suffice in resolving wayfinding issues and that digital interventions may be required.

Additionally, navigation challenges were concentrated in high-footfall, multi-departmental areas—consistent with **Anagnostopoulos et al. (2017)**, who identified significant stress among staff due to constant direction-giving. This highlights the potential of digital navigation tools not only to enhance visitor experience but also to reduce the non-clinical workload of hospital staff.

5.2.2 Digital Literacy and Readiness

While smartphone penetration was relatively high among patients (63%) and attendants (80%), only a minority felt comfortable using digital maps—24% and 43%, respectively. In contrast, staff showed

100% proficiency across both smartphone usage and digital mapping tools. These results indicate a **digital readiness gap** between hospital staff and other stakeholder groups, particularly patients.

This finding is corroborated by **Ženka et al. (2021a, 2021b)**, who observed that digital navigation acceptance increases with education and decreases with age. Staff, who are generally younger and tech-trained, display greater confidence in digital platforms. On the other hand, patients, especially the elderly, often lack familiarity or trust in digital tools, posing a challenge for digital health interventions.

The implication here is clear: while hospitals can and should adopt smart technologies, **the digital onboarding process for patients and attendants must be simplified**, possibly through staff-assisted kiosks, intuitive mobile interfaces, and multilingual onboarding modules.

5.2.3 Perception of BootWay iNaaS: Usefulness and Adoption Potential

The overwhelming majority of staff (100%) found BootWay iNaaS useful, with a high likelihood-to-use score (4.59 out of 5). Patients and attendants also showed strong perceived usefulness at 70.7% and 80%, respectively, with moderate-to-high adoption scores (~3.6). These findings reflect a **generally favorable attitude toward digital indoor navigation tools**, with nuances based on stakeholder type.

This corresponds with **Wichmann & Leyer (2021)**, who found that behavioral intentions to use navigation apps are significantly influenced by attitude and subjective norms. In the current study, staff were not only the most supportive of the system but also displayed fewer adoption barriers, possibly due to better digital exposure and operational understanding. Patients and attendants showed some hesitation, but the relatively high adoption scores indicate latent demand, especially if the technology is designed with user-friendly features.

5.2.4 Preferences for Navigation Features

The top features preferred by patients and attendants included **voice-guided directions**, **department search**, and **real-time location updates**. Multilingual support was also important, especially among patients (36.6%). Staff valued **departmental search** (100%) and **integration with OPD/appointment systems** (75.9%) the most, which aligns with their workflow and responsibility patterns.

This again aligns with **Gupta et al. (2024)**, whose scoping review of mobile-based hospital navigation tools in India emphasized the need for personalized, multilingual, and real-time solutions. Similarly, **Brodt et al. (2025)** reported that improved user interface features in indoor navigation tools were associated with reduced staff intervention and improved visitor satisfaction.

The variation in feature preference highlights the need for **modular system design**—i.e., BootWay iNaaS should allow different stakeholder groups to customize features relevant to them.

5.2.5 Barriers to Adoption

Patients and attendants reported several key barriers:

- **Technical complexity** (39% and 33%)
- **Lack of smartphones or internet** (29.3% and 16.7%)
- **Language challenges and trust issues** (14–10%)

In contrast, **79.3% of staff reported no barriers**, reinforcing their readiness.

These insights align with **Wichmann (2022)**, who emphasized that UI simplicity, language accessibility, and onboarding design are key to successful IPS adoption. **Ženka et al. (2021b)** similarly noted that older adults were less inclined to use digital solutions, citing complexity and trust as major factors.

The findings indicate that **barrier-aware implementation**—focusing on training, offline modes, and support for low-literacy users—is critical to success.

5.3 Alignment with Objectives and Research Questions

The study was guided by four key research objectives and corresponding research questions. This section reflects on how the quantitative findings fulfill each of these goals and provide meaningful insights relevant to the development and adoption of hospital-based indoor navigation systems like BootWay iNaaS.

Objective 1: To identify wayfinding challenges encountered by patients, attendants, and staff.

Research Question 1: What are the common navigation difficulties reported by patients, attendants, and staff?

- This objective was clearly met. The study found that **92.7% of patients** and **73.3% of attendants** experienced difficulty navigating the hospital premises. The most frequently reported difficult areas were the **Pharmacy (27%)**, **OPD (25%)**, **Wards (23%)**, and **Toilets (22%)**. In contrast, hospital staff reported **no significant navigation challenges**, highlighting their familiarity with the hospital layout.
- These results validate the need for user-friendly indoor navigation support for patients and visitors, especially in high-footfall service zones.

Objective 2: To assess stakeholder perceptions of the usefulness and usability of a digital indoor navigation system.

Research Question 2: How do users perceive the usefulness of a hospital-based digital indoor navigation system?

- The findings support this objective strongly. The majority of respondents across all stakeholder groups found the concept of BootWay iNaaS to be **useful**:
 - **Patients:** 70.7%
 - **Attendants:** 80%
 - **Staff:** 100%
- The staff group had the highest confidence in using the system, with a **likelihood-to-use score of 4.59/5**, followed by patients and attendants (~3.6). These values indicate a **positive perception and readiness** for digital wayfinding among users, provided the system is intuitive and inclusive.

Objective 3: To evaluate the most desired features and functionalities in BootWay iNaaS from a user perspective.

Research Question 3: What specific features are most valued by potential users of BootWay iNaaS?

- This objective was achieved through feature selection analysis. Respondents were asked to choose preferred features from a predefined list. The top-rated functionalities included:
 - **Voice-guided directions** (Patients: 83%, Attendants: 77%)
 - **Departmental search** (Staff: 100%, Patients: 71%)
 - **Real-time location updates** (Staff: 82.7%, Patients: 56%)
 - **Multilingual support** (Patients: 36.6%)
- These findings indicate a high demand for **interactive, easy-to-use, and language-inclusive features**, suggesting that BootWay should prioritize a personalized and adaptive interface for diverse users.

Objective 4: To measure stakeholder readiness and openness toward adopting a digital navigation solution.

Research Question 4: What is the level of readiness and openness among stakeholders for adopting a digital indoor navigation system?

- This objective was also fulfilled. While **smartphone usage** was relatively high across all groups (Patients: 63%, Attendants: 80%, Staff: 100%), comfort levels with digital maps varied significantly, being lowest among patients. Yet, the overall **willingness to adopt** BootWay was strong, particularly among staff, who reported **minimal barriers**.
- Barriers reported by patients and attendants included:
 - **Technical complexity**
 - **Lack of access to smartphones or internet**
 - **Language issues**
- These results suggest that while **readiness exists**, **implementation success** depends on addressing accessibility and usability concerns.

5.4 Comparison with Literature

Theme	Finding from This Study	Supporting Literature
Navigation Difficulty	High among patients and attendants	Sahoo et al. (2024), Kalyan et al. (2024)
Tech Comfort Disparity	Staff > Attendants > Patients	Ženka et al. (2021), Wichmann (2022)
Feature Preferences	Voice, maps, search, multilingual	Gupta et al. (2024), Brodt et al. (2025)
Barriers to Adoption	Complexity, internet access, language	Wichmann (2022), Ženka et al. (2021)
Staff Overload with Direction Help	Reported, potential time saved via IPS	Anagnostopoulos et al. (2017), Majerová et al. (2022)

CHAPTER 6

FINDINGS & RECOMMENDATIONS

This chapter summarizes the major findings of the study and translates them into practical, actionable recommendations. These findings are based on structured data collected from 100 stakeholders, including patients, attendants, and hospital staff across multiple tertiary care hospitals. The recommendations are categorized for hospitals, technology providers (such as BootWay), and policy-level decision-makers. In addition, this chapter outlines areas for future research to further improve the development and adoption of indoor navigation systems in healthcare facilities.

Key Findings

- A significant majority of patients (92.7%) and attendants (73.3%) reported difficulty navigating the hospital.
- Most challenging areas included the **Pharmacy, OPD, Wards, and Toilets**.
- Over 70% of non-staff respondents had to ask someone for directions, primarily hospital staff.
- **Smartphone usage** was high across all groups (Patients: 63%, Attendants: 80%, Staff: 100%), but **comfort with digital maps** was lower in patients and attendants.
- **BootWay iNaaS** was perceived as useful by the majority of respondents:
 - 70.7% of patients, 80% of attendants, and 100% of staff
- **Top feature preferences** included:
 - Voice-guided directions
 - Real-time location updates
 - Departmental search
 - Multilingual support
- **Barriers to adoption** reported by patients and attendants included:
 - Lack of digital literacy
 - No smartphone/internet access
 - Interface complexity

- Language limitations
- Staff reported minimal to no barriers and showed the highest readiness for adoption.

Recommendations for Practice

For Hospitals

1. **Adopt Smart Navigation Systems:** Hospitals should implement indoor navigation solutions like BootWay iNaaS to reduce delays, enhance patient satisfaction, and improve staff efficiency.
2. **Install Multilingual Kiosks:** Touchscreen navigation kiosks with multilingual capabilities should be placed at entry points and common junctions.
3. **Train Staff for Support:** Receptionists and ward attendants should be trained to help first-time users interact with the digital navigation system.
4. **Optimize Physical Signage:** Digital systems should complement—not replace—clear, standardized signage for users who are not digitally inclined.
5. **Integrate with OPD and Appointment Systems:** Synchronize the indoor navigation tool with the hospital’s existing digital infrastructure to provide real-time appointment and room data.

For Technology Providers (BootWay)

1. **Design for Simplicity and Accessibility:** User interfaces must be intuitive, language-inclusive, and suitable for low-literacy users, especially the elderly.
2. **Include Voice and Visual Guidance:** The system should support real-time, turn-by-turn directions through both voice prompts and visual maps.
3. **Offer Offline/Low-Data Functionality:** Ensure users can access basic map services without relying on high-speed internet.
4. **Stakeholder-Customized Features:** Develop user modes (e.g., patient, staff, attendant) with tailored feature sets and navigation priorities.
5. **Collect Usage Analytics:** Integrate a backend dashboard for hospitals to monitor app usage, common navigation problems, and satisfaction metrics.

For Policy and Administration

1. **Encourage Digital Navigation Inclusion in NABH/NHM Guidelines:** Recognize indoor navigation systems as a component of patient-centric care in hospital accreditation criteria.

2. **Subsidize Digital Accessibility Projects:** Provide funding support for hospitals to install digital wayfinding solutions in public healthcare institutions.
3. **Set Minimum Standards for Smart Navigation:** Define UI/UX accessibility benchmarks, multilingual support requirements, and privacy protections for healthcare navigation systems.
4. **Integrate with Ayushman Bharat Digital Mission (ABDM):** Consider BootWay-like systems as add-ons to the digital health ecosystem under ABDM.

CHAPTER 7

CONCLUSION & LIMITATIONS

Conclusion

This study aimed to assess the navigation-related challenges and digital readiness of hospital stakeholders—patients, attendants, and staff—with the objective of evaluating the need and potential acceptance of a mobile-based indoor navigation solution: **BootWay iNaaS**. Through structured data collected from **100 respondents** across multiple tertiary care hospitals, the research provided valuable insights into the current barriers users face within hospital settings and their openness to adopting digital wayfinding systems.

The findings revealed that **a majority of patients and attendants experience significant difficulties** in navigating hospital spaces, particularly in locating the pharmacy, OPD, wards, and toilets. Despite high smartphone penetration among respondents, there existed a digital confidence gap—especially among older patients—when it came to using maps or QR-code-based tools.

Encouragingly, all three stakeholder groups showed a **positive perception of BootWay iNaaS**, with staff members demonstrating the highest likelihood of adoption. Respondents emphasized the need for intuitive features such as **voice guidance, real-time departmental search, and multilingual support**. However, **barriers** like technical complexity, lack of internet access, and language limitations remain critical concerns—especially for non-staff users.

This research underscores the relevance and timeliness of introducing a tailored indoor navigation system in Indian hospital settings. If designed inclusively, BootWay iNaaS has the potential to bridge the gap between infrastructure complexity and patient experience, reduce operational inefficiencies, and improve overall hospital service delivery.

Limitations of the Study

While the study provides significant insights, certain limitations must be acknowledged:

1. **Sample Size and Scope:** The study included 100 respondents across selected tertiary care hospitals. While stratified by stakeholder category, the sample size limits statistical generalizability to all healthcare settings.
2. **Structured Data Only:** The study relied solely on **quantitative data** through a structured questionnaire. It did not capture **qualitative feedback**, emotional responses, or real-time user experiences that could further enrich understanding.

3. **Geographical and Institutional Bias:** Respondents were drawn from urban tertiary care hospitals. The results may not reflect conditions or attitudes in **rural hospitals, primary health centers, or specialty institutions.**

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ANNEXURES

Annexures I – Study Instrument – Questionnaire

Section A: Demographics

1. Stakeholder category:

1. Patient
2. Attendant
3. Hospital Staff

2. Age: _____

3. Gender:

1. Male
2. Female
3. Other

4. Educational Qualification:

1. Below 10th
2. 10th–12th
3. Graduate
4. Postgraduate

5. Have you visited this hospital before?

1. Yes
2. No

Section B: Navigation Experience

6. On your most recent hospital visit, did you face difficulty finding departments/rooms?

1. Yes
2. No

7. How easy was it to find your way around the hospital?

1. Very Easy
2. Easy
3. Neutra

4. Difficult
5. Very Difficult

8. Which areas were most difficult to locate? (Select all that apply)

1. OPD
2. Diagnostic (X-ray, MRI)
3. Pharmacy
4. Wards
5. Billing
6. Toilets
7. Others: _____

9. Did you have to ask for directions?

1. Yes
2. No

10. If yes, whom did you ask?

1. Security
2. Staff
3. Attendants
4. Random person

Section C: Familiarity with Digital Tools

11. Do you use a smartphone?

1. Yes
2. No

12. Are you comfortable using digital maps (e.g., Google Maps)?

1. Yes
2. No
3. Somewhat

13. Have you ever used a QR code or hospital kiosk?

1. Yes
2. No

Section D: Perception of iNaaS (BootWay)

14. Would a mobile-based hospital navigation system be useful for you?

1. Yes
2. No
3. Not Sure

15. Which features would you find most helpful? (Select up to 3)

1. Voice-guided directions
2. Multilingual support
3. Departmental search
4. Real-time location updates
5. Wheelchair-accessible route info
6. Integration with OPD/appointment system
7. Emergency exit locator

16. How likely are you to use such a system if available?

1. Very Likely
2. Likely
3. Neutral
4. Unlikely
5. Very Unlikely

Section E: Barriers & Suggestions

17. What could prevent you from using a digital indoor navigation system?

1. Lack of smartphone/internet
2. Language issues
3. Technical complexity
4. Trust issues with digital tools
5. No need for it

18. Additional suggestions (optional):