JIP
Jurnal Ilmiah PLATAX
Universitas Sam Ratulangi
Terakreditasi Ristekdikti No: 28/E/KPT/2019
ISSN : 2302-3589 (Online)
E_mail : jip_platax@unsrat.ac.id

AI Capabilities as Mediators in Marketing Innovation: A Cross-Cultural Study of Technology Features and User Engagement Among Generation Z in Indonesia and Hungary

Ferdy Roring[a]*, Peter Nagy[a], Johan Tumiwa[a,b], Adrian Nagy[c], Franda Benedicta Paat[d].

[a] *Department of Management, Faculty of Economics and Business, Sam Ratulangi University – Indonesia*
[b] *Institute of Economics, Faculty of Economics and Business, University of Debrecen – Hungary*
[c] *Institute of Applied Economics, Faculty of Economics and Business, University of Debrecen –Hungary*
[d] *International Business Administration (IBA), Department of Management, Faculty of Economics and Business, Sam Ratulangi University, Manado 95115, Indonesia; frandapaat23@gmail.com*

**Corresponding author:* ferdyroring@unsrat.ac.id
Manuscript received: 19 Nov. 2025. Revision accepted: 19 Jan. 2026

Abstract. This study investigates the mediating role of AI capabilities in the relationship between technology features and user engagement among Generation Z, with a cross-cultural focus on Indonesia and Hungary. The aim is to explore how cultural and technological contexts shape marketing innovation and user behavior. The research employs Partial Least Squares Structural Equation Modeling (PLS-SEM) and Multi-Group Analysis (MGA) to analyze survey data from 743 Generation Z respondents (415 in Indonesia and 328 in Hungary). The study examines direct and mediated relationships between technology features, AI capabilities, and user engagement, and tests cross-cultural differences. The results reveal that AI capabilities significantly mediate the effect of technology features on user engagement, with notable differences between the two countries. Indonesian Gen Z emphasizes the direct and mediated effects of technology features, leveraging immersive and interactive platforms, while Hungarian Gen Z prioritizes ethical and sustainability-driven AI solutions as key drivers of engagement. The study is limited to Generation Z in two countries, and future research could expand the scope to include other generational cohorts and regions. Longitudinal studies and behavioral data could also enhance the understanding of evolving user engagement dynamics. The findings highlight the importance of integrating AI-driven personalization, interactivity, and predictive analytics into marketing strategies to enhance engagement. Businesses targeting Gen Z should tailor their approaches to specific cultural and technological contexts, leveraging immersive technologies in Indonesia and sustainability-focused AI in Hungary. This research underscores the potential of AI and technology features to shape ethical and sustainable consumption patterns among Generation Z, informing corporate social responsibility and digital marketing practices. The study provides a quantitative hierarchy of relationships between technology features, AI capabilities, and user engagement, validated across culturally diverse contexts. It offers actionable insights for businesses and contributes to the theoretical understanding of cross-cultural technology adoption and marketing innovation.
Keywords: Generation Z, AI Capabilities, User Engagement, Technology Features, Cross-Cultural Analysis

JEL Codes : M31, O33, L86, D83

INTRODUCTION

Marketing innovation has become essential for companies operating in the digital era, particularly for businesses within the metaverse—a virtual, immersive environment where users interact digitally through avatars. The metaverse emerged as a key arena for brand engagement, especially during the COVID-19 pandemic when digital interaction became central to daily life. However, as societies transition into the post-pandemic era, many people are gradually returning to physical spaces, reducing their reliance on virtual environments. Despite this trend, Generation Z (Gen Z), as digital natives, continues to be intimately involved in the metaverse, valuing immersive, interactive, and personalized experiences. In the metaverse, AR/VR technology is essential for brands to provide interactive, dynamic settings where consumers can investigate items and engage with virtual worlds. However, there is still limited research on how these features impact emotional and intellectual engagement within the metaverse (Li et al., 2023). Alongside this, Generative AI technologies like ChatGPT and Midjourney enhance customization and real-time personalization, which Gen Z expects from brands. Despite its growing use, Generative AI's role in personalized engagement within AR environments remains underexplored (Y. Hu et al., 2023). Therefore, for those companies who is targeting Gen Z, staying competitive in the metaverse requires not only technological sophistication but

also an understanding of how to create seamless, engaging, and personalized experiences that resonate with this generation's expectations.

In light of these gaps, this research is particularly important in the post-COVID era, where the broader population's digital behavior is shifting away from immersive environments, but Gen Z remains deeply invested in these technologies. By investigating the relationship between AR/VR technology features**,** Generative AI capabilities**,** and user engagement in the metaverse, this study aims to provide insights into how businesses can continue to engage Gen Z in the evolving digital landscape. Using PLS-MGA analysis, this study will compare the impact of these technologies on Gen Z's engagement in Indonesia and Hungary, two culturally distinct markets. The findings will contribute to a deeper understanding of how to sustain marketing innovation in the metaverse for a generation that remains actively engaged with digital-first platforms.

Marketing Innovation and the Metaverse

The emergence of the metaverse in marketing innovation has been increasingly studied, particularly in how digital marketing agencies adapt to these technologies (Alshurideh et al., 2023). The metaverse offers a new space for social interactions, including shopping and advertising, as explored through the 7P marketing mix, which highlights its role in revolutionizing marketing strategies (Mentes & Omarli, 2023). Additionally, IoT and metaverse technologies have been found to enhance data visualization, interaction, and customer engagement, thus improving overall marketing efforts (Gao, 2022).

However, the metaverse also brings opportunities and challenges, particularly in advertising strategies that aim to connect virtual and real-world campaigns (Eyada, 2023). For instance, Nike's collaboration with Roblox showcases how brands can utilize virtual spaces to influence consumer behavior, demonstrating the future potential of the metaverse as a marketing platform (Hollensen et al., 2023).

The systematic review by Crespo-Pereira et al. (2023) highlights the convergence of these technologies and the need for further research on how metaverse marketing aligns with social sciences and communication trends. Additionally, the use of digital innovations, including VR, NFTs, and the metaverse, is reshaping both marketing and PR communications, further reinforcing the significance of these technologies in shaping the future of consumer engagement (Oltarzhevskyi & Oltarzhevska, 2023). The incorporation of AI tools such as ChatGPT and Midjourney into the metaverse also allows brands to quickly produce personalized content, fostering deeper engagement with consumers through AI-generated virtual environments (Y. Hu et al., 2023).

Personalization plays an increasingly important part in digital marketing efforts. According to research, using AI-powered solutions allows marketers to develop hyper-personalized content based on individual interests and habits. (Desai, 2022). Moreover, personalized marketing strategies, driven by data analytics and AI, have become crucial for enhancing consumer loyalty, engagement, and purchase intentions, particularly in digital environments such as the metaverse (Ranjan, 2022). The Technology Acceptance Model (TAM) has further emphasized how ease of use and usefulness are vital factors influencing Gen Z's engagement with technologies like the Apple Vision Pro, which merges AR and VR capabilities (Liu, 2023).

Definitions and Theoretical Anchoring of Constructs

Multi-device functionality, as a key aspect of technology features (Li et al., 2023; Marks & White, 2020). The role of technology features in the metaverse such as head-mounted displays and 3D-tracked tablets to improve interactions in shared virtual spaces (Marks &

White, 2020) is becoming increasingly significant as it enhances collaboration and user engagement. VR provides intuitive navigation, while AR offers precise control through touch. However, there remains a gap in understanding how these multi-device setups influence engagement among Gen Z, who value seamless transitions and interactions across multiple devices in digital environments. Similarly, Reipschläger and Dachselt (2019) introduce a 3D modeling system that combines AR with interactive displays, providing ergonomic and precise control, further underscoring the need to explore the impact of multi-device collaboration on user engagement in the metaverse.

Post-COVID, digital behavior shifted away from immersive environments, but the Apple Vision Pro, with its mixed reality capabilities blending AR and VR, offers new opportunities to enhance user engagement by seamlessly merging digital and physical environments (Egger et al., 2023). To aligns this technology with Gen Z's preference for interactive, digital-first technologies, Liu et al. (Li et al., 2023) highlights perceived simplicity of use and utility as important drivers of user engagement and buy intents among Gen Z consumers, making this technology characteristic particularly relevant for broader marketing applications and beyond.

Generation Z Consumer Behavior: The Influence of Digital Literacy

The consumer behavior of Generation Z is a prominent area of research due to their unique position as digital natives, heavily influenced by technology and social media. Grigoreva et al. (2021) highlight how this generation's behavior is shaped by their digital literacy and reliance on smartphones, which drives their engagement with online shopping and social media platforms. Similarly, Bhuwaneshwari and Hemasuruthi (2023) argue that social media influencers play a crucial role in guiding Gen Z's purchasing decisions, underlining the importance of digital literacy and peer influence.

Generation Z's consumer behavior in Indonesia is confident in their technological abilities but also values social interaction, especially during challenging times (Hinduan et al., 2020). Factors such as social, personal, and psychological influences significantly shape their purchasing decisions (Pradytya & Pradana, 2022). Andriyanty and Wahab (2022) explore the ethnocentric behavior of Indonesian Generation Z, particularly their preference for domestic food and beverage products, driven by economic and individual factors. Indonesian Gen Z relies heavily on social media and instant messaging for their digital activities, which reinforces their media consumption patterns (Evita et al., 2023). Furthermore, Erwin et al. (2023) examine how social media influencers impact Indonesian Gen Z, particularly on platforms like Instagram, where influencers' authenticity and transparency play crucial roles in shaping purchasing decisions.

In Hungary, Generation Z exhibits different consumption patterns. Treutz (2020) examines how Hungarian Gen Z interacts with territorial marketing and regional branding, showing that their emotional and consumer behaviors are influenced by regional identity. Moreover, in Post-pandemic, Hungarian Gen Z tends to prefer shorter trips and relies heavily on online reviews and digital sources for travel decisions (Basa et al., 2023). This aligns with Mondok and Zambo (2022), who emphasize that rural tourism in Hungary must adapt to Gen Z's digital preferences and desire for personalized experiences. Regarding food consumption, Garai-Fodor and Popovics (2022) note that Hungarian Gen Z has a more neutral attitude towards local food products, suggesting a need for educational campaigns to boost their interest in Hungarian brands. Similar to the findings of Djafarova and Foots (2022) on ethical concerns and environmental awareness, Balázsné Lendvai et al. (2022) categorize Hungarian Gen Z

consumers based on the LOHAS (Lifestyle of Health and Sustainability) model, showing a growing trend among Gen Z to prioritize sustainability in their consumption habits.

Hypotheses Development

We believe that Gen Z have unique preferences for interactive, personalized, and intuitive experiences are shaped by the combined influence of technology features and AI capabilities.

The advancement of technology features, such as user-friendly interfaces, real-time responsiveness, and customization options, significantly influences the capabilities of AI systems. Gen Z, as digital natives, is particularly responsive to advanced technological features that enhance the functionality of AI, such as natural language processing and predictive analytics. These technological features allow AI to process vast amounts of data effectively, providing more precise outputs and supporting various applications like chatbots and personalized experiences. For example, interactive features in banking apps can enhance perceived animacy and intelligence, which play a vital role in shaping AI's effectiveness (Bhatnagr & Rajesh, 2024). Furthermore, these capabilities enable Gen Z users to engage with AI tools seamlessly, as observed in e-commerce platforms that leverage AI to refine recommendation systems and improve usability (Zhang et al., 2021). Based on the aforementioned discussion, we have formulated the research hypothesis as follows:

H_1: Technology features have a significant positive effect on AI capabilities.

AI capabilities, such as personalization, interactivity, and predictive functionalities, play a pivotal role in fostering user engagement. Gen Z values immersive and dynamic interactions, which are made possible by AI-powered features like personalized recommendations, real-time feedback, and gamified experiences. For instance, generative AI tools, such as ChatGPT, have shown significant potential in increasing emotional engagement by providing personalized responses tailored to user needs (Kavitha et al., 2024). Additionally, AI tools in education improve engagement by offering interactive and adaptive learning experiences, which have proven highly effective for Gen Z students (Singh et al., 2024). As AI enables more personalized and relevant interactions, it builds trust and loyalty among users, especially in service contexts like digital banking (Babatunde et al., 2024). Hence:

H_2: AI capabilities have a significant positive effect on user engagement.

Technology features directly influence user engagement by offering intuitive and interactive experiences. Gen Z, characterized by their preference for seamless digital interactions, is more likely to engage with platforms that provide features like augmented reality (AR), voice recognition, and gamified interfaces. These features reduce friction in interactions, simplify navigation, and create a more enjoyable user experience. For example, interactive features in e-learning platforms, supported by AI, have been found to enhance critical thinking and foster deeper engagement (Baskoro et al., 2023). Similarly, AI-powered chatbots with human-like interaction capabilities significantly enhance customer satisfaction by addressing user queries effectively, leading to higher engagement (Saklani & Kala, 2024). Building upon the preceding discussion, the research hypothesis has been formulated as follows:

H_3: Technology features have a significant positive effect on user engagement.

The relationship between technology features and user engagement is partially mediated by AI capabilities. While advanced technology features directly improve the user experience, their impact is amplified when these features support AI functionalities. For instance, in e-commerce, AI-enabled personalization powered by technology features like data analytics and responsive design creates highly tailored user experiences, driving greater engagement

(Wijethilak et al., 2024). Furthermore, Gen Z users' interaction with AI tools like ChatGPT highlights the importance of intuitive technology features that support the personalization and emotional engagement offered by AI (Kavitha et al., 2024). By integrating technology features with AI capabilities, platforms can create more immersive, satisfying experiences that resonate with Gen Z's digital preferences (Singh et al., 2024). Building upon the preceding discussion, we underscore the mediating role of AI capabilities. Consequently, the research hypothesis has been formulated as follows:

H_4: The effect of technology features on user engagement is mediated by AI capabilities.

The influence of technology features on AI capabilities and user engagement varies between Indonesian and Hungarian Gen Z due to differences in technological adoption and cultural preferences. Indonesian Gen Z heavily relies on mobile-first technologies and social media platforms to interact with AI-powered tools, such as personalized shopping apps and gamified interfaces that enhance engagement through immersive and interactive experiences (Evita et al., 2023; Pradytya & Pradana, 2022). Conversely, Hungarian Gen Z emphasizes sustainable and health-conscious AI solutions, reflecting their preference for ethical and environmentally friendly technologies (Lendvai et al., 2022; Treutz, 2020). These cultural differences shape how AI capabilities—such as personalization, interactivity, and predictive functions—mediate the relationship between technology features and user engagement. In Indonesia, AI amplifies engagement by enabling real-time, personalized interactions through dominant mobile technologies (Andriyanty & Wahab, 2022). In contrast, Hungarian Gen Z's engagement is influenced by their focus on ethical and health-driven technological integration, often moderated by regional branding and sustainability considerations (Basa et al., 2023; Lendvai et al., 2022).

H_5: The impact of technology features on user engagement, mediated by AI capabilities, differs between Indonesian and Hungarian Gen Z

The research framework connects these hypotheses by positioning AI capabilities as both an outcome of technology features (H_1) and a driver of user engagement (H_2). It also considers the direct effect of technology features on user engagement (H_3), while emphasizing the mediating role of AI capabilities in this relationship (H_4). Additionally, the framework incorporates a comparative dimension, examining how the mediated effect varies between Indonesian and Hungarian Gen Z (H_5), reflecting cultural and technological adoption differences. Together, these hypotheses define the pathways and contextual variations tested within the proposed framework, as illustrated in Figure 1.

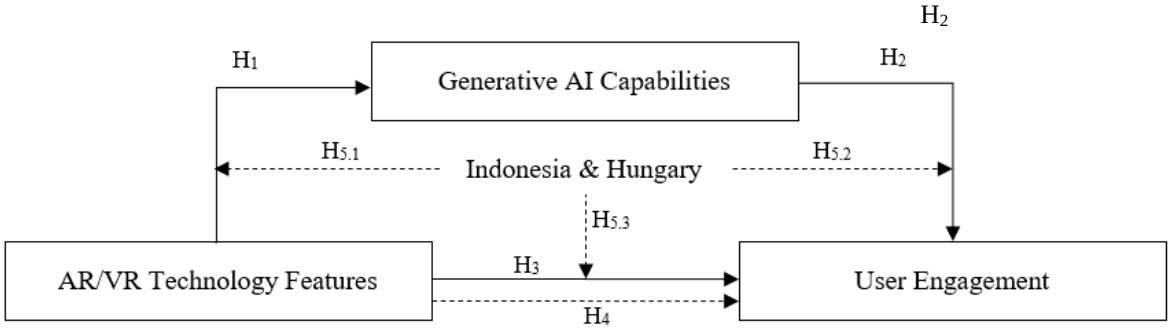

Figure 1. Research Framework and Hypothesis

METHODOLOGY

Variable Measurement

The study employs an 8-point Likert scale, where 1 represents "strongly disagree" and 8 represents "strongly agree", to measure the variables. Indicators and loading factor for each variable are derived from prior research as follows Table 1.

Table 1. Measurement of latent variables, manifest variables, factor loadings, and AVE.

Latent Variable	Manifest Variable	Item	Loading Factor	AVE
AR/VR Technology Features	AR/VR creates immersive brand experiences (Bozzelli et al., 2019).	TF1	0.852	0.835
	AR/VR enhances product visualization (Lee et al., 2023).	TF2	0.894	
	The technology integrates seamlessly with other devices (Marks & White, 2020).	TF3	0.790	
	AR/VR provides intuitive user navigation (Gao, 2022).	TF4	0.956	
	It enables interactive engagement with virtual environments (Eyada, 2023).	TF5	0.877	
	AR/VR offers real-time user feedback (Mentes & Omarli, 2023).	TF6	0.945	
	The platform supports gamified interactions (Evita et al., 2023).	TF7	0.965	
	AR/VR allows for customization of user experiences (Reipschläger & Dachselt, 2019).	TF8	0.971	
	It enables social and collaborative virtual experiences (Crespo-Pereira et al., 2023).	TF9	0.957	
Generative AI Capabilities	AI provides personalized recommendations (Pradytya & Pradana, 2022).	AI1	0.773	0.657
	AI creates predictive insights based on user data (Y. Hu et al., 2023).	AI2	0.803	
	It supports interactive and conversational interfaces (Chheang et al., 2023).	AI3	0.773	
	AI generates content tailored to individual preferences (Desai, 2022).	AI4	0.684	
	The platform leverages AI to optimize the customer journey (Liu, 2023).	AI5	0.872	
	AI capabilities improve the efficiency of digital interactions (Eyada, 2023).	AI6	0.881	
	It ensures the ethical use of AI features (Lendvai et al., 2022).	AI7	0.868	
User Engagement	The platform maintains user attention over time (Treutz, 2020).	UE1	0.921	0.816
	It encourages active participation (Erwin et al., 2023).	UE2	0.901	
	Users find the experience enjoyable and satisfying (Pradytya & Pradana, 2022).	UE3	0.945	
	The platform fosters emotional connections with users (Djafarova & Foots, 2022).	UE4	0.847	

Latent Variable	Manifest Variable	Item	Loading Factor	AVE
	Engagement translates into positive brand perception (Crespo-Pereira et al., 2023).	UE5	0.904	
	It motivates users to revisit the platform frequently (Gursoy et al., 2023)	UE6	0.899	

Source: Author's data analysis and modification from prior research, 2024

Data Collection

This study does not involve human experimentation; instead, it focuses entirely on gathering opinions and perceptions about research factors. The data collection procedure is totally voluntary, guaranteeing that respondents submit their feedback without force. There are no financial incentives or gifts offered in exchange for participation, and all respondents provide informed consent before participating in the study.

The study's population consists of Generation Z individuals in Indonesia and Hungary, reflecting two distinct cultural and technological contexts. The total sample size is 743 respondents, with 415 from Indonesia and 328 from Hungary. This sample size meets statistical requirements for structural equation modeling (SEM), where a minimum of 200 samples per group is recommended for reliable analysis (Chin, 1998; J. F. J. Hair et al., 2014). Additionally, the diverse sample provides sufficient power for conducting the Multi-Group Analysis (MGA) and enables robust comparison between the two groups.

To address potential biases, the study employs procedural measures to reduce Common Method Bias (CMB), such as respondent anonymity and random question order. Exploratory Factor Analysis (EFA) was used to run a Harman single-factor test, which revealed that the first factor explains less than 50% of the variation, indicating that there are no significant CMB concerns (Podsakoff et al., 2003). Furthermore, Variance Inflation Factor (VIF) values were less than 5, as advised by Hair et al. (2019), supporting the absence of multicollinearity and common method variance problems.

After a meticulous data collection process, Table 2 presents the demographic characteristics of the respondents, which are crucial for understanding the contextual influences that may impact the research outcomes.

Table 2. Characteristics of the Respondents

	Frequency	(%)
Country		
Hungary	415	55.9
Indonesia	328	44.1
Gender		
Male	493	66.4
Female	250	33.6
Ocupation		
Students (Full-Time)	37	5.0
Part-Time Workers	152	20.5
Full-Time Workers	429	57.7
Freelancers/Entrepreneurs	77	10.4
Unemployed/Other	48	6.5
Age		
12–14 years: Early Adolescents	25	3.4

	Frequency	(%)
15–17 years: Late Adolescents	5	.7
18–20 years: Young Adults (Transition Phase)	158	21.3
21–23 years: Early Career Stage	379	51.0
24–25 years: Mid-Career/Early Adulthood	128	17.2
26–27 years: Established Young Professionals	48	6.5
Income		
Low Income: Below 20% of the average national income.	18	5.2
Lower-Middle Income: 20%–40% of the average national income.	183	52.4
Middle Income: 41%–60% of the average national income.	60	17.2
Upper-Middle Income: 61%–80% of the average national income.	52	14.9
High Income: 81%–100% of the average national income.	18	5.2
Very High Income: Above 100% of the average national income.	18	5.2

Data Validity

Factor loadings exceed 0.6, and AVE surpasses 0.5. The Fornell-Larcker criterion and Heterotrait-Monotrait (HTMT) ratio values in Tables 3 confirms that all constructs are distinct from one another.

Table 3. Discriminant Validity

	Fornell-Larcker criterion			**Heterotrait-monotrait ratio (HTMT)**	
	AI	**TF**	**UE**		
AI	0.811			TF ←→ AI	0.424
TF	0.416	0.914		UE ←→ AI	0.888
UE	0.846	0.408	0.903	UE ←→ TF	0.416

Findings

Assessment of the Structural Model

This subchapter presents the assessment of the structural model, focusing on the explanatory power of the model ($\mathbf{R^2}$), effect sizes ($\boldsymbol{f^2}$), and model fit indices. These evaluations ensure the robustness of the hypothesized relationships and the suitability of the model for hypothesis testing.

Table 4. Structural Model Assessment

$\boldsymbol{f^2}$		$\mathbf{R^2}$	
AI → UE	1.966	**UE**	0.719
TF → AI	0.209	**AI**	0.173
	Saturated model		**Estimated model**
SRMR	0.072		0.072
d_ULS	1.310		1.310
d_G	1.520		1.520
Chi-square	5126.661		5126.661
NFI	0.782		0.782

The R^2 value for AI → UE indicates that AI capabilities explain 71.9% of the variance in user engagement, demonstrating a strong predictive power. Similarly, TF → AI explains 17.3% of the variance in AI capabilities, which is moderate. The f^2 values suggest that the effect of AI on user engagement is substantial (1.966), while the effect of technology features on AI capabilities is small to moderate (0.209) based on the guidelines by Cohen (1988) and Chin (1998). Subsequently, the model fit indices indicate that the structural model is well-fitted. The SRMR (Standardized Root Mean Square Residual) value of 0.072 is below the threshold of 0.08, indicating a good fit (L. Hu & Bentler, 1998, 1999). Both d_ULS and d_G are within acceptable ranges, and the Chi-square is reported alongside a satisfactory NFI (Normed Fit Index) of 0.782, which approaches the recommended threshold of 0.80. These results align with prior research (J. F. J. Hair et al., 2014), which suggests that these indices collectively confirm the adequacy of the model for explaining the hypothesized relationships.

Structural Relationships Indonesian and Hungarian – MGA Test

This subsection presents the results of the Multi-Group Analysis (MGA), which examines differences in structural relationships between the Indonesian and Hungarian samples. The analysis employs the Permutation MGA Test using Measurement Invariance of Composite Models (MICOM) Test, as detailed in Tables 5, to ensure the validity and robustness of the cross-group comparisons.

Table 5. Measurement invariance of composite models (MICOM)

Step 2					
	Original correlation	Correlation permutation mean	5.0%	Permutation p value	
AI	0.992	1.000	0.999	0.000	
TF	0.999	1.000	0.999	0.025	
UE	1.000	1.000	1.000	0.530	
Step 3a (mean)					
	Original difference	Permutation mean difference	2.5%	97.5%	Permutation p value
AI	-0.181	0.003	-0.145	0.144	0.012
TF	0.096	0.002	-0.138	0.146	0.187
UE	0.138	0.004	-0.140	0.145	0.056
Step 3b (variance)					
	Original difference	Permutation mean difference	2.5%	97.5%	Permutation p value
AI	0.125	-0.003	-0.300	0.305	0.423
TF	0.001	0.001	-0.269	0.259	0.994
UE	0.007	-0.006	-0.378	0.377	0.967

The MICOM results confirm compositional invariance for all constructs (AI, TF, and UE) across the Indonesian and Hungarian samples, as the original correlations are close to 1 (AI = 0.992, TF = 0.999, UE = 1.000), and the permutation p-values for compositional invariance are within acceptable thresholds (AI = 0.000, TF = 0.025, UE = 0.530). However, the test for equality of means (Step 3a) reveals significant differences for AI capabilities (original difference = -0.181, p = 0.012), indicating that Indonesian and Hungarian Gen Z perceive AI capabilities differently. In contrast, no significant mean differences are found for technology features (original difference = 0.096, p = 0.187) and user engagement (original difference = 0.138, p = 0.056). The equality of variances test (Step 3b) shows no significant differences for any construct, as all p-values exceed 0.05, indicating consistent variability across

the two groups. The MICOM histograms are shown below to further validate the findings, supporting the use of Multi-Group Analysis (MGA) for investigating structural path differences while accounting for the observed mean differences in AI capabilities.

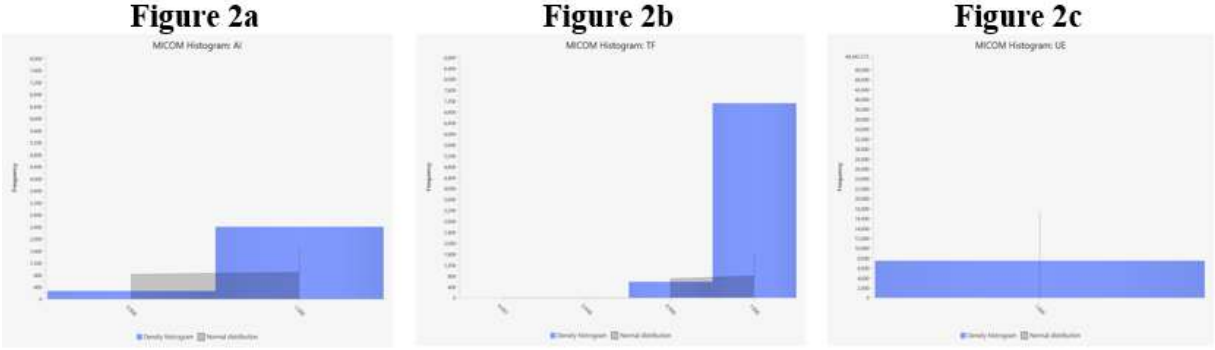

Figure 2. MICOM Histogram Result

Results of Hypotheses Assessment

The hypothesis testing results offer valuable insights into the relationships between technology features (TF), AI capabilities (AI), and user engagement (UE), as well as the variations observed across samples from Indonesia and Hungary.

Table 6. Hypothesis Testing and Multi-Group Analysis (MGA) Results

	Hypotheses	**Std. Beta**	***t*-value**	***p*-values**
H_1	TF → AI	0.416	10.370	0.000
H_2	AI → UE	0.817	43.799	0.000
H_3	TF → UE	0.068	2.651	0.008
H_4	TF → AI → UE	0.340	10.227	0.000

H_5	**MGA - Test**	**Std. Beta**		**Mean Dif.**	***t* value**		***p* value**	
		Hungary	**Indonesia**		**Hungary**	**Indonesia**	**Hungary**	**Indonesia**
$H_{5.1}$	AI → UE	0.880	0.771	-0.109	43.105	22.546	0.000	0.000
$H_{5.2}$	TF → AI	0.221	0.581	0.359	3.669	13.036	0.000	0.000
$H_{5.3}$	TF → UE	-0.012	0.136	0.148	0.482	3.087	0.630	0.002
$H_{5.4}$	TF → AI → UE	0.195	0.448	0.253	3.616	11.748	0.000	0.000

The relationship between technology features and AI capabilities (H_1) is significant ($\beta = 0.416$, $t = 10.370$, $p = 0.000$), indicating that technology features strongly enhance the development and application of AI capabilities. This aligns with prior research emphasizing the importance of AR/VR features, interactivity, and device integration in enabling AI functionalities such as personalization and predictive insights (Marks & White, 2020; Hu et al., 2023). The novelty of this finding lies in its quantification of the relationship, demonstrating that TF plays a critical role in fostering AI capabilities across diverse contexts, including Indonesia and Hungary.

The relationship between AI capabilities and user engagement (H_2) is extremely strong ($\beta = 0.817$, $t = 43.799$, $p = 0.000$), underscoring the centrality of AI in driving user interaction, satisfaction, and long-term loyalty. Previous studies have highlighted AI's ability to provide personalized and interactive experiences, which are key drivers of engagement for Gen Z

(Desai, 2022; Liu, 2023). This study not only validates those insights but also provides a quantitative hierarchy of effects, confirming that AI capabilities are the strongest determinant of user engagement. The cross-cultural validation of this relationship emphasizes the universal relevance of AI for engaging Gen Z, regardless of cultural or technological differences.

The direct relationship between technology features and user engagement (H_3) is weaker but still statistically significant ($\beta = 0.068$, $t = 2.651$, $p = 0.008$). This suggests that while technology features directly contribute to user engagement, their effect is largely mediated by AI capabilities. This aligns with prior studies (Gao, 2022; Mentes & Omarli, 2023), which indicate that TF enhances user engagement indirectly by enabling sophisticated AI-driven experiences. The study isolates the smaller direct effect of TF on UE, emphasizing the mediating role of AI. This underscores the importance of building robust technology ecosystems that enable AI-driven innovations, as the combined effect significantly enhances user engagement. Therefore, businesses can leverage this finding by ensuring that their technology features seamlessly integrate with AI functionalities to deliver a holistic and engaging user experience.

The mediated relationship between technology features and user engagement through AI capabilities is statistically significant ($\beta = 0.340$, $t = 10.227$, $p = 0.000$), confirming the mediating role of AI in this pathway. This finding indicates that technology features indirectly influence user engagement by enhancing AI capabilities, which in turn drive engagement. The result aligns with prior research that suggests technology features like AR/VR and interactivity provide the foundation for AI-driven functionalities, such as personalization and predictive analytics, which significantly boost user engagement (Marks & White, 2020; Gao, 2022). The novelty of this finding lies in quantifying the indirect effect, showing that the mediated pathway has a substantial impact compared to the direct effect of technology features on user engagement ($\beta = 0.068$, discussed in H_3). This highlights the critical role of AI as a bridge between technology features and user engagement, particularly in meeting the expectations of tech-savvy Gen Z users. The study further extends prior research by validating this relationship in a cross-cultural context, demonstrating that the mediating effect of AI capabilities holds true for both Indonesian and Hungarian Gen Z.

The MGA result stems from the relationship between technology features and AI capabilities ($H_{5.1}$) is significant for both Hungary ($\beta = 0.221$, $t = 3.669$, $p = 0.000$) and Indonesia ($\beta = 0.581$, $t = 13.036$, $p = 0.000$). However, the effect is substantially stronger in Indonesia, as evidenced by the mean difference ($\Delta = 0.359$) and higher standardized beta value. This suggests that Indonesian Gen Z relies more heavily on technology features to enable AI capabilities, likely due to their higher adoption of mobile-first technologies and social media platforms (Evita et al., 2023). In Hungary, while significant, the weaker effect may reflect a more mature technological ecosystem where AI capabilities are driven by factors beyond foundational technology features, such as sustainability and ethical considerations (Balázsné Lendvai et al., 2022).

The impact of AI capabilities on user engagement ($H_{5.2}$) is strong and significant in both countries, with Hungary showing a slightly higher standardized beta ($\beta = 0.880$, $t = 43.105$, $p = 0.000$) compared to Indonesia ($\beta = 0.771$, $t = 22.546$, $p = 0.000$). The mean difference ($\Delta = -0.109$) suggests a stronger reliance on AI in Hungary, consistent with findings that Hungarian Gen Z emphasizes AI-driven ethical and health-conscious solutions (Treutz, 2020). In contrast, Indonesian Gen Z's engagement may depend more on interactive and immersive experiences facilitated by AI (Nengah et al., 2022).

The direct effect of technology features on user engagement ($H_{5.3}$) is significant in Indonesia ($\beta = 0.136$, $t = 3.087$, $p = 0.002$) but not in Hungary ($\beta = -0.012$, $t = 0.482$, $p = 0.630$). The mean difference ($\Delta = 0.148$) indicates that Indonesian Gen Z finds direct value in technology features like AR/VR and interactivity for enhancing engagement (Marks & White, 2020). In Hungary, this direct effect is negligible, reinforcing the mediating role of AI capabilities in translating technology features into user engagement.

The mediated relationship between technology features and user engagement through AI capabilities ($H_{5.4}$) is significant in both Hungary ($\beta = 0.195$, $t = 3.616$, $p = 0.000$) and Indonesia ($\beta = 0.448$, $t = 11.748$, $p = 0.000$). However, the effect is stronger in Indonesia, as indicated by the mean difference ($\Delta = 0.253$). This underscores the importance of AI as a mediating factor, particularly in Indonesia, where technology features have a more direct influence on user engagement through AI. In Hungary, the weaker mediated effect reflects a more indirect pathway, aligning with the emphasis on AI's ethical and sustainability-driven applications (Balázsné Lendvai et al., 2022).

CONCLUSION

This study explored the relationships between technology features, AI capabilities, and user engagement among Generation Z in Indonesia and Hungary. The findings confirmed that AI capabilities play a critical mediating role, amplifying the effect of technology features on user engagement. Moreover, cross-cultural differences revealed that Indonesian Gen Z places greater emphasis on direct and mediated effects of technology features, while Hungarian Gen Z prioritizes AI capabilities driven by ethical and sustainability considerations. These insights contribute to the theoretical understanding of technology adoption and marketing innovation and provide actionable guidance for businesses targeting culturally diverse markets.

Research Implications

This study provides critical insights into the role of technology features and AI capabilities in driving user engagement among Generation Z in Indonesia and Hungary. The findings have several theoretical and practical implications:

Theoretical Implications:

The study extends existing research on marketing innovation by quantitatively demonstrating the mediating role of AI capabilities between technology features and user engagement. This highlights the hierarchical importance of AI in translating technological advancements into meaningful user experiences, particularly in culturally diverse settings. The validated structural model and cross-cultural comparison contribute to the body of knowledge on multi-group analysis, emphasizing the varying impacts of technology features and AI capabilities across regions.

Theoretical Implications:

Businesses targeting Gen Z should prioritize investments in AI-driven solutions, such as personalization, predictive analytics, and interactivity, as these capabilities are the strongest drivers of user engagement. In Indonesia, a mobile-first market, companies should focus on integrating advanced technology features with AI capabilities to maximize engagement. Interactive platforms, gamification, and immersive experiences are particularly effective in this context. In Hungary, where ethical and sustainability-driven AI solutions are more valued, businesses should align their AI applications with health-conscious and environmentally friendly practices to resonate with Gen Z's preferences. These insights can guide firms

operating in the metaverse or other digital-first environments to design tailored engagement strategies that cater to specific cultural and technological contexts.

Directions for Further Research

While this study provides significant contributions, several avenues for future research emerge:

- **Broader Demographic Analysis**: Future studies could include other generational cohorts, such as Millennials or Generation Alpha, to compare the role of AI and technology features across different age groups.
- **Expanding Regional Scope**: Research could explore additional countries or regions with distinct technological landscapes to validate the generalizability of these findings and uncover new cultural nuances.
- **Longitudinal Studies**: Conducting longitudinal research could provide insights into how the relationships between technology features, AI capabilities, and user engagement evolve over time, especially with the rapid advancements in digital technologies.
- **Integrating Behavioral Metrics**: Adding behavioral data, such as actual engagement metrics from digital platforms, could complement survey-based perceptions and provide a more comprehensive understanding of user engagement dynamics.

By addressing these issues, future research can expand on the findings of this study to increase our understanding of technology adoption, AI integration, and user engagement in varied cultural contexts.

REFERENCES

Alshurideh, M. T., Akour, I. A., Kurdi, B. Al, Hamadneh, S., & Alzoubi, H. M. (2023). Impact of Metaverse and Marketing Innovation on Digital Transformation. *2023 International Conference on Business Analytics for Technology and Security (ICBATS)*, 1–5. https://doi.org/10.1109/ICBATS57792.2023.10111241

Andriyanty, R., & Wahab, D. (2022). Indonesian Generation Z Consumer Ethnocentrism on Food and Beverage Product. *Technium Social Sciences Journal*, *28*, 522–538. https://doi.org/10.47577/tssj.v28i1.5909

Babatunde, S. O., Odejide, O. A., Edunjobi, T. E., & Ogundipe, D. O. (2024). The Role of AI in Marketing Personalization: A Theoretical Exploration of Consumer Engagement Strategies. *International Journal of Management & Entrepreneurship Research*, *6*(3), 936–949. https://doi.org/10.51594/ijmer.v6i3.964

Basa, K., Machová, R., & Boros, A. (2023). Examination of the tourism market after the COVID-19 : travel habits of generation Y and Z in Slovakia and Hungary. *Marketing i Menedžment Innovacij*, *14*(2), 101–114. https://doi.org/10.21272/mmi.2023.2-010.

Baskoro, G., Mariza, I., & Sutapa, I. N. (2023). Innovation to Improve Critical Thinking Skills in the Generation Z using Peeragogy as a Learning Approach and Artificial Intelligence (AI) as a Tool. *Jurnal Teknik Industri*, *25*(2), 121–130. https://doi.org/10.9744/jti.25.2.121-130

Bhatnagr, P., & Rajesh, A. (2024). Artificial intelligence features and expectation confirmation theory in digital banking apps: Gen Y and Z perspective. *Management Decision*, *In press*. https://doi.org/10.1108/MD-07-2023-1145

Bozzelli, G., Raia, A., Ricciardi, S., De Nino, M., Barile, N., Perrella, M., Tramontano, M., Pagano, A., & Palombini, A. (2019). An integrated VR/AR framework for user-centric interactive experience of cultural heritage: The ArkaeVision project. *Digital*

Applications in Archaeology and Cultural Heritage, *15*, e00124. https://doi.org/10.1016/j.daach.2019.e00124

Chheang, V., Marquez-Hernandez, R., Patel, M., Rajasekaran, D., Sharmin, S., Caulfield, G., Kiafar, B., Li, J., & Barmaki, R. (2023). Towards Anatomy Education with Generative AI-based Virtual Assistants in Immersive Virtual Reality Environments. *ArXiv*, *abs/2306.1*. https://doi.org/https://doi.org/10.48550/arXiv.2306.17278.

Chin, W. W. (1998). Commentary Issues and Opinion on Structural Equation Modeling Clear Reporting. *Modern Methods for Business Research Methodology for Business and Management*, *22*(1), 7–16.

Cohen, J. (1988). *Statistical Power Analysis for the Behavioral Sciences (2nd ed.)*. Lawrence Erlbaum Associates. https://www.utstat.toronto.edu/~brunner/oldclass/378f16/readings/CohenPower.pdf

Crespo-Pereira, V., Sánchez-Amboage, E., & Membiela-Pollán, M. (2023). Facing the challenges of metaverse: a systematic literature review from Social Sciences and Marketing and Communication. *El Profesional de La Información*, *32*(1). https://doi.org/10.3145/epi.2023.ene.02

Desai, D. (2022). *Hyper-Personalization* (pp. 40–53). https://doi.org/10.4018/978-1-7998-7959-6.ch003

Djafarova, E., & Foots, S. (2022). Exploring ethical consumption of generation Z: theory of planned behaviour. *Young Consumers*, *23*(3), 413–431. https://doi.org/10.1108/YC-10-2021-1405

Dr. M. Bhuwaneshwari, & Hemasuruthi S. (2023). A Study on Social Media Influences on Generation Z Buying Behaviour. *International Journal of Advanced Research in Science, Communication and Technology*, *3*(3), 89–95. https://doi.org/10.48175/IJARSCT-11413

Egger, J., Gsaxner, C., Chen, X., Bian, J., Kleesiek, J., & Puladi, B. (2023). No TApple Vision Pro for Healthcare: "The Ultimate Display"? -- Entering the Wonderland of Precision Medicineitle. *ArXiv*, *abs*(2308.04313). https://doi.org/https://doi.org/10.48550/arXiv.2308.04313.

Erwin, E., Saununu, S. J., & Rukmana, A. Y. (2023). The Influence of Social Media Influencers on Generation Z Consumer Behavior in Indonesia. *West Science Interdisciplinary Studies*, *1*(10), 1028–1038. https://doi.org/10.58812/wsis.v1i10.317

Evita, N., Prestianta, A. M., & Asmarantika, R. A. (2023). Patterns of media and social media use in generation z in Indonesia. *Jurnal Studi Komunikasi (Indonesian Journal of Communications Studies)*, *7*(1), 195–214. https://doi.org/10.25139/jsk.v7i1.5230

Eyada, B. (2023). Advertising in the Metaverse: Opportunities and Challenges. *International Journal of Marketing Studies*, *15*(1), 22. https://doi.org/10.5539/ijms.v15n1p22

Gao, S. (2022). Research on the Innovation of the Internet of Things Business Model under the New Scenario of Metaverse. *2022 3rd International Conference on Internet and E-Business*, 44–49. https://doi.org/10.1145/3545897.3545904

Garai-Fodor, M., & Popovics, A. (2022). Changes in Food Consumption Patterns in Hungary, with Special Regard to Hungarian Food. *Acta Polytechnica Hungarica*, *19*(8), 187–204. https://doi.org/10.12700/APH.19.8.2022.8.11

Grigoreva, E. A., Garifova, L. F., & Polovkina, E. A. (2021). Consumer Behavior in the Information Economy: Generation Z. *International Journal of Financial Research*, *12*(2), 164. https://doi.org/10.5430/ijfr.v12n2p164

Gursoy, D., Lu, L., Nunkoo, R., & Deng, D. (2023). Metaverse in services marketing: an

overview and future research directions. *The Service Industries Journal*, *43*(15–16), 1140–1172. https://doi.org/10.1080/02642069.2023.2252750

Hair, J. F. J., Hult, G. T. M., Ringle, C. M., & Sarstedt, M. (2014). *A primer on partial least squares structural equation modeling (PLS-SEM)*. Sage Publications Inc.

Hair, J. F., Risher, J. J., Sarstedt, M., & Ringle, C. M. (2019). When to use and how to report the results of PLS-SEM. *European Business Review*, *31*(1), 2–24. https://doi.org/10.1108/EBR-11-2018-0203

Hinduan, Z. R., Anggraeni, A., & Agia, M. I. (2020). Generation Z in Indonesia: The Self-Driven Digital. In *The New Generation Z in Asia: Dynamics, Differences, Digitalisation* (pp. 121–134). Emerald Publishing Limited. https://doi.org/10.1108/978-1-80043-220-820201012

Hollensen, S., Kotler, P., & Opresnik, M. O. (2023). Metaverse – the new marketing universe. *Journal of Business Strategy*, *44*(3), 119–125. https://doi.org/10.1108/JBS-01-2022-0014

Hu, L., & Bentler, P. M. (1998). Fit indices in covariance structure modeling: Sensitivity to underparameterized model misspecification. *Psychological Methods*, *3*(4), 424–453.

Hu, L., & Bentler, P. M. (1999). Cutoff criteria for fit indexes in covariance structure analysis: Conventional criteria versus new alternatives. *Structural Equation Modeling: A Multidisciplinary Journal*, *6*(1), 1–55. https://doi.org/10.1080/10705519909540118

Hu, Y., Zhang, D., & Quigley, A. (2023). GenAIR: Exploring Design Factor of Employing Generative AI for Augmented Reality. *Proceedings of the 2023 ACM Symposium on Spatial User Interaction*, 1–3. https://doi.org/10.1145/3607822.3618018

Kahawandala, N., Peter, S., & Niwunhella, H. (2020). Profiling purchasing behavior of Generation Z. *2020 International Research Conference on Smart Computing and Systems Engineering (SCSE)*, 155–160. https://doi.org/10.1109/SCSE49731.2020.9313038

Kavitha, K., Joshith, V. P., & Sharma, S. (2024). Beyond text: ChatGPT as an emotional resilience support tool for Gen Z – A sequential explanatory design exploration. *E-Learning and Digital Media*, *In press*. https://doi.org/10.1177/20427530241259099

Lee, J.-K., Lee, S., Kim, Y., Kim, S., & Hong, S.-W. (2023). Augmented virtual reality and 360 spatial visualizations for supporting user-engaged design. *Journal of Computational Design and Engineering*, *10*(3), 1047–1059. https://doi.org/10.1093/jcde/qwad035

Lendvai, M. B., Kovács, I., Balázs, B. F., & Beke, J. (2022). Health and Environment Conscious Consumer Attitudes: Generation Z Segment Personas According to the LOHAS Model. *Social Sciences*, *11*(7), 269. https://doi.org/10.3390/socsci11070269

Li, Y., Ch'ng, E., & Cobb, S. (2023). Factors Influencing Engagement in Hybrid Virtual and Augmented Reality. *ACM Transactions on Computer-Human Interaction*, *30*(4), 1–27. https://doi.org/10.1145/3589952

Liu, Z. (2023). Using Technology Acceptance Model to Analyse the Influential Factors on Consumers Purchase Intention. *Advances in Economics, Management and Political Sciences*, *49*(1), 230–237. https://doi.org/10.54254/2754-1169/49/20230520

Marks, S., & White, D. (2020). Multi-Device Collaboration in Virtual Environments. *Proceedings of the 2020 4th International Conference on Virtual and Augmented Reality Simulations*, 35–38. https://doi.org/10.1145/3385378.3385381

Mentes, M., & Omarli, S. (2023). Marketing in the Metaverse: Evaluation through the 7P Marketing Mix. *Journal of Hunan University Natural Sciences*, *50*(3). https://doi.org/10.55463/issn.1674-2974.50.3.14

Mondok, A., & Zámbó, Z. (2022). Key challenges for rural destinations to meet the expectations of Generation Z travellers. *Acta Carolus Robertus*, *12*(Különszám), 68–78. https://doi.org/10.33032/acr.3419

Oltarzhevskyi, D., & Oltarzhevska, O. (2023). VR, NFT, Metaverse... How digital innovations affect the development of marketing and PR communications. *Current Issues of Mass Communication*, *33*, 26–33. https://doi.org/10.17721/CIMC.2023.33.26-33

Podsakoff, P. M., MacKenzie, S. B., Lee, J.-Y., & Podsakoff, N. P. (2003). Common method biases in behavioral research: A critical review of the literature and recommended remedies. *Journal of Applied Psychology*, *88*(5), 879–903. https://doi.org/10.1037/0021-9010.88.5.879

Pradytya, I. N. A., & Pradana, M. (2022). The Influence of Consumer Behavior on Consumer Purchase of Fashion Products (Case Study of Generation Z in Bali). *Proceedings of the International Conference on Industrial Engineering and Operations Management*, 1–9. https://doi.org/10.46254/AF03.20220166

Ranjan, R. (2022). Product Innovation and Personalization via social media: Learnings from the Phenomenal Success of BYJU. In *Management Strategies for Sustainability, New Knowledge Innovation, and Personalized Products and Services* (pp. 288–302). https://doi.org/10.4018/978-1-7998-7793-6.ch012

Reipschläger, P., & Dachselt, R. (2019). DesignAR: Immersive 3D-Modeling Combining Augmented Reality with Interactive Displays. *Proceedings of the 2019 ACM International Conference on Interactive Surfaces and Spaces*, 29–41. https://doi.org/10.1145/3343055.3359718

Saklani, S., & Kala, D. (2024). Perception of Gen Z Customers towards Chatbots as Service Agents. *Journal of Telecommunications and the Digital Economy*, *12*(1), 356–376. https://doi.org/10.18080/jtde.v12n1.781

Singh, E., Vasishta, P., & Singla, A. (2024). AI-enhanced education: exploring the impact of AI literacy on generation Z's academic performance in Northern India. *Quality Assurance in Education*. https://doi.org/10.1108/QAE-02-2024-0037

Treutz, Á. U. (2020). Transformation of Z-Generation in the context of globalization and place marketing: the case of Hungarian students. *SocioEconomic Challenges*, *4*(1), 28–35. https://doi.org/10.21272/sec.4(1).28-35.2020

Wijethilak, H. P. G. D., Singh, S. K., & Dhand, S. (2024). *AI for Personalizing Customer Interactions* (pp. 221–244). https://doi.org/10.4018/979-8-3373-0219-5.ch011

Zhang, Q., Lu, J., & Jin, Y. (2021). Artificial intelligence in recommender systems. *Complex & Intelligent Systems*, *7*(1), 439–457. https://doi.org/10.1007/s40747-020-00212-w