Jutisi: Jurnal Ilmiah Teknik Informatika dan Sistem Informasi
https://ojs.stmik-banjarbaru.ac.id/index.php/jutisi/index
Jl. Ahmad Yani, K.M. 33,5 - Kampus STMIK Banjarbaru
Loktabat – Banjarbaru (Tlp. 0511 4782881), e-mail: puslit.stmikbjb@gmail.com
e-ISSN: 2685-0893

Analyzing Spotify User Experience using UEQ and Fuzzy K-Means Clustering

DOI: http://dx.doi.org/10.35889/jutisi.v14i2.2928

Caroline Amanda Chinta[1], Charitas Fibriani[2*]
Sistem Informasi, Universitas Kristen Satya Wacana, Salatiga, Indonesia
*e-mail *Corresponding Author:* charitas.fibriani@uksw.edu

Abstract

This study evaluates the user experience (UX) of Spotify using the User Experience Questionnaire (UEQ) and Fuzzy K-Means clustering. The main issue addressed is the need to understand user satisfaction, especially related to reliability. The objective is to assess Spotify's UX quality and group users based on satisfaction. A total of 128 participants completed the UEQ, covering six dimensions: Attractiveness, Perspicuity, Efficiency, Dependability, Stimulation, and Novelty. Results show five dimensions rated as "Excellent," while Dependability was rated "Below Average," indicating issues with control and consistency. Clustering analysis identified three user groups with different satisfaction levels. One cluster consistently reported low ratings across all dimensions. These findings reflect Spotify's overall strong UX, while also pointing out areas for improvement. The integration of UEQ and clustering provides valuable insights into user segmentation and can serve as a framework for future UX evaluations.
Keywords: *Clustering; Fuzzy K-Means; Spotify; UEQ; User Experience*

Abstrak

Penelitian ini mengevaluasi pengalaman pengguna (*User Experience*/UX) aplikasi Spotify menggunakan *User Experience Questionnaire* (UEQ) dan metode klasterisasi *Fuzzy K-Means*. Masalah utama yang dibahas adalah perlunya pemahaman terhadap kepuasan pengguna, khususnya dalam aspek keandalan. Tujuan penelitian ini adalah menilai kualitas UX Spotify dan mengelompokkan pengguna berdasarkan tingkat kepuasannya. Sebanyak 128 partisipan mengisi UEQ yang mencakup enam dimensi: *Attractiveness, Perspicuity, Efficiency, Dependability, Stimulation*, dan *Novelty*. Hasil menunjukkan lima dimensi memperoleh nilai *Excellent*, sedangkan dimensi *Dependability* berada pada kategori *Below Average*, mengindikasikan adanya masalah dalam kontrol dan konsistensi. Analisis klaster menghasilkan tiga kelompok pengguna dengan tingkat kepuasan yang berbeda. Salah satu klaster secara konsisten menunjukkan penilaian rendah di semua dimensi. Temuan ini mencerminkan performa UX Spotify yang sangat baik secara umum, namun tetap ada aspek yang perlu ditingkatkan. Integrasi UEQ dan analisis klaster memberikan wawasan mendalam tentang segmentasi pengguna dan menjadi acuan untuk evaluasi UX selanjutnya.
Kata kunci: *Clustering; Fuzzy K-Means; Spotify; UEQ; User Experience*

1. Introduction

Music has long served as a universal form of entertainment and emotional expression throughout human history. In recent decades, technological advancement has drastically changed the way people access and interact with music [1]. The shift from physical media to digital platforms, particularly music streaming services such as Spotify, Apple Music, and Joox, has provided users with instant access to vast music libraries across devices. Among these, Spotify has emerged as one of the most dominant players in the global market. Its widespread usage especially among younger, tech-savvy demographics highlights the growing demand for seamless, intuitive, and enjoyable user experiences (UX) within digital music platforms [2]. As UX becomes a competitive differentiator in the crowded streaming market, evaluating the quality of user interaction is increasingly important to ensure user retention and satisfaction.

Spotify's interface design, recommendation algorithms, and interactive features have contributed to its success in attracting millions of active users worldwide [3]. However, the increasing complexity of user needs and the continuous expansion of features bring challenges in ensuring that the overall UX remains coherent, effective, and user-centered. Reports from usability reviews and anecdotal user feedback on social platforms and review sites have pointed out issues such as interface clutter, inconsistent navigation, or recommendation fatigue [4],[5]. Moreover, the app's experience may vary significantly among different user groups based on factors such as usage frequency, listening habits, and personal expectations. These discrepancies make it necessary to perform an empirical UX evaluation to understand how different users perceive Spotify's interface and functionalities.

To address these concerns, this study adopts a Human-Computer Interaction (HCI) approach that emphasizes user-centered evaluation of digital systems [6]. Specifically, the User Experience Questionnaire (UEQ) is used to measure six key dimensions of UX: Attractiveness, Perspicuity, Efficiency, Dependability, Stimulation, and Novelty [7],[8]. Each dimension captures a different aspect of how users perceive and emotionally respond to the application. While UEQ provides structured quantitative data, this research further integrates the Fuzzy K-Means (FKM) clustering algorithm to explore hidden patterns in user perception. FKM enables the grouping of users based on similarity in UX responses, allowing overlapping memberships to reflect the nuanced and non-binary nature of human experiences [9]. By applying clustering and evaluating the quality of separation using the silhouette score, this study identifies meaningful user segments, offering insights into which dimensions drive the most variation and dissatisfaction among user clusters [10],[11].

The main objective of this research is to evaluate Spotify's user experience through the lens of HCI by employing the UEQ instrument in combination with FKM clustering. Specifically, this study aims to assess users' perception of Spotify's interface based on six UX dimensions, segment users into clusters with similar experience patterns, and analyze the distinct UX needs across these clusters. The expected outcome is to uncover specific strengths and weaknesses in Spotify's user interface, inform future UI/UX design improvements, and contribute to a deeper understanding of user segmentation in music streaming platforms. Furthermore, the results are intended to serve as a reference for designers, developers, and product managers in creating more user-centered and adaptive digital experiences.

2. Literature Review

Several prior studies have explored the application of the User Experience Questionnaire (UEQ) in evaluating music streaming platforms. Applied both the System Usability Scale (SUS) and UEQ on Spotify, with 104 respondents, the results showed Spotify achieved positive UX across all UEQ dimensions, with average scores well above 0.8 Similarly [9], compared Spotify and Joox using UEQ, revealing both apps received positive impressions—scoring above 0.8 in all six scales, Spotify slightly outperforming Joox [1]. Long-term UX has been evaluated using the UX Curve method to compare Spotify and Joox, demonstrating Spotify's superior user experience in mobile contexts [12]

Building on previous research, Spotify's user experience has also been examined using the UTAUT framework to identify key behavioral and facilitating factors influencing satisfaction and intention to use the app [10]. In another study, customer satisfaction was measured using the Customer Satisfaction Index (CSI), confirming a "very satisfied" category with a high score of 87.4% [11]. Although these studies validate that Spotify excels in UX and satisfaction, they rely on descriptive survey results or traditional adoption models without leveraging clustering techniques to uncover diverse user groups.

In contrast, Fuzzy K-Means clustering offers a powerful way to segment users based on their UEQ responses by allowing partial membership in multiple clusters. While Fuzzy K-Means has been applied in domains like e-commerce and education to manage overlapping data, there is no existing application of Fuzzy K-Means on UEQ data for music streaming services, particularly Spotify within recent journal research. For instance, Fuzzy K-Means has been used to cluster unemployment rates by region in Riau [13], to estimate software development efforts in online credit services [14], and to group village-level data for regional planning and development [15]. Despite these advancements, none has applied Fuzzy K-Means to segment user perception

data derived from the User Experience Questionnaire (UEQ) in the context of digital music streaming, highlighting a clear research gap.

To address this gap, this study integrates the User Experience Questionnaire (UEQ) with Fuzzy K-Means clustering to enhance the evaluation of Spotify's user experience. Unlike previous studies that primarily rely on descriptive survey data, the combination of structured UX measurement and clustering enables a more refined segmentation of user satisfaction levels, allowing users to belong to multiple clusters based on varying perceptions. By analyzing Spotify from a Human-Computer Interaction (HCI) perspective, this research aims to identify the platform's strengths and weaknesses, uncover deeper patterns in user interaction behaviors, and propose targeted improvements to enhance the overall user experience.

3. Methodology

This chapter outlines the methodology used to evaluate Spotify's user experience (UX) through the User Experience Questionnaire (UEQ) and to segment users using Fuzzy K-Means Clustering. The research is based on the growing relevance of user-centered design and the high usage of Spotify among Gen Z university students. It aims to measure UX perceptions and identify user segments through clustering. The overall process includes defining objectives, selecting participants, collecting and preprocessing data, applying clustering, interpreting results, and using appropriate analysis tools, as illustrated in Figure 1.

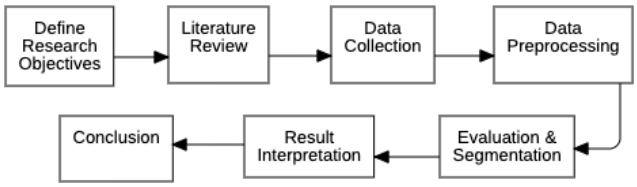

Figure 1. Research Methodology Flowchart

This study aims to evaluate Spotify's user interface and experience through a computational approach that combines the User Experience Questionnaire (UEQ) and K-Means Clustering. The objective is to assess user satisfaction across six key dimensions of UX: Attractiveness, Perspicuity, Efficiency, Dependability, Stimulation, and Novelty, and to segment users into distinct experience-based groups based on their evaluations.

The target population of this study is Gen Z users, specifically undergraduate students at Universitas Kristen Satya Wacana (UKSW) aged between 17 and 28 years old who actively use Spotify. A purposive sampling method was employed to ensure that participants met these criteria. Data were collected through an online survey using the standardized UEQ instrument, distributed via Google Forms. The questionnaire consists of 26 bipolar items across the six UX dimensions, each rated on a 7-point semantic differential scale ranging from -3 (very negative) to +3 (very positive). Responses were collected until a sufficient number of valid entries were obtained to ensure meaningful analysis. This sample represents approximately 5% of the estimated Spotify user population among UKSW students, making it a reasonable and adequate sample size for UX evaluation and clustering analysis. The number of participants also aligns with prior studies using UEQ and clustering methods, which typically involve 100–150 respondents, further supporting the reliability of the dataset.

After data collection, several preprocessing steps were conducted. First, invalid or incomplete responses were removed during the data cleaning phase. Each item was then converted from its semantic scale into numerical values following UEQ guidelines. For each participant, the average score for each of the six UX dimensions was calculated, producing a six-dimensional feature vector. To maintain consistency and allow comparability across dimensions, normalization was applied using z-score standardization where x is the original score, μ is the mean, and σ is the standard deviation of the respective dimension as shown in Equation (1):

$$z = (x - \mu) / \sigma \quad (1)$$

The cleaned and standardized data were then subjected to K-Means Clustering. Although the initial design considered the use of fuzzy clustering, the final implementation employed the standard K-Means algorithm due to its direct interpretability and visual clarity for segmentation. The number of clusters was set to three based on preliminary trials. The K-Means algorithm aims

to partition data into *k* non-overlapping subsets by minimizing intra-cluster variance, as formulated in the objective function shown in Equation (2), where *Ci* denotes the set of data points in cluster *i*, and *μi* is the centroid of that cluster:

$$J = \Sigma\ (i=1\ \text{to}\ k)\ \Sigma\ (x \in Ci)\ ||x - \mu i||^2 \quad (2)$$

To facilitate interpretation of the clustering results, a Principal Component Analysis (PCA) was conducted to reduce the dimensionality of the six-dimensional UX data to two principal components. This enabled the construction of a two-dimensional visualization. PCA was implemented by computing the covariance matrix of the standardized data, extracting eigenvalues and eigenvectors, and projecting the original dataset into a lower-dimensional space using the top eigenvectors, as shown in Equation (3), where *X* is the standardized data matrix and *W* is the matrix of selected eigenvectors:

$$Z = X \cdot W \quad (3)$$

The resulting clusters were analyzed to interpret user characteristics within each group. For instance, one cluster tended to represent dissatisfied users who rated Spotify low across most UX dimensions, particularly Dependability and Novelty. Another cluster consisted of moderately satisfied users with average ratings, while the third group comprised highly satisfied users, characterized by high scores in Attractiveness, Efficiency, and Stimulation. These distinctions were supported by the visualization in PCA space, where the clusters formed visibly separate groupings. To contextualize Spotify's performance, the average scores from each UX dimension were compared to standardized UEQ benchmark categories, which classify performance levels as Excellent, Good, Above Average, Below Average, or Bad. This comparison helps position Spotify's UX relative to industry expectations and similar digital products. All processes, including preprocessing, clustering, and visualization, were implemented using Python in the Google Colabs environment. The analysis utilized libraries such as Pandas and NumPy for data processing, Scikit-learn for clustering and dimensionality reduction, and Matplotlib and Seaborn for data visualization.

This methodology provides a structured and comprehensive framework for evaluating the user experience of Spotify. By integrating a standardized UX assessment tool with computational analysis, the research offers insights into both overall user perception and detailed segmentation based on experience patterns, strengthening the validity of the findings.

4. Result and Discussion

4.1 Data Collection

The data collection phase involved gathering responses from 128 valid participants who belong to Generation Z. These participants were undergraduate students aged between 17 and 28 years old and were all active Spotify users. The data were obtained using the User Experience Questionnaire (UEQ), a standardized instrument consisting of 26 bipolar items designed to measure user experience across six dimensions: Attractiveness, Perspicuity, Efficiency, Dependability, Stimulation, and Novelty. Each participant responded to the UEQ scale based on their interactions and experiences with the Spotify application. This allowed for a comprehensive analysis of the subjective perception of Spotify's user interface and its effectiveness. The responses were recorded using a Likert scale ranging from -3 to +3.

Table 1. Sample of UEQ Item Responses

Participant	Item 1	Item 2	Item 3	Item 4	Item 5	Item 6	Item 7	Item ...	Item 26
P01	7	1	5	7	7	1	7	…	7
P02	1	7	7	1	6	6	5	…	4
P03	7	1	1	1	6	6	1	…	7
P04	7	1	6	7	6	7	1	…	6
P05	7	1	7	7	7	1	7	…	5

To provide an overview of the raw data obtained, a sample of participant responses is presented in Table 1. This sample illustrates how individual scores were distributed across the first seven UEQ items and the final item (Item 26) for five respondents, prior to dimensional

aggregation. Although only a portion of the total 26 items is shown, the sample effectively demonstrates the structure and format of the collected data, which served as the foundation for subsequent analysis of user experience dimensions.

4.2 Data Preprocessing

The raw data obtained from the UEQ questionnaire were subjected to a preprocessing phase to ensure accuracy and validity. This included cleaning the data to remove incomplete or invalid entries, normalizing the values for further statistical analysis, and preparing the data structure for clustering. Descriptive statistics such as mean, standard deviation, and 95% confidence intervals were calculated for each of the six dimensions. The resulting dataset was then transformed into a format suitable for both benchmarking analysis and K-Means clustering.

Table 2. Mean Scores of UEQ Scales

Confidence intervals (p=0.05) per scale						
Scale	Mean	Std. Dev.	N	Confidence	Confidence interval	
Attractiveness	2,190	0,509	128	0,088	2,102	2,278
Perspicuity	2,199	0,541	128	0,094	2,105	2,293
Efficiency	2,023	0,596	128	0,103	1,920	2,127
Dependability	1,131	0,674	128	0,117	1,014	1,248
Stimulation	2,213	0,607	128	0,105	2,108	2,318
Novelty	1,961	0,643	128	0,111	1,850	2,072

Table 2 presents the mean scores and confidence intervals for each dimension. All dimensions, except for Dependability, fall within the "Excellent" range according to UEQ guidelines. Dependability showed the lowest mean (1.131), with a confidence interval ranging from 1.014 to 1.248. While this still indicates a generally positive perception, it suggests that users perceive less consistency and control in Spotify's interface compared to other aspects. This highlights an area for potential improvement, particularly in enhancing system reliability and user trust. Novelty recorded a mean score of 1.961, placing it between the "Positive" and "Excellent" categories. This implies users still perceive Spotify as relatively innovative, though there is room for improvement through more creative and fresh design elements.

4.3 Evaluation & Segmentation

Evaluation was conducted using both statistical and comparative methods. The statistical analysis enabled an objective understanding of user sentiment, while the comparative evaluation placed the results in the context of broader application standards.

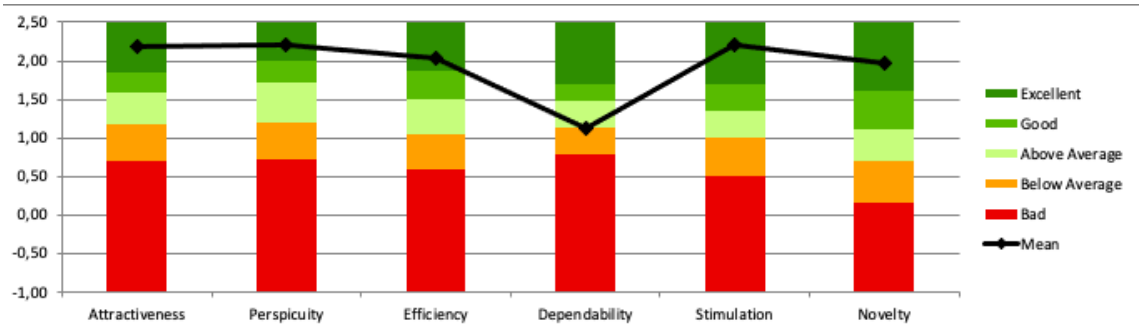

Figure 2. UEQ Scale Means Categorized by User Experience Quality Levels

Figure 2 categorizes the UEQ dimensions into five quality levels: Bad, Below Average, Above Average, Good, and Excellent. Attractiveness, Perspicuity, Efficiency, and Stimulation scored near the top, indicating highly favorable user perceptions. The black line on the chart represents the average score for each dimension. Dependability received the lowest average rating, slightly above 1.0, categorized as Above Average. This suggests that user perceptions of stability and reliability are not as strong as those for other aspects of the application. Meanwhile, Novelty falls between Above Average and Good, indicating users see the app as moderately innovative but not particularly outstanding.

Table 3. Benchmark Comparison of Spotify's UEQ Results

Scale	Mean	Comparison to benchmark	Interpretation
Attractiveness	2,19	Excellent	In the range of the 10% best result
Perspicuity	2,20	Excellent	In the range of the 10% best result
Efficiency	2,02	Excellent	In the range of the 10% best result
Dependability	1,13	Below average	50% of result better, 25% of result worse
Stimulation	2,21	Excellent	In the range of the 10% best result
Novelty	1,96	Excellent	In the range of the 10% best result

The visualization shown in Table 3 reinforces the previous statistical findings by illustrating a comparative view of user perceptions across six UX dimensions. Notably, *Dependability* emerges as the only dimension receiving a relatively neutral evaluation. This indicates that although most users are generally satisfied, a portion of them may experience occasional uncertainty regarding the application's consistency and reliability. These perceptions could stem from moments of unexpected behavior, insufficient system feedback, or minor interruptions that affect their trust and confidence in using the platform.

In contrast, *Stimulation* and *Perspicuity* garnered the highest evaluations, signaling both an emotionally engaging and cognitively seamless user experience. A strong *Perspicuity* score implies that users find the interface intuitive and easy to understand, while a high *Stimulation* rating reflects a sense of excitement and enjoyment that encourages continued use. These results suggest that Spotify succeeds in delivering a product that is not only functional but also enjoyable and user-friendly.

To place Spotify's UX performance in a broader context, the UEQ scores were benchmarked against global data provided by the UEQ Data Analysis Tool. This comparative analysis reveals that five of the six dimensions *Attractiveness*, *Perspicuity*, *Efficiency*, *Stimulation*, and *Novelty* are categorized as "Excellent," placing them within the top 10% of all evaluated digital products. These results affirm Spotify's strengths in areas such as visual appeal, engagement, ease of use, and innovation. Conversely, *Dependability* is rated "Below Average," which positions it in the lower 50% of benchmarked products. This contrast underscores an area for potential improvement. Enhancing the system's predictability, robustness, and responsiveness could significantly boost user trust, ultimately contributing to a more consistent and satisfying long-term experience.

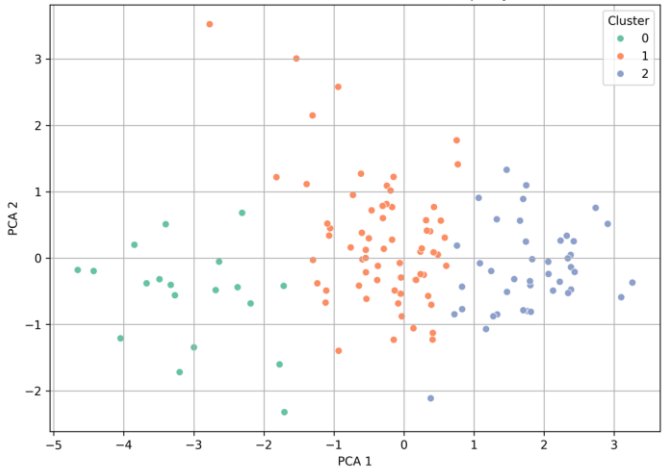

Figure 3. Cluster Visualization of UEQ Spotify Responses

To further elaborate on the findings obtained from the User Experience Questionnaire (UEQ), a K-Means clustering analysis was conducted on the dataset. This analytical step aimed to uncover whether distinct patterns could be identified among users based on their experiences with Spotify. The six UEQ dimensions, which include Attractiveness, Perspicuity, Efficiency, Dependability, Stimulation, and Novelty, served as the primary input variables for the clustering model. K-Means organizes data points into internally cohesive groups by minimizing variance within each cluster using an optimization function as described in formula (2). To improve interpretability, the clustering results were processed using Principal Component Analysis (PCA), which reduces multidimensional data into two principal components while retaining the most

informative patterns of variance, as shown in formula (3). Although clustering assigns each user to a specific group, the PCA visualization displays only the dominant affiliation of each individual to clearly represent the segmented user profiles.

The PCA visualization in Figure 3 shows the distribution of Spotify users across three clearly defined clusters based on their responses to the UEQ dimensions. The plot illustrates distinct separation among the clusters, suggesting that users' experiences differ meaningfully depending on their evaluations. Cluster 0, shown in green and located on the far left of the PCA plot, includes users who reported relatively low satisfaction. As seen in Figure 5, their responses indicate more critical evaluations, particularly in the dimensions of dependability and novelty. These two dimensions also recorded the lowest average scores in the overall dataset. The position of this cluster in the negative region of the PCA space suggests a shared perception of dissatisfaction, possibly influenced by issues related to system reliability, limited user control, or lack of innovation in the Spotify interface.

In contrast, Cluster 1, displayed in orange and located near the center of the plot, consists of users with moderate or neutral experiences. As illustrated in Figure 3, the scores provided by this group tend to fall within the middle range, especially for perspicuity, efficiency, and stimulation. Their evaluations indicate that Spotify met basic usability expectations without delivering a notably engaging or memorable experience. Cluster 2, represented in blue and positioned on the right side of the PCA plot, contains users who expressed high satisfaction across most UX dimensions. As reflected in Figure 5, they provided significantly positive ratings in attractiveness, efficiency, and stimulation. Although their ratings in dependability and novelty were somewhat lower compared to other dimensions, these aspects did not negatively impact their overall experience with the platform. This cluster reflects a group of users who find Spotify functional, appealing, and emotionally rewarding to use.

In conclusion, the clustering and PCA results provide additional insights that support the statistical findings discussed earlier. Although many users expressed positive experiences, there remains a segment with lower satisfaction, especially regarding dependability and novelty. These two dimensions represent critical areas for further improvement in Spotify's user interface.

4.4 Result Interpretation & Recommendation

The findings indicate that most users view Spotify positively across all UEQ dimensions, particularly in Attractiveness, Perspicuity, Efficiency, and Stimulation. However, Dependability and Novelty consistently showed lower scores, signifying these as areas for improvement. Users expressed concerns related to system consistency, reliability, and a lack of new, engaging features.

To address Dependability, Spotify should enhance feedback mechanisms, error handling, and system consistency. Studies highlight that stable and responsive systems improve user trust and perceived reliability [1], [6], [9], especially in streaming platforms where uninterrupted service is essential [10]. For Novelty, adding interactive and innovative UI features can stimulate user interest. Research shows that users favor platforms that offer fresh, engaging experiences [1], [8], [12], and prior studies note Spotify's lack of perceived uniqueness despite strong functionality [9], [11]. Enhancing personalization, visual dynamics, or content presentation may boost novelty perception and long-term engagement. Such improvements are especially relevant for users in lower-rated clusters [11], [13]. Aligning UX strategies with UEQ insights can lead to measurable gains in usability and emotional response [4], [5], helping Spotify remain competitive in the evolving digital music landscape.

4.5 Discussion

The results of this study support and extend previous research involving the use of UEQ to assess mobile applications, including findings in [1], [4], and [7], which also identified Attractiveness, Efficiency, and Stimulation as top-performing dimensions. The high ratings observed in this study reinforce the idea that Spotify delivers a visually appealing, intuitive, and emotionally engaging experience. Conversely, the weak performance in the Dependability dimension aligns with studies such as [9] and [11], which similarly found that issues of reliability and system control affect user trust. This recurring theme indicates an ongoing need for improving predictability and user confidence in mobile platforms. The integration of K-Means clustering for segmentation in this study aligns with the methodologies employed in [13], [14], and [15], where

clustering was used to extract meaningful user segments based on UX data. The application of PCA further aided in visualizing the complex relationships between user responses. This dual approach of combining quantitative evaluation with unsupervised learning enhances the interpretability and practical application of UX feedback.

Overall, this study contributes to the understanding of user experience evaluation by demonstrating how UEQ and clustering techniques can be jointly used to uncover deeper insights. It validates Spotify's strengths in several UX aspects while identifying specific areas where enhancements are both needed and expected. This contributes to the broader field of UX research and provides practical recommendations for digital product development.

5. Conclusion

This study concludes that Spotify offers a generally positive user experience, particularly in the areas of attractiveness, clarity, efficiency, and stimulation. However, dependability and novelty remain weaker points that influence user satisfaction. Through clustering analysis, three distinct user groups were identified highly satisfied, moderately satisfied, and less satisfied users, each reflecting different perceptions of the platform. These findings highlight the importance of addressing reliability and innovation to improve user engagement. Moreover, the combination of UEQ and clustering proves to be an effective approach for uncovering nuanced user experience patterns, offering valuable direction for future UX development in digital platforms.

References

[1] Angela, F. Halim, T. A. Pramana, and A. Simanjuntak, "User experience evaluation on music streaming applications with UEQ method," *JURTEKSI (Jurnal Teknologi dan Sistem Informasi)*, vol. 8, no. 2, pp. 209–218, Apr. 2022, doi: 10.33330/jurteksi.v8i2.1323.

[2] A. A. Anantia, Y. Masnita, and K. Kurniawati, "Effectiveness of digital music platforms' social media interaction on advertising trust using cognitive aspects," *Manajemen dan Bisnis*, vol. 22, no. 1, p. 1, Mar. 2023, doi: 10.24123/jmb.v22i1.624.

[3] J. Li, "Analysis of the trend of Spotify," *BCP Business & Management*, vol. 34, pp. 919–926, Dec. 2022, doi: 10.54691/bcpbm.v34i.3112.

[4] I. Maulidya, C. O. P. Salma, G. H. K. Beda, I. R. G. Barus, and A. Fami, "Analyzing user experience in KAI Access application using the UEQ method," *JISA (Jurnal Informatika dan Sains)*, vol. 7, no. 1, pp. 48–52, 2024, doi: 10.31326/jisa.v7i1.2007.

[5] I. Maulidya, A. B. Prabowo, and M. F. Firmansyah, "Analyzing user experience in KAI Access application using the UEQ method," *JISA (Jurnal Informatika dan Sains)*, vol. 3, no. 1, pp. 12–18, 2024.

[6] M. Mujinga, "Online banking user experience: A User Experience Questionnaire (UEQ) assessment in South Africa," *Journal of Digital Banking*, vol. 4, no. 2, pp. 88–95, 2024.

[7] S. Terang Bangsa, "Penerapan model Human Computer Interaction (HCI) dalam analisis sistem informasi," *Jurnal Sistem Informasi Bisnis*, vol. 1, no. 1, pp. 1–8, 2011

[8] F. Richas and I. Kamal, "Comparison analysis of user experience on m-BCA and BRImo mobile banking applications using the User Experience Questionnaire (UEQ) method," *International Journal of Management, Business, and Economics*, vol. 2, no. 3, pp. 47–51, 2024.

[9] I. K. R. Janardana, "Analisis usability dan user experience aplikasi Spotify dengan metode System Usability Scale dan UEQ," *Jurnal Informatika dan Teknik Elektro Terapan*, vol. 13, no. 2, Apr. 2025, doi: 10.23960/jitet.v13i2.6442.

[10] R. U. Fahmi, A. G. Zahran, and S. P. Suwandi, "Analisis user experience terhadap tingkat kepuasan pengguna pada aplikasi Spotify dengan metode UTAUT," *DJTechno: Jurnal Teknologi Informasi*, vol. 4, no. 1, pp. 154–169, 2023, doi: 10.46576/djtechno.v4i1.3334.

[11] R. R. Damanik, R. Belferik, W. Chandra, M. D. Rosyadi, and A. R. M. H. Noor Asegaff, "Evaluasi kepuasan pelanggan aplikasi Spotify berdasarkan Customer Satisfaction Index (CSI): Studi kasus pengguna di Indonesia," *SATESI: J. Sains Teknol. dan Sist. Inform.*, vol. 4, no. 2, pp. 133–138, Oct. 2024, doi: 10.54259/satesi.v4i2.3214.

[12] Z. R. Karyono, Y. T. Mursityo, and H. M. Az-Zahra, "Analisis perbandingan pengalaman pengguna pada aplikasi music streaming menggunakan metode UX Curve (Studi pada Spotify dan Joox)," Jurnal Administrasi Bisnis, vol. 71, no. 1, pp. 123–131, 2019.

[13] P. D. P. Riau Sarbaini, W. Saputri, and F. Muttakin, "Cluster analysis menggunakan algoritma Fuzzy K-Means untuk tingkat pengangguran," *J. Tek. dan Manaj. Ind. Terapan (JTMIT)*, vol. 1, pp. 78–84, 2022.
[14] T. Tanjung, F. Ariani, W. Susanty, and A. Y. Vandika, "Perhitungan estimasi upaya pengembangan software pulsa online dengan Fuzzy C-Means dan Fuzzy K-Means," *EXPERT: J. Manaj. Sist. Inform. dan Teknol.*, vol. 12, no. 1, p. 49, Jun. 2022, doi: 10.36448/expert.v12i1.2471.
[15] M. B. Johra, "Soft clustering dengan algoritma Fuzzy K-Means (Studi kasus: Pengelompokan desa di Kota Tidore Kepulauan)," *BAREKENG: J. Ilmu Mat. dan Terapan*, vol. 15, no. 2, pp. 385–392, Jun. 2021, doi: 10.30598/barekengvol15iss2pp385-392.