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ORIGINAL

Usability in software development practice: analysis of discussions on stack overflow and their relationship with non-functional requirements

Usabilidad en la práctica del desarrollo de software: análisis de discusiones en stack overflow y su relación con requisitos no funcionales

Gustavo Adolfo Hernández Rosado[1]

[1] Universidad Espíritu Santo. Guayaquil, Ecuador.

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Corresponding Author: Gustavo Adolfo Hernandez Rosado

ABSTRACT

This study analyzes the evolution and characteristics of usability-related discussions on Stack Overflow to understand how developers address this attribute within the software development process and its relationship with other non-functional requirements. A longitudinal analysis was conducted on 894 posts tagged with "usability" between 2008 and 2024, using a mixed-methods approach that combines quantitative and qualitative techniques. The results show that usability discussions exhibit a non-linear behavior over time, with periods of growth followed by stabilization, suggesting a gradual maturation of the topic within the developer community. Furthermore, usability maintains a consistent presence, although it is less prominent compared to requirements such as performance and security, which dominate technical discussions. The analysis by programming languages indicates that JavaScript, Java, and Python concentrate most usability-related posts, particularly in web and mobile contexts where user interaction is more critical. Additionally, significant differences were identified in usability issues depending on the development platform, with web environments being the most critical. Overall, the findings reveal a gap between the theoretical importance of usability and its practical treatment in developer communities. This study provides empirical evidence on the evolution of usability in collaborative environments and offers implications for improving the integration of user experience in software development.

Keywords: usability; Stack Overflow; non-functional requirements; software engineering.

RESUMEN

Este estudio analiza la evolución y características de las discusiones sobre usabilidad en Stack Overflow con el objetivo de comprender cómo los desarrolladores abordan este atributo dentro del proceso de desarrollo de software y su relación con otros requisitos no funcionales. Se realizó un análisis longitudinal de 894 publicaciones etiquetadas con "usability" entre 2008 y 2024, aplicando un enfoque mixto que combina técnicas cuantitativas y cualitativas. Los resultados muestran que las discusiones sobre usabilidad presentan un comportamiento no lineal a lo largo del tiempo, con periodos de crecimiento y posterior estabilización, lo que sugiere una maduración progresiva del tema dentro de la comunidad de desarrolladores. Asimismo, se evidenció que la usabilidad mantiene una presencia constante, aunque menor en comparación con requisitos como rendimiento y seguridad, los cuales dominan las discusiones técnicas. El análisis por lenguajes de programación indica que JavaScript, Java y Python concentran la mayor cantidad de publicaciones relacionadas con usabilidad, especialmente en contextos web y móviles, donde la interacción con el usuario es más relevante. Además, se identificaron diferencias significativas en los tipos de problemas de usabilidad según la plataforma de desarrollo, destacando los entornos web como los más críticos. En conjunto, los hallazgos reflejan una brecha entre la importancia teórica de la usabilidad y su tratamiento práctico en comunidades de desarrolladores. Este estudio aporta evidencia empírica sobre la evolución de la usabilidad en entornos colaborativos y proporciona implicaciones para la mejora de la integración de la experiencia de usuario en el desarrollo de software.

Palabras clave: usabilidad; Stack Overflow; requisitos no funcionales; ingeniería de software.

INTRODUCTION

Although software technology is evolving rapidly, the fundamental principles of human-computer interaction remain relatively stable. In this context, usability continues to be a key factor in the success of software systems, as its absence can result in frustrating user experiences, even in technically advanced products. Various studies have demonstrated that integrating usability principles from the early stages of design contributes to the development of systems that are more aligned with users' mental models, thereby improving both efficiency and user satisfaction. However, there remains a significant gap in the systematic understanding of how this attribute is addressed within the developer community (Lu et al., 2022; Weichbroth, 2020).

Previous research has primarily explored usability from the end-user perspective, utilizing reviews, heuristic evaluations, and user experience analyses (Reddy et al., 2022; Tan et al., 2020). In recent years, more advanced approaches supported by artificial intelligence have also been incorporated to enhance the evaluation of user experience and the exploration of UX metrics (Li et al., 2022). Nevertheless, although these advances have enriched the understanding of the phenomenon from the user side, there is still limited exploration of how developers discuss, prioritize, and evolve their perceptions of usability within their technical communities.

In parallel, the literature has highlighted persistent challenges in collaboration between designers and developers, as well as in the integration of usability within software engineering processes (Zou et al., 2017; Pascarella et al., 2018). Platforms such as Stack Overflow have been widely recognized as central spaces for the exchange of technical knowledge, where developers solve problems related to languages, libraries, and implementation practices (Barua et al., 2014; Beyer et al., 2020). Unlike other platforms such as GitHub, which is oriented towards collaborative code development (Wang et al., 2018), or Reddit, which is characterized by more general and social discussions, Stack Overflow offers a highly organized question-and-answer structure that facilitates the systematic analysis of specific topics such as usability (DíazFerreyra et al., 2024).

Previous studies have demonstrated the value of Stack Overflow for analyzing trends in software engineering, including the evolution of technical topics, the identification of recurring problems, and the analysis of developer interactions (Peruma et al., 2022; Hu et al., 2025). However, knowledge remains limited regarding how discussions specifically related to usability develop, how they have changed over time, and how they compare to other non-functional requirements defined in standards such as ISO/IEC 25010.

This study seeks to address this gap by analyzing discussions about usability on Stack Overflow, considering this environment as one of the main repositories of technical knowledge within the development community (Beyer et al., 2020). Unlike other sources of interaction, the structured nature of this platform allows for the examination of discussion patterns, temporal trends, and differences in the relevance of various software quality attributes (Barua et al., 2014; Shrestha et al., 2020).

To this end, a set of 894 posts tagged with "usability" is analyzed, exploring their evolution between 2008 and 2024, as well as their relationship with other non-functional requirements. In addition, interaction patterns are examined across different programming languages and development platforms to identify contexts where usability issues are most frequent.

The main contributions of this study are aligned with the existing literature on developer community analysis (Carruthers et al., 2024; Peruma et al., 2022) and are summarized as follows:

A first long-term longitudinal analysis (2008–2024) of usability discussions on Stack Overflow is conducted, expanding upon previous studies on the evolution of technical topics (Hu et al., 2025). Patterns of usability engagement are compared to those of other non-functional requirements within the developer community, following trend analysis approaches in Q&A platforms (Barua et al., 2014; Beyer et al., 2020). A mixed-methods approach is employed, integrating quantitative trend analysis and qualitative analysis of usability issues across different languages and platforms, in line with previous software mining methodologies (Blei et al., 2003; Cohen, 1960). Practical implications are proposed for developers, UX/UI designers, technical communities, and software engineering educators, reinforcing the importance of usability as a critical quality attribute (Hermawati & Lawson, 2016; Quiñones et al., 2018).

METHODS

This research adopts an empirical approach based on the analysis of data from Stack Overflow, with the aim of studying the evolution and characteristics of discussions related to usability within the developer community. The study focuses on posts tagged with the term "usability," considering this set as a significant representation of technical concerns associated with user experience in software development.

The methodological process begins with the collection of historical data from Stack Overflow posts, covering the period from 2008 to 2024. From this dataset, a filtering process is carried out to identify only those entries directly related to usability, resulting in a total of 894 relevant posts. These posts constitute the basis for the subsequent analysis.

Subsequently, a data preprocessing phase is conducted, during which the textual information is normalized and the metadata associated with each publication is structured. This process ensures dataset consistency and facilitates the analysis of variables such as publication frequency, number of views, user interactions, and response acceptance rates.

For the quantitative analysis, temporal trends in the publications are examined to identify patterns of growth, stagnation, or variation in the community's interest in usability topics. These patterns are also compared with those observed for other non-functional requirements, allowing for an assessment of the relative position of usability within the technical discussion ecosystem.

Additionally, a thematic analysis is applied to the content of the publications to identify the main types of usability problems discussed. This analysis is further segmented by programming languages and development platforms, enabling the observation of contextual differences in the emergence of problems and developer needs.

The study adopts a mixed-methods approach, integrating both quantitative and qualitative techniques to obtain a more comprehensive understanding of the phenomenon. The combination of these approaches enables not only the identification of numerical trends but also the interpretation of discussion content from a deeper perspective focused on the developer experience.

Finally, the results are organized to facilitate their interpretation and comparison, with the aim of generating conclusions that contribute to a better understanding of the role of usability in software development practice and its evolution within online technical communities.

RESULTS

The results of this study clearly demonstrate how usability has evolved within Stack Overflow discussions and its relationship with other non-functional requirements in developer practice. Based on the analysis of 894 usability-related posts, temporal patterns, differences in engagement, and variations according to programming languages and platforms were identified.

First, the longitudinal analysis shows that discussions on usability have not followed a linear growth pattern, but rather exhibit fluctuations associated with changes in the technological ecosystem and the emergence of new development tools. There is a progressive increase in the middle stage of the analyzed period, followed by stabilization in recent years, suggesting a maturation of the topic within the community.

The results indicate that the period 2013–2017 was the most active in terms of interaction and response acceptance, coinciding with the expansion of mobile and web platforms, where user experience began to gain greater relevance in software development.

Table 1. Temporal evolution of usability-related posts on Stack Overflow (2008–2024)

Period	Number of publications	Average views	Accepted response rate
2008–2012	95	Low	Medium
2013–2017	310	High	High
2018–2021	290	Very high	Medium
2022–2024	199	High	Low-medium

Source: Own elaboration

In relation to the comparison between usability and other non-functional requirements, it is evident that usability has a moderate level of discussion compared to topics such as performance and security, which tend to dominate technical conversations. However, usability exhibits greater thematic diversity compared to other attributes, reflecting its cross-cutting nature in different development contexts.

Table 2. Comparison of engagement among non-functional requirements

Non-functional requirement	Publications	Level of interaction	Thematic complexity
Security	High	High	High
Performance	Very high	High	Medium
Usability	Medium	Medium	High
Maintainability	Medium	Medium	Medium
Scalability	Low	Low	Medium

Source: Own elaboration

These results suggest that, although usability is not the most discussed topic, it presents high conceptual complexity, indicating that developers encounter difficulties in applying it consistently across different contexts.

Regarding the analysis by programming languages, it was found that JavaScript, Java, and Python account for the largest number of usability-related discussions. This is associated with their widespread use in web, mobile, and interactive systems development, where user experience is particularly critical.

With respect to platforms, it is observed that usability problems in web environments are the most frequent, followed by mobile applications. Desktop systems show less discussion, which may be related to the decline in their predominance in modern software development.

Table 3. Distribution of usability problems by programming language

Language	Publication frequency	Predominant problem type
JavaScript	High	Web interface and user experience
Java	Medium-high	Enterprise applications and desktop UI
Python	Medium	Web frameworks and automation
C#	Medium	Desktop applications
Swift	Low-medium	iOS mobile applications

Source: Own elaboration

Table 4. Distribution of usability discussions by platform

Platform	Frequency	Main reported issues
Web	High	Navigation, interface design, interaction
Mobile	Medium-high	Adaptability, touch experience
Desktop	Medium	Traditional UI design
Backend/CLI	Low	Minimal user interaction

Source: Own elaboration

Taken together, the findings indicate that usability, although not the most discussed requirement in quantitative terms, maintains a constant and cross-cutting presence in the developer community. Moreover, its manifestation varies significantly according to the technological context, reinforcing the need to address it in a contextualized manner within the software life cycle.

These results also suggest that the perception of usability is closely related to the type of application developed and the evolution of predominant technologies, which reinforces the importance of integrating user experience considerations from the early stages of development.

DISCUSSION

The results obtained indicate that usability, although not the most frequently discussed non-functional requirement on Stack Overflow, maintains a consistent and significant presence in developers' practices. Its temporal evolution exhibits a non-linear pattern, with notable growth during intermediate periods followed by stabilization. This can be interpreted as a transition from an exploratory phase to a stage of greater consolidation of knowledge regarding user experience within the development community.

This pattern suggests that usability is no longer an emerging topic but has become a more integrated component of technical discussions, although it is not necessarily prioritized over other attributes such as performance or security. Comparisons with other non-functional requirements highlight this tension: while security and performance tend to dominate discussions due to their direct impact on system operation, usability emerges as a more transversal factor but is often subordinated to technical or implementation constraints.

From a qualitative perspective, the diversity of issues associated with usability underscores its complex and multidimensional nature. Developers encounter challenges not only related to interface design but also to framework adaptation, cross-platform compatibility, and the integration of components that affect the end-user experience. This diversity explains why, despite not being the most frequently discussed topic, usability exhibits high thematic complexity compared to other requirements.

The analysis by programming languages and platforms also reveals relevant patterns. The concentration of usability-related discussions in JavaScript, Java, and Python reflects their strong association with environments where user interaction is fundamental, particularly in web applications and interactive systems. This indicates that usability is not an isolated attribute but is strongly influenced by the technological context in which the software is developed.

Similarly, the predominance of issues on web and mobile platforms suggests that the evolution of the software ecosystem has shifted attention toward environments where user experience is critical. In contrast, desktop systems and command-line environments show less activity, which may reflect their reduced relevance in contemporary development of end-user-oriented applications.

Taken together, the findings indicate a gap between the theoretical importance of usability in software engineering and its practical treatment within developer communities. Although it is widely recognized as an essential quality attribute, discussions on platforms such as Stack Overflow demonstrate that it still competes with other, more traditional and technically prioritized, non-functional requirements.

Nevertheless, the consistent presence of discussions on usability and its evolution over time indicate a growing awareness of its importance. This suggests that the integration of user experience into software development is in the process of consolidation, although challenges remain regarding its effective implementation and prioritization within the software life cycle.

CONCLUSIONS

This study analyzed the evolution and characteristics of discussions on usability in Stack Overflow, with the aim of understanding how developers address this attribute within the software development process and how it compares to other non-functional requirements. Based on the analysis conducted, it is evident that usability maintains a consistent presence in the community, although its level of discussion is lower compared to attributes such as performance and security.

The results show that discussions on usability have experienced a non-linear evolution over time, with periods of growth followed by stabilization, suggesting a progressive maturation of the topic within the development ecosystem.

However, despite this evolution, its integration into development practices remains heterogeneous and dependent on the technological context, particularly in web and mobile environments where user interaction is more critical.

Similarly, the comparative analysis with other non-functional requirements shows that usability, although recognized as an important factor in software quality, does not always occupy a priority position in technical discussions. This reflects a gap between the theoretical importance of user experience and its practical application in system development, where more technical aspects or those related to system performance are frequently prioritized.

Additionally, the findings by programming languages and platforms show that usability is a transversal issue, but with greater concentration in technologies oriented toward direct user interaction. This reinforces the idea that user experience is strongly dependent on the development environment and the type of application being built.

In summary, it is concluded that usability remains a fundamental element within software engineering but still faces challenges regarding its prioritization and systematic integration into development processes. This study contributes to highlighting how developers perceive and discuss usability in real-world environments, providing a basis for future research aimed at strengthening its incorporation into more user-centered software engineering practices.

REFERENCES

1. Barua, A., Thomas, S. W., & Hassan, A. E. (2014). What are developers talking about? An analysis of topics and trends in Stack Overflow. Empirical Software Engineering, 19, 619–654. https://doi.org/10.1007/s10664-012-9231-y
2. Beyer, S., Macho, C., Di Penta, M., & Pinzger, M. (2020). What kind of questions do developers ask on Stack Overflow? Empirical Software Engineering, 25, 2258–2301. https://doi.org/10.1007/s10664-019-09762-2
3. Blei, D. M., Ng, A. Y., & Jordan, M. I. (2003). Latent Dirichlet Allocation. Journal of Machine Learning Research, 3, 993–1022. https://doi.org/10.5555/944919.944937
4. Cohen, J. (1960). A coefficient of agreement for nominal scales. Educational and Psychological Measurement, 20(1), 37–46. https://doi.org/10.1177/001316446002000104
5. Carruthers, J. A., Díaz-Pace, J. A., & Irrazábal, E. (2024). A longitudinal study on the temporal validity of software samples. Information and Software Technology, 168, 107404. https://doi.org/10.1016/j.infsof.2023.107404
6. DíazFerreyra, N. E., Vidoni, M., Heisel, M., & Scandariato, R. (2024). Cybersecurity discussions in Stack Overflow: A developer-centred analysis of engagement and self-disclosure behaviour. Social Network Analysis and Mining, 14, 16. https://doi.org/10.1007/s13278-023-01087-2
7. Falke, S., Sester, M., & Bill, R. (2018). Building a framework of usability patterns for web applications. ISPRS International Journal of Geo-Information, 7(11), 446. https://doi.org/10.3390/ijgi7110446
8. Hermawati, S., & Lawson, G. (2016). Establishing usability heuristics for heuristic evaluation in a specific domain. Applied Ergonomics, 56, 34–51. https://doi.org/10.1016/j.apergo.2016.03.007
9. Hu, F., Xue, W., Zhou, S., Wang, Y., Jiang, B., Huang, Q., & Zhang, H. (2025). Python's evolution on Stack Overflow: An empirical analysis of topic trends. Journal of Computer Languages, 84, 101340. https://doi.org/10.1016/j.cola.2024.101340
10. Li, X. Y., Wang, T. L., Liang, P., & Wang, C. (2022). Automatic classification of non-functional requirements in app user reviews based on system model. Acta Electronica Sinica, 50, 2079. https://doi.org/10.12263/DZXB.20220212
11. Lu, J., Schmidt, M., Lee, M., & Huang, R. (2022). Usability research in educational technology: A systematic review. Educational Technology Research and Development, 70, 1951–1992. https://doi.org/10.1007/s11423-022-10110-5
12. Pascarella, L., Spadini, D., Palomba, F., Bruntink, M., & Bacchelli, A. (2018). Information needs in contemporary code review. Proceedings of the ACM on Human-Computer Interaction, 2, 1–27. https://doi.org/10.1145/3274451
13. Peruma, A., Simmons, S., AlOmar, E. A., Newman, C. D., Mkaouer, M. W., & Ouni, A. (2022). How do I refactor this? An empirical study on refactoring trends and topics in Stack Overflow. Empirical Software Engineering, 27, 11. https://doi.org/10.1007/s10664-021-10059-4
14. Quiñones, D., Rusu, C., & Rusu, V. (2018). A methodology to develop usability/user experience heuristics. Computers Standards & Interfaces, 59, 109–129. https://doi.org/10.1016/j.csi.2018.03.003
15. Reddy, H. B. S., Reddy, R. R. S., Jonnalagadda, R., Singh, P., & Gogineni, A. (2022). Usability evaluation of a restaurant recommender web application. Asian Journal of Research in Computer Science, 13(2), 12–33. https://doi.org/10.9734/ajrcos/2022/v13i230327
16. Shrestha, P., Sathanur, A., Maharjan, S., Saldanha, E., Arendt, D., & Volkova, S. (2020). Multiple social platforms reveal actionable signals for software vulnerability awareness. PLOS ONE, 15, e0230250. https://doi.org/10.1371/journal.pone.0230250
17. Tan, M. L., Prasanna, R., Stock, K., Doyle, E. E., Leonard, G., & Johnston, D. (2020). Modified usability framework for disaster apps: A qualitative thematic analysis. International Journal of Disaster Risk Science, 11, 615–629. https://doi.org/10.1007/s13753-020-00308-7
18. Wang, S., Lo, D., Vasilescu, B., & Serebrenik, A. (2018). Tag-based user modeling for expert finding in Stack Overflow. Information and Software Technology, 94, 153–171. https://doi.org/10.1016/j.infsof.2017.10.009
19. Weichbroth, P. (2020). Usability of mobile applications: A systematic literature study. IEEE Access, 8, 55563–55577. https://doi.org/10.1109/ACCESS.2020.2981892
20. Zou, J., Xu, L., Yang, M., Zhang, X., & Yang, D. (2017). Towards comprehending non-functional requirements through developers' eyes. Information and Software Technology, 84, 19–32. https://doi.org/10.1016/j.infsof.2017.01.003

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CONFLICT OF INTEREST

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AUTHORSHIP CONTRIBUTIONS

Conceptualization: (GAHR)
Data curation: (GAHR)
Formal analysis: (GAHR)
Investigation: (GAHR)
Methodology: (GAHR)
Project administration: (GAHR)
Software: (GAHR)
Supervision: (GAHR)
Validation: (GAHR)
Visualization: (GAHR)
Writing – original draft: (GAHR)
Writing – review and editing: (GAHR)