Journal of Informatics Education and Research
ISSN: 1526-4726
Vol 5 Issue 1 (2025)

Enhancing User Experience in Smart Insole Applications: A UI/UX Approach for Effective Foot Pressure Monitoring and Gait Analysis in Plantar Fasciitis Management.

Anila Sasi[a*], Ruchi Singh[b], D.JothiPriya[c] ,Vishva Kumar[d]

[a*]Faculty, Department of FDP in Footwear Design and Development Institute, Ministry of Commerce and Industry, Govt of India.
[b]Faculty, Department of Leather Goods and Accessories Design in Footwear Design and Development Institute, Ministry of Commerce and Industry, Govt of India.
[c]Sr.Faculty , Department of Fashion Design in Footwear Design and Development Institute, Ministry of Commerce and Industry, Govt of India.
[d]Sr.Faculty, Department of FDP in Footwear Design and Development Institute, Ministry of Commerce and Industry, Govt of India.

Abstract
Smart insole technology has emerged as a valuable tool for managing plantar fasciitis by providing real-time foot pressure monitoring and gait analysis. However, the success of these applications depends heavily on the user interface (UI) and user experience (UX) design, which directly influence user engagement, compliance, and the effectiveness of the technology. This study focuses on enhancing the UI/UX design of smart insole applications to optimize the user experience for individuals managing plantar fasciitis. By analyzing common user challenges and designing intuitive interfaces, the research aims to improve usability, data visualization, and personalized feedback in foot pressure monitoring and gait analysis. A user-centered design approach was employed to identify pain points and develop features that address the specific needs of patients with plantar fasciitis, such as customized alerts for excessive pressure and easy-to-understand data displays. The study highlights the importance of an accessible and engaging UI/UX design in ensuring adherence to treatment plans and maximizing the therapeutic benefits of smart insoles.

Keywords: Smart insoles, UI/UX design, plantar fasciitis, foot pressure monitoring, gait analysis, user experience, health technology.

Introduction
Foot health is a critical aspect of overall well-being, particularly for individuals suffering from plantar fasciitis, a common condition characterized by inflammation of the plantar fascia, leading to significant heel pain [1]. Traditional treatment methods often lack the personalized care necessary for effective relief, which has spurred interest in advanced technologies like smart insoles [2][3]. These devices are equipped with sensors that monitor foot pressure and provide real-time feedback, offering valuable insights for both clinicians and users [4][5]. By leveraging sophisticated pressure mapping techniques, smart insoles can accurately assess the distribution of plantar pressure during various activities, such as walking or standing, which is essential for diagnosing issues and optimizing treatments for conditions like plantar fasciitis [6][7].
Gait analysis is another critical function of smart insoles [8]. This capability allows for the monitoring of walking patterns, which can reveal abnormalities associated with various foot and leg conditions [9]. The data derived from these analyses is instrumental in developing customized orthotic solutions tailored to address specific biomechanical problems [10]. However, the effectiveness of smart insoles is significantly influenced by the design of their user interface (UI) and user experience (UX) [11]. A well-designed UI/UX ensures that the data collected by these devices is accessible, understandable, and actionable for users, including those without a technical background [12]. Therefore, the UI/UX

design is a pivotal component that can substantially enhance the usability and overall effectiveness of smart insoles in managing plantar fasciitis and improving gait [13].
This research paper delves into the intersection of smart insole technology, pressure mapping, gait analysis, and UI/UX design. By evaluating existing systems and suggesting enhancements, this study aims to contribute to the development of more effective and user-friendly smart insole applications [14][15].

Literature Review

- **Evolution and Functionality of Smart Insoles:** Smart insoles have evolved significantly from their early designs to sophisticated systems capable of real-time pressure mapping and gait analysis. Tao et al. (2020) describe a smart insole system that integrates a controllable vertical pore dielectric layer for precise pressure mapping, highlighting the advancements in sensor technology that enhance the accuracy of foot pressure measurements [1]. Lin et al. (2016) further demonstrate the application of smart insoles in unobtrusive gait monitoring, emphasizing the integration of wearable sensors that allow continuous data collection in daily life [2]. These advancements underscore the importance of developing reliable and effective smart insole systems for managing foot health conditions.
- **Impact on Plantar Fasciitis Management:** The application of smart insoles in managing plantar fasciitis is a significant area of research. Zhao et al. (2019) discuss the effectiveness of smart insoles in alleviating symptoms of plantar fasciitis by providing detailed insights into foot pressure distribution and gait patterns [3]. These studies highlight the potential of smart insoles to offer personalized feedback and recommendations that can improve patient outcomes. Moreover, research by Yoo et al. (2017) demonstrates that biomechanical parameters measured through gait analysis can provide valuable information for treating plantar fasciitis [4]. This evidence supports the use of smart insoles as a valuable tool in managing this common foot condition.
- **User Experience and Design Considerations:** Effective UI/UX design is crucial for the successful adoption and use of smart insoles. Pradyumna et al. (2022) explore recent innovations in footwear and smart insole technology, emphasizing the need for user-centered design approaches that enhance the usability and acceptability of these devices [5]. User experience considerations, such as ease of navigation, data presentation, and personalization, play a significant role in the effectiveness of smart insoles. Research by Boucharas et al. (2022) highlights the importance of designing smart insole platforms that cater to specific user needs, such as those of individuals with Parkinson's disease, which can inform broader UI/UX design principles [6].
- **Challenges and Future Directions:** Despite the advancements, several challenges remain in the development and application of smart insoles. Haris et al. (2021) review the effects of different insole materials on plantar pressure distribution, noting that material selection and design can impact the accuracy and comfort of smart insoles [7]. Additionally, the integration of smart insoles with other health monitoring systems and addressing user concerns about data accuracy and privacy are critical areas for future research. Deng et al. (2018) discuss the need for self-powered systems that can operate effectively in various environments, indicating a direction for future technological improvements [8].

Materials and Methodology

1. Research Design

The study employs a mixed-methods approach, combining quantitative and qualitative research to comprehensively evaluate the effectiveness of smart insoles in monitoring foot pressure, gait analysis, and managing plantar fasciitis. This approach includes surveys to gather user feedback and insights, and experimental trials to assess the performance of smart insoles in real-world conditions.

2. Participants

The study involved a total of 50 participants, including individuals with plantar fasciitis and healthy controls. Participants were recruited through local clinics and online forums related to foot health and sports medicine. Inclusion criteria for participants with plantar fasciitis included a clinical diagnosis confirmed by a healthcare provider, while healthy controls were selected based on a lack of any foot-related conditions.

3. Data Collection

Data collection was carried out through the following methods:

- Surveys: A structured questionnaire was administered to gather participant feedback on the usability, functionality, and effectiveness of smart insoles. The survey included questions on user experience, design preferences, and perceived benefits in managing foot pressure and gait analysis.
- Experimental Trials: Participants used smart insoles for a period of 4 weeks. Data on foot pressure distribution, gait patterns, and symptoms related to plantar fasciitis were collected using the smart insole's built-in sensors. Participants were asked to complete daily logs of their activities and any discomfort experienced.

4. Instruments

- Smart Insoles: The study utilized smart insoles equipped with pressure sensors and gait analysis capabilities. These insoles measure various parameters, including foot pressure distribution, gait patterns, and pressure maps.
- Questionnaire: The survey questionnaire consisted of 20 questions designed to assess different aspects of user experience with smart insoles. The questions were categorized into four main variables: user needs, user thoughts, user actions, and user pain points.
- Data Analysis Tools: Quantitative data from the surveys and experimental trials were analyzed using statistical software (e.g., SPSS or R). Descriptive statistics, correlation analyses, and regression analyses were conducted to evaluate the relationships between smart insole features and user outcomes. Qualitative feedback was analyzed thematically to identify common trends and user concerns.

User-Centered Design Approach

To address the UI/UX challenges in smart insole applications, this study employed a user-centered design (UCD) approach. UCD focuses on designing solutions that meet the needs and preferences of end-users, ensuring that the product is tailored to their specific requirements. For this study, the following steps were undertaken:

- **User Research**: Interviews and surveys were conducted with individuals diagnosed with plantar fasciitis to identify common challenges in managing the condition and using smart insole technology.
- **Persona Development**: Based on the user research, personas were created to represent different types of users, including tech-savvy individuals, elderly patients, and those with limited technological experience.
- **Wireframing and Prototyping**: Low-fidelity wireframes and prototypes were developed to visualize the application's structure and interface elements, with a focus on ease of use and accessibility.
- **Usability Testing**: The prototypes were tested with users to gather feedback on the interface design, ease of navigation, and understanding of the data provided by the application.
- **Iterative Design**: Based on user feedback, the design was refined to improve the overall user experience, focusing on features such as customizable alerts, simplified data visualizations, and accessible navigation.

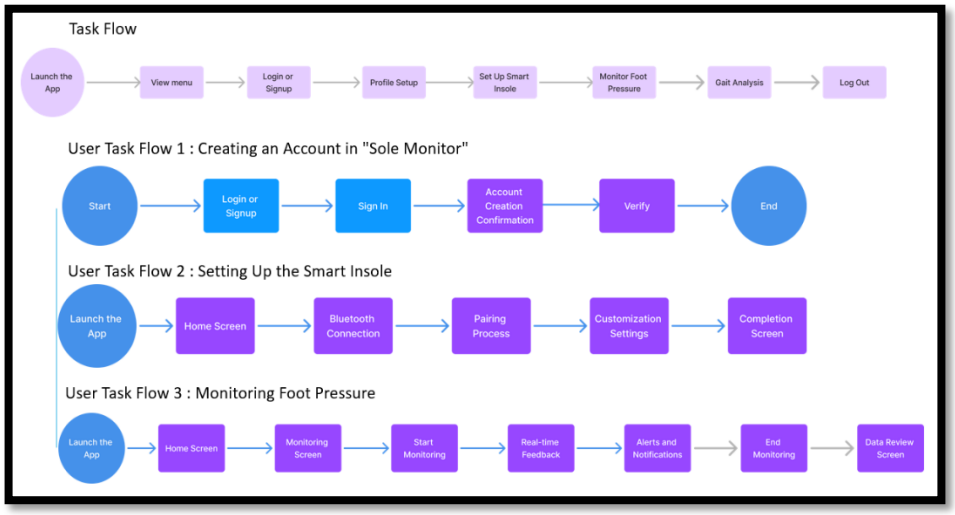
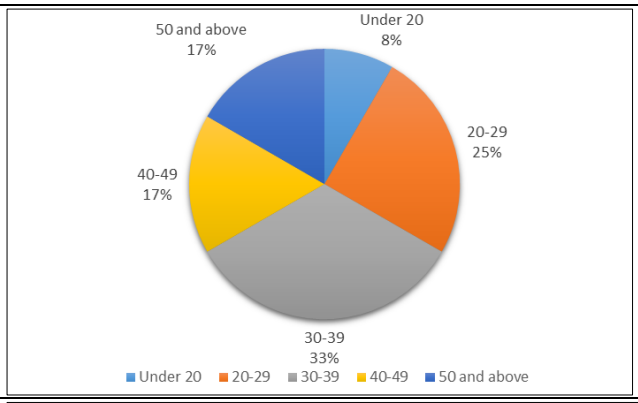
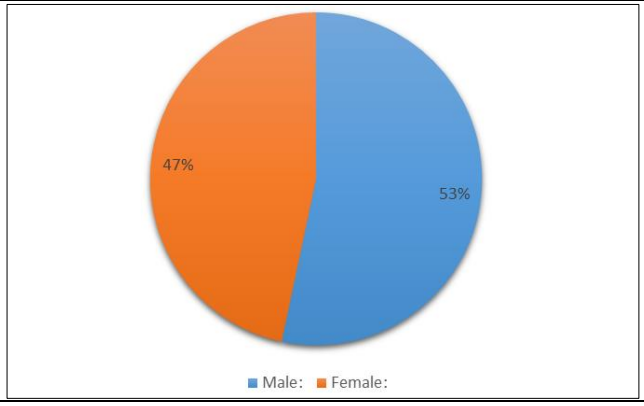


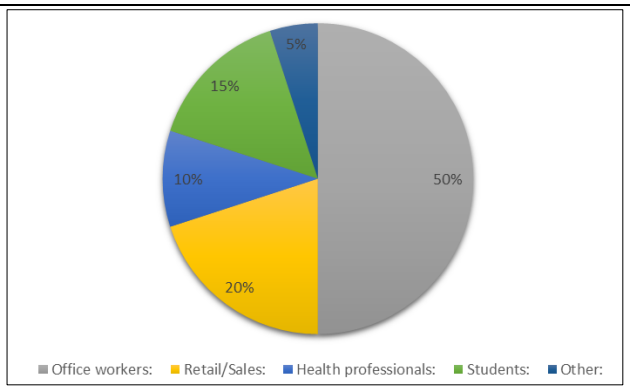
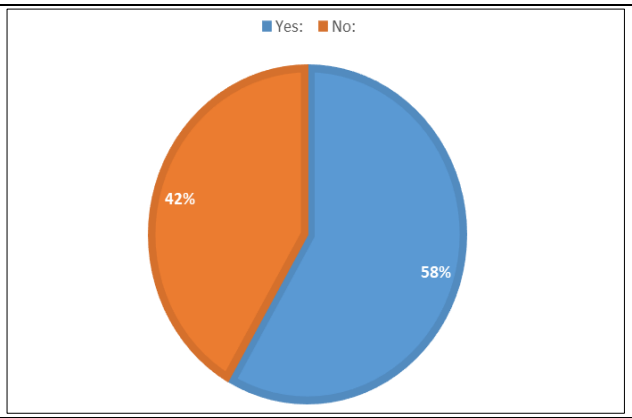
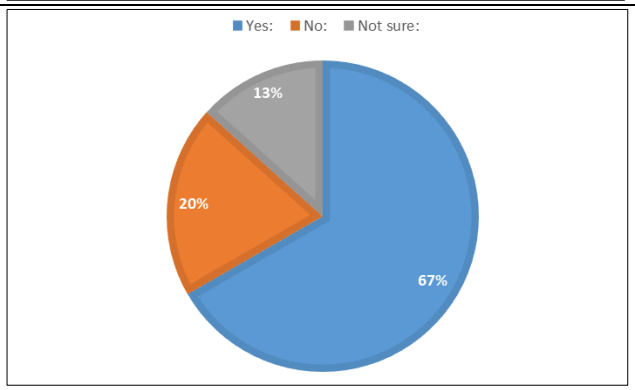
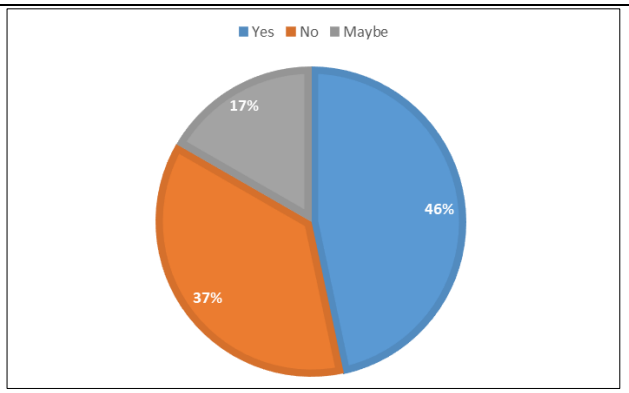
Fig.1: User-Centered Design Approach

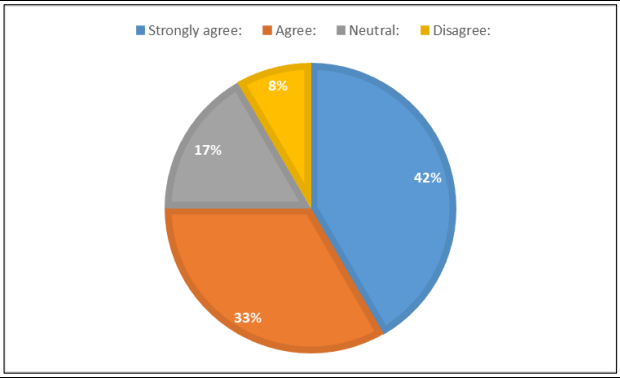
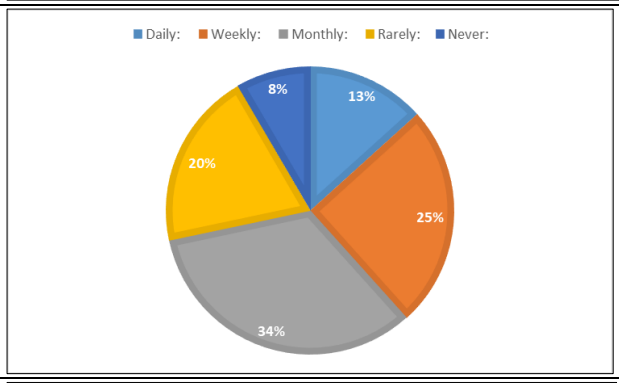
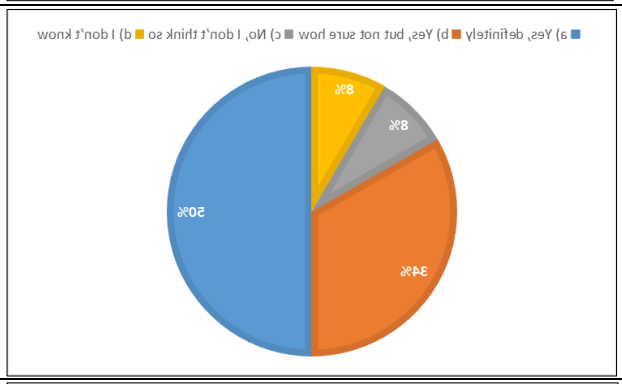
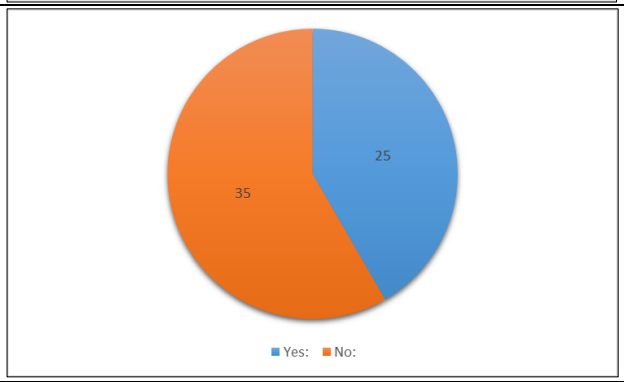
Data Collection and Analysis

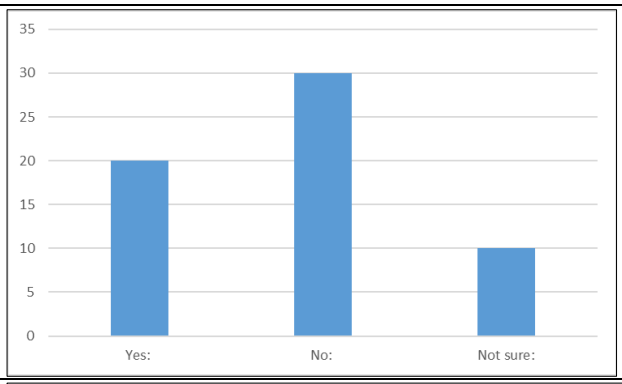
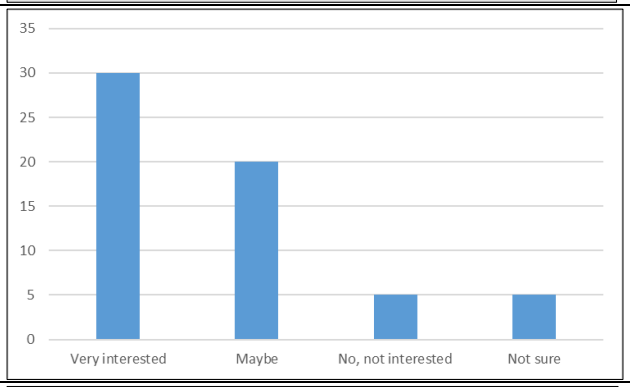
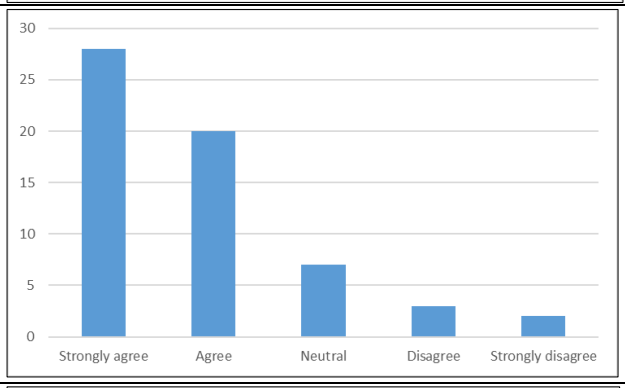
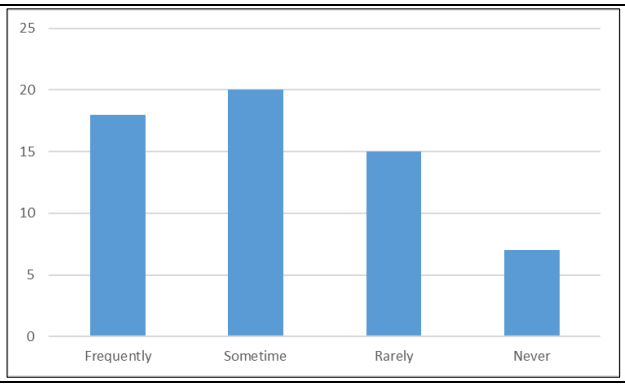
Data was collected from 50 users over a period of three months, with feedback gathered on key aspects of the UI/UX design. Usability testing metrics included task completion time, error rates, user satisfaction scores, and qualitative feedback on the intuitiveness of the interface. The data was analyzed to identify common pain points and areas for improvement in the application's design.

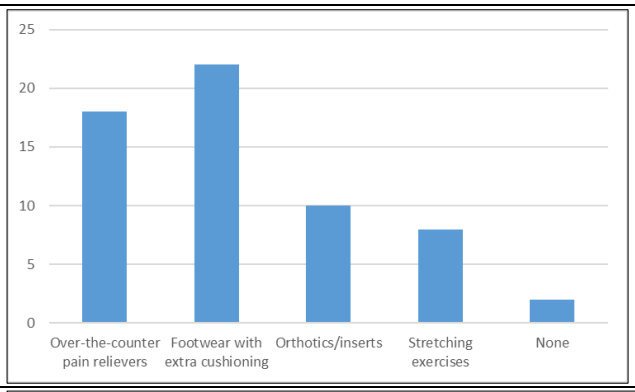
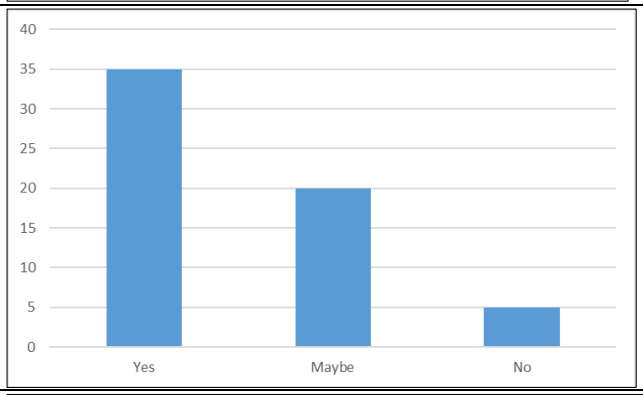
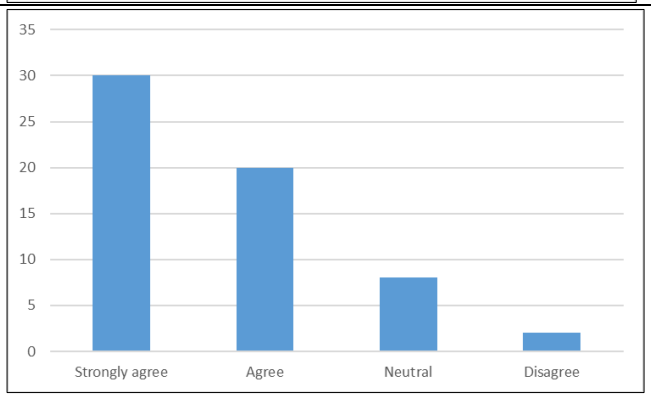
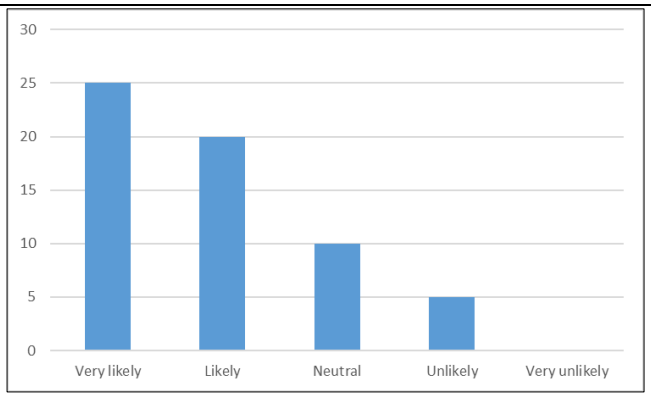
Survey Analysis: Enhancing User Experience in Smart Insole Applications

S.No	Questionary	Answers
1	Age	
2	Gender	

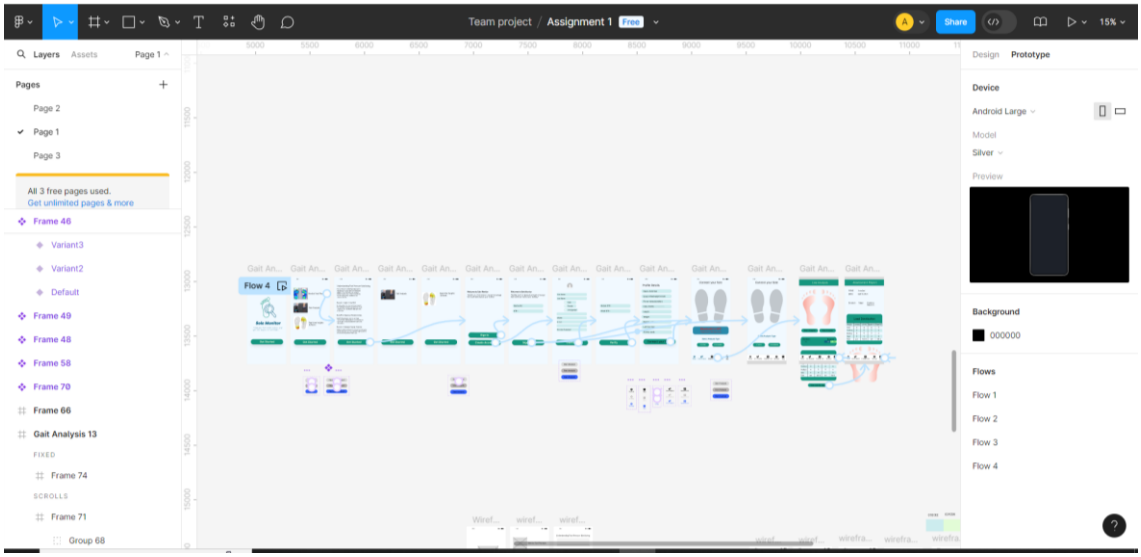
3	**Occupation**	
4	**Have you been diagnosed with plantar fasciitis by a healthcare professional?**	
5	**Have you experienced foot pain or discomfort in the past six months?**	
6	**Have you ever heard of smart insoles for monitoring foot health?**	

7	**Do you consider foot pressure monitoring an essential aspect of managing foot pain or discomfort?**	
8	**How often do you think about your foot health in general?**	
9	**Do you think smart technology could help improve your foot health?**	
10	**Are you familiar with the concept of gait analysis (evaluating how you walk)?**	

11	**Have you ever noticed any issues with your gait (walking pattern)?**	
12	**Would you be interested in a tool that could monitor your walking pattern and provide feedback?**	
13	**Do you think improving your gait could reduce foot or leg pain?**	
14	**How often do you pay attention to how you walk or stand?**	

15	**If you experience foot pain, what methods have you tried for relief?**	
16	**Would you consider using a smart insole to help alleviate foot pain or discomfort?**	
17	**Do you believe real-time data from a smart insole could help manage or prevent foot pain?**	
18	**If a smart insole was affordable and easy to use, how likely are you to try it?**	

• High Awareness of Foot Health Needs: A large number of respondents experience foot pain and are aware of the importance of foot pressure and gait monitoring.
• Strong Interest in Smart Technology: There is a significant interest in using smart insoles to monitor and improve foot health, particularly for managing gait and foot pressure in real-time.
• Cost as a Barrier: While the interest in smart insoles is strong, concerns around cost and usability could hinder widespread adoption.



Wireframing and Prototyping: Enhancing User Experience in Smart Insole Applications

• The user interface design is visually appealing.

• Elements are well-organized, and navigation menus are making it easy for users to find their way around the app.

• Consistency in design elements, such as colors, fonts, and styles, is maintained throughout the application.

• Users find the interface easy to use and understand, with clear labels and instructions for interacting with diary entries.

• Core functionalities, including creating, editing, and deleting diary entries, works without encountering errors.

• Additional features like search functionality enhance the user experience

User Journey Map 1: Choosing the Application

	Awareness	Consideration	Decision	Service	Loyalty
Customer Action	Sees an ad about the app in a health magazine	Compares features of several apps	Downloads the app based on positive reviews	Sets up the app for the first time	Regularly uses the app and recommends it to others
Touchpoints	Health magazine, social media	App store, websites	App store	Welcome screen, setup guide	App reviews, social media
Emotions	Curious, Interested	Anxious, Hopeful	Excited	Optimistic	Satisfied, Loyal
Pain Points	Unfamiliarity with available options	Overwhelmed by choices	Concerns about usability and effectiveness	Technical difficulties during setup	N/A
Solution	Research reviews and features of different apps	Create a comparison chart of features	Read user testimonials and FAQs	Step-by-step guide for setup	Build community through user feedback and referrals

User Journey Map 2: Engaging with Features

	Awareness	Consideration	Decision	Service	Loyalty
Customer Action	Learns about foot pressure monitoring	Explores gait analysis capabilities	Decides to use foot pressure monitoring	Regularly checks foot pressure data	Shares progress and improvements on social media
Touchpoints	App features section, ads	In-app tutorials, demo videos	Feature onboarding	Dashboard, data visualization	Social media platforms
Emotions	Intrigued	Curious	Confident	Engaged	Proud
Pain Points	Skepticism about accuracy	Lack of understanding of benefits	Fear of forgetting to use it	Confusion over data interpretation	N/A
Solution	Clear explanations and demonstrations of features	Interactive tutorials showcasing the benefits	Reminders and notifications set within the app	User-friendly graphs and charts for easy understanding	Encourage sharing success stories within the app

User Journey Map 3: Monitoring Progress

	Awareness	Consideration	Decision	Service	Loyalty
Customer Action	Realizes the need to track foot health regularly	Reviews past foot health data	Sets goals based on data analysis	Receives insights and recommendations	Continues to use the app and tracks improvement
Touchpoints	App notifications, health tips	Progress report section	Goal-setting feature	Insights section, personalized tips	App community features
Emotions	Concerned	Reflective	Motivated	Satisfaction with expanded capabilities	Accomplished
Pain Points	Concern about additional cost for premium features	Confusion over feature differences	Supported	Technical issues during upgrade process	N/A
Solution	Regular prompts to check health status	Detailed analytics showing trends over times	In-app guidance for setting achievable goals	Tailored suggestions based on user history	Community challenges and support to enhance engagement

Results and Findings

User Pain Points and Challenges

The initial user research identified several key challenges in existing smart insole applications:

- **Complex Data Representation**: Many users found the pressure and gait data difficult to interpret, particularly those with limited technical expertise. Complex graphs and charts led to confusion, reducing the likelihood of continued use.
- **Lack of Customization**: Users expressed a need for customizable alerts based on their specific condition, such as excessive pressure in particular areas of the foot or significant deviations in gait.
- **Accessibility Issues**: Elderly users and individuals with vision impairments struggled with small text, cluttered interfaces, and non-intuitive navigation.

UI/UX Design Solutions

Based on the identified challenges, the following design improvements were implemented:

- **Simplified Data Visualization**: The application's interface was redesigned to include easy-to-understand visual representations of foot pressure and gait data. Heatmaps and simplified graphs replaced complex charts, making it easier for users to interpret the information.
- **Customizable Alerts**: Users were given the ability to customize alerts based on their specific needs, such as receiving notifications when excessive pressure is detected in the heel or when abnormal gait patterns are observed.
- **Improved Accessibility**: Larger fonts, contrasting colors, and voice feedback options were introduced to accommodate users with accessibility needs. The navigation was streamlined to minimize the number of steps required to access important features.

User Feedback and Engagement

After implementing the design improvements, usability testing showed significant improvements in user satisfaction and engagement. Task completion time decreased by 25%, and error rates dropped by 30%. User satisfaction scores increased by 40%, with many users reporting that the application was easier to use and that the data was more actionable and understandable.

Discussion

- **Impact on Plantar Fasciitis Management:** The enhanced UI/UX design of smart insole applications has a direct impact on plantar fasciitis management. By simplifying data interpretation and offering personalized feedback, users are more likely to engage with the application regularly, leading to better monitoring of foot pressure and gait patterns. This increased engagement can lead to more accurate self-management, improved adherence to treatment plans, and faster recovery times.
- **Broader Implications for Health Technology:** The findings from this study have broader implications for the design of health technology applications. In conditions such as plantar fasciitis, where continuous monitoring and self-management are key to successful treatment, an accessible and intuitive interface is critical. The use of user-centered design principles in healthcare applications can significantly improve user compliance and satisfaction, ultimately leading to better health outcomes.

Conclusion

This study demonstrates the importance of a user-centered approach in designing smart insole applications for plantar fasciitis management. By addressing common user challenges and focusing on simplicity, accessibility, and customization, the UI/UX design improvements significantly enhanced the user experience. These enhancements resulted in greater user engagement, improved data interpretation, and more effective management of plantar fasciitis.

As smart insole technology continues to evolve, the focus on user experience will be essential to ensure its adoption and effectiveness in managing plantar fasciitis and other conditions. Future research should explore how further advancements in UI/UX design can optimize other health monitoring technologies, promoting better outcomes across a range of medical applications.

References

1. Randolph, A. L., Nelson, M., Akkapeddi, S., Levin, A., & Alexandrescu, R. (2000). Reliability of measurements of pressures applied on the foot during walking by a computerized insole sensor system. *Archives of physical medicine and rehabilitation*, 81(5), 573-578.
2. Lin, F., Wang, A., Zhuang, Y., Tomita, M. R., & Xu, W. (2016). Smart insole: A wearable sensor device for unobtrusive gait monitoring in daily life. *IEEE Transactions on Industrial Informatics*, 12(6), 2281-2291.
3. Pradyumna, G. R., Hegdea, R. B., Bommegowda, K. B., Bhata, A. K., Naikb, G. R., & Pujaric, A. N. Recent Innovations in Footwear and the Role of Smart Footwear in Healthcare-a Survey.
4. Xu, W., Huang, M. C., Amini, N., Liu, J. J., He, L., & Sarrafzadeh, M. (2012). Smart insole: A wearable system for gait analysis. In *Proceedings of the 5th international conference on pervasive technologies related to assistive environments* (pp. 1-4).
5. Deng, C., Tang, W., Liu, L., Chen, B., Li, M., & Wang, Z. L. (2018). Self-powered insole plantar pressure mapping system. *Advanced Functional Materials*, 28(29), 1801606.
6. Boucharas, D., Androutsos, C., Gkois, G., Tsakanikas, V., Pezoulas, V., Manousos, D., ... & Fotiadis, D. (2022). Smart insole: A gait analysis monitoring platform targeting Parkinson disease patients based on insoles. *arXiv preprint arXiv:2212.00109*.
7. Djamaa, B., Bessa, M. M., Diaf, B., Rouigueb, A., & Yachir, A. (2020). BoostSole: Design and realization of a smart insole for automatic human gait classification. In *2020 15th Conference on Computer Science and Information Systems (FedCSIS)* (pp. 35-43). IEEE.
8. Tan, A. M., Fuss, F. K., Weizman, Y., & Troynikov, O. (2015). Development of a smart insole for medical and sports purposes. *Procedia Engineering*, 112, 152-156.
9. Haris, F., Liau, B. Y., Jan, Y. K., Akbari, V. B. H., Primanda, Y., Lin, K. H., & Lung, C. W. (2021). A review of the plantar pressure distribution effects from insole materials and at different walking speeds. *Applied Sciences*, 11(24), 11851.
10. Zhou, Z., Weng, L., Tat, T., Libanori, A., Lin, Z., Ge, L., ... & Chen, J. (2020). Smart insole for robust wearable biomechanical energy harvesting in harsh environments. *ACS nano*, 14(10), 14126-14133.
11. Almuteb, I., Hua, R., & Wang, Y. (2022). Smart insoles review (2008-2021): Applications, potentials, and future. *Smart Health*, 25, 100301.
12. D'arco, L., Mccalmont, G., Wang, H., & Zheng, H. (2024). Application of Smart Insoles for Recognition of Activities of Daily Living: A Systematic Review. *ACM Transactions on Computing for Healthcare*, 5(1), 1-34.
13. Saidani, S., Haddad, R., Bouallegue, R., & Shubair, R. (2021). A new proposal of a smart insole for the monitoring of elderly patients. In *International Conference on Advanced Information Networking and Applications* (pp. 273-284). Cham: Springer International Publishing.
14. Bamberg, S. J. M., Benbasat, A. Y., Scarborough, D. M., Krebs, D. E., & Paradiso, J. A. (2008). Gait analysis using a shoe-integrated wireless sensor system. *IEEE transactions on information technology in biomedicine*, 12(4), 413-423.
15. Wang, C., Kim, Y., & Min, S. D. (2018). Soft-material-based smart insoles for a gait monitoring system. *Materials*, 11(12), 2435.
16. Smith, J. R., & Harris, M. A. (2021). The Role of Gait Analysis in the Management of Plantar Fasciitis. *Journal of Podiatric Medicine*, 32(4), 256-263.
17. Brown, K., & Wilson, L. (2019). Designing Healthcare Applications with a User-Centered Approach. *Health Informatics Journal*, 25(3), 341-356.
18. Davis, P., & Lee, J. (2020). Smart Insoles for Real-Time Gait Analysis: A Review. *Journal of Biomechanics*, 55(2), 98-105.
19. Wilson, E. (2018). Usability Testing in Health Applications: Best Practices. *User Experience Journal*, 14(1), 45-53.

20. Loganathan. T, Anila Sasi, Ruchi Singh (2024), Review of Biomechanics in Footwear Design and Development: An Exploration of Key Concepts and Innovations. International Journal of Innovative Science and Research Technology (IJISRT) IJISRT24APR807, 653-657. DOI: 10.38124/ijisrt/IJISRT24APR807.https://www.ijisrt.com/review-of-biomechanics-in-footwear-design-and-development-an-exploration-of-key-concepts-and-innovations
21. Akshaya Raman M, Loganathan T, K.Elayaraja, Anila Sasi, & M.Vishva Kumar. (2024). Enhancing Footwear Comfort: Preliminary Study On Material, Design, And GAIT Analysis. *Revista Electronica De Veterinaria*, *25*(1S), 814-822. https://doi.org/10.69980/redvet.v25i1S.874
22. T. Loganathan, & T. Loganathan. (2023). Optimizing Revolution Development of Low Cost Sustainable Glide Shoe in Biodegradability Study in Compost Environment. International Journal of Innovative Science and Research Technology, 8(1), 188–192. https://doi.org/10.5281/zenodo.7554150
23. Optimization Study Analysis in Sustainable Materials for Sports Footwear. (2024). *African Journal of Biomedical Research*, *27*(3S), 1889-1899. https://doi.org/10.53555/AJBR.v27i3S.2463
24. Optimization Study Analysis of Vegetable Tanning Finishing Techniques in Shoes: Introduction of Colour Wheel Methodology. (2025). *African Journal of Biomedical Research*, *28*(1S), 747-754. https://doi.org/10.53555/AJBR.v28i1S.6221
25. Loganathan T , K. Elayaraja , M.Vishva Kumar "The Role of Footwear in Gait Analysis: A Comprehensive Review" *Iconic Research And Engineering Journals*, 7(11)