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Sustainable Use Intention of Voice Search in the U.S.: A Study on User Psychology Factors

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Abstract: Voice search technology has gained popularity in recent years, transforming the way individuals interact with digital devices. This study aims to explore the sustainable use intention of voice search, focusing on the psychological factors that influence new technology adoption. Using the Technology Acceptance Model (TAM) and anthropomorphism theory, it provides insights for developers, marketers, and policymakers interested in voice search technology. Through an online survey targeting experienced voice search users in the U.S., the study examines the impact of TAM factors (perceived usefulness, ease of use, quality satisfaction) and anthropomorphism traits (narcissism, Machiavellianism) on sustainable use intention of voice search. Results from hierarchical regression analysis show that perceived usefulness, ease of use, and quality satisfaction positively affect sustainable intention of voice search. Additionally, narcissism and Machiavellianism predict sustainable intention of voice search. By merging TAM and anthropomorphism theory, this study enhances our understanding of voice search behavior and technology adoption.

Keywords: voice recognition technology; sustainable technology adoption; anthropomorphism; narcissism; Machiavellianism

1. Introduction

In recent years, voice search technology has emerged as a transformative force in the world of digital interactions. The rise of voice assistants and the increasing integration of voice recognition technology into our daily lives has made voice search a prevalent and sustainable means of accessing information and services [1,2]. Leading technology companies like Google, Amazon, and Microsoft have leveraged this innovation to enhance information retrieval, streamline task execution, and facilitate online purchases through voice commands [3]. Growing demand for the Internet of Things (IoT) has driven this shift, resulting in the widespread use of voice-command devices both at home and in the workplace. Various voice-enabled tools, such as Apple's Siri, Microsoft's Cortana, Google Assistant, and Baidu's Duer, have provided users with a diverse range of voice-powered search and shopping options. Consequently, this development has expanded the conventional concept of online search activities, adding voice-activated commands to traditional text-based typing.

In response to shifting trends, Amazon attributes 30% of its sales to voice-activated orders, while Google has reported that more than 20% of all searches are now conducted via voice [4]. Furthermore, 55% of users currently utilize voice search to ask questions on mobile phones [5], and approximately 40% of U.S. consumers now engage with voice assistants on a monthly basis [6]. These statistics highlight a notable shift toward voice-centric content and search that is likely to accelerate in the coming decade. This shift has prompted industry experts to begin emphasizing the importance of implementing Voice Engine Optimization (VEO) strategies rather than relying solely on traditional Search Engine Optimization (SEO) to cater to changing user preferences in an increasingly voice-driven digital environment [7].

While this transition is crucial, the lack of attention to voice search trends in academia and industry has left companies unprepared to meet users' evolving expectations. Hence, the main goal of this study is to analyze the characteristics of users who engage in voice search, and thoroughly explore the factors that influence their usage patterns and information preferences. To accomplish this goal, the study employs two theoretical frameworks, the Technology Acceptance Model (TAM)

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and anthropomorphism theory, to gain insights into voice search behavior. Particularly, this study focuses on search engines within the domain of voice search systems across various devices, including automobile driving systems, smart speakers, and wearable devices. This focus is motivated by the widespread practice of information retrieval through search engines in our daily lives (e.g., Googling) [8]. The findings of the study will provide fundamental insight into the adoption of voice search technology in the world of digital interactions.

2. Theoretical Background and Hypothesis Development

2.1. Sustainable Use Intention and The Technology Acceptance Model (TAM)

Sustainable use intention, also known as continued usage intention, reflects a user's commitment to repeatedly utilize a product or service [9–11]. It highlights the likelihood of long-term user-provider relationships and holds significant importance for businesses, especially those offering innovative products and services [9]. Understanding sustainable use intention is particularly relevant in the IT service industry, where maintaining loyal customers amid easy service access and exit is challenging [2]. Thus, this research seeks to shed light on the factors influencing sustainable use intention of voice search, offering valuable insights for academia and businesses.

In particular, this study focuses on the Technology Acceptance Model (TAM) to predict sustainable use intention of voice search. As one of the dominant models for predicting user acceptance of new technology [12], TAM provides a foundational approach for comprehending how users embrace voice-based search technology. Derived from Fishbein and Ajzen's Theory of Reasoned Action [13], the TAM was introduced by Davis in 1989 [14]. Since its inception, it has proven to be a valuable theoretical tool for describing users' acceptance of and behavioral intentions regarding new technology.

The TAM consists of four major components: perceived usefulness (PU), perceived ease of use (PEU), attitude, and behavioral intentions. The first two deal with application features, while the remainder are concerned with the application's impacts on users [15]. Davis uses two concepts, PU and PEU, as key variables within the TAM to explain users' intentions to accept and use new technology [14]. PU refers to the extent to which users believe that utilizing a particular system can enhance their work on individual tasks [14], while PEU refers to belief that using technology should involve minimal effort and involve no special mental and physical difficulties [14]. These concepts are increasingly relevant in today's rapidly advancing technological landscape, where efficiency and ease of obtaining information are ever more important [16].

The TAM's robustness has been validated through previous studies demonstrating its wide-ranging adaptability across various technological domains. These domains include wireless internet [17], online banking [18,19], mobile applications [20], mobile commerce [21], e-learning [22], augmented reality (AR) [23], and chatbots [16,24]. Furthermore, researchers have employed the TAM in studies of users' intentions to use not only currently adopted technologies but also future technologies and services that are yet to be adopted [19,22,25]. Given its adaptability, this study employs the TAM as a theoretical framework for examining the factors that influence the acceptance of voice search.

2.1.1. Perceived Usefulness (PU)

In this study, perceived usefulness (PU) is defined as the degree to which individuals believe that using voice search within search engines enhances their performance. When users perceive voice search as highly useful for locating information through search engines, they are more likely to utilize voice search functions. The findings of various previous studies support this prediction. For example, Horton et al. [12] suggested that PU significantly predicts the acceptance of intranet use among employees in the UK. Wu and Wang [21] also provided evidence that PU has a positive influence on behavioral intentions to use mobile commerce (i.e., monetary transactions via a wireless telecommunication network) and, in turn, positively affects actual use. Recent research has also demonstrated the influence of PU on intentions to adopt AR in mobile apps [15]. Therefore, this study

predicts that there will be a positive relationship between PU and sustainable use intentions of voice search.

Hypothesis 1: *Perceived usefulness of voice search positively affects sustainable use intentions of voice search.*

2.1.2. Perceived Ease of Use (PEU)

This study defines PEU as the extent to which individuals believe that using voice search is easy and requires minimal physical or mental effort. As with PU, previous research has established PEU as a critical variable in understanding acceptance in various technology domains [26]. Tao et al. [25] conducted a meta-analysis that demonstrated that PEU plays a significant role in individual desire to utilize consumer-oriented health information technologies. Similarly, studies on AR have consistently demonstrated that the PEU of AR positively impacts its acceptance [15]. More importantly, recent research regarding attitudes and behavioral intentions toward smart speakers, which are frequently employed for voice search, has shown that a high level of PEU for smart speakers strongly influences favorable attitudes toward them [27]. Thus, if search engine users perceive voice-activated search as neither complex nor difficult, they tend to continuously use it.

Hypothesis 2: *Perceived ease of use of voice search positively affects sustainable use intentions of voice search.*

2.1.3. Perceived Quality Satisfaction (PQS)

In recent decades, research regarding the TAM has expanded significantly and revealed the model's limitations. To mitigate these limitations, researchers have incorporated variables beyond the foundational variables of PU and PEU into the model [26]. One of these additional variables is Perceived Quality Satisfaction (PQS). Notably, consistent with the contemporary trend of individual media consumption, especially for information-seeking purposes, PQS has gained increasing significance. For example, research has indicated that a strong satisfaction level with mobile app quality signifies users' eagerness to utilize them [20]. This preference has emerged because mobile apps seamlessly integrate existing devices with the internet, enhancing the overall user experience. Given that voice search is a recurring behavior and that users regard the quality of information supplied by search engines as highly important [8], the inclusion of PQS in this investigation is warranted. Consequently, this study expects that PQS will demonstrate substantial explanatory power, alongside PU and PEU.

Hypothesis 3: *Perceived quality satisfaction of voice search positively affects sustainable use intentions of voice search.*

2.2. Anthropomorphism and Voice Search

Fundamentally, the TAM should help elucidate the factors that underlie the adoption of voice search within search engines. Nonetheless, research regarding the TAM has consistently indicated that precisely predicting technology adoption requires consideration of the ways personality traits influence individual preferences [12,26]. This study thus employs anthropomorphism theory as an additional theoretical framework to examine voice search adoption. Unlike text search, voice search primarily involves natural language queries and commands (e.g., "Where is the hair salon near my house?" or "Tell me about the movies being released today!"), requiring a communication style that mimics human-to-human interaction [21] When users engage in voice-based conversations with machines, they tend to perceive the machines as social actors and try to understand them as they might human interlocutors [28]. This perspective is encapsulated in the CASA model (Computers as Social Actors), which suggests that computers exhibit human-like social attributes [28]. As a result, humans unconsciously apply similar social heuristics in computer-human interactions as they do in human-human interactions.

In voice-command interactions with search engines, users instinctively use complete sentences, so the interactions resemble conversations with humans. In line with this trend, efforts to infuse

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products and offerings with human-like qualities extend beyond mere visual resemblance. Consider, for example, Amazon's Echo, which is referred to as Alexa and utilizes a female voice that mimics human intonations and exhibits several distinct personality traits [29]. This leads users to perceive the search engine as a social actor rather than a mere machine, prompting them to respond in ways that align with this perception.

2.2.1. Anthropomorphism and Narcissism

Recent research on anthropomorphism has indicated that various potential variables including cognitive and psychological factors can influence responses to anthropomorphized entities [30,31]. Specifically, individuals with high levels of self-confidence tend to exert control over others through their personal authority, leading to them to respond more favorable to anthropomorphized devices [29]. Indeed, Awad and Youn demonstrated that narcissists hold more positive views of humanized brands [32]. This is because individuals exhibiting narcissistic traits often display characteristics associated with self-confidence, such as inflated self-assessments and pronounced feelings of entitlement and superiority [33,34].

These traits can generate feelings of efficacy when interacting with nonhuman entities. Previous studies have suggested that people with high levels with self-confidence are likely to explore, take risks, and attempt to solve problems when engaging in information searches [8]. Furthermore, narcissistic individuals are also known to desire dominance so they can assert power and control [35]. Therefore, individuals who believe in their own efficacy and control are more likely to believe that they can control human-like machines. These findings suggest that individuals with narcissistic tendencies would likely prefer voice-command search.

Hypothesis 4: *Narcissism positively affects sustainable use intentions of voice search.*

2.2.2. Anthropomorphism and Machiavellianism

Finally, this study investigates the significant role that Machiavellianism plays in shaping individuals' inclinations toward anthropomorphic devices and their subsequent intention to use said devices. Machiavellianism originated from Niccolò Machiavelli's renowned work, *The Prince*, which contends that successful leaders must be willing to manipulate others without hesitation to pursue their personal interests and achieve their goals [36]. The foundational framework for Machiavellianism was established by Christie and Geis, who developed a scale to measure the trait, thereby facilitating extensive research in the field of social psychology [36]. Subsequent studies have delved further into the nuances of Machiavellianism, shedding light on associated traits [37].

Previous studies have indicated that those with high Machiavellian tendencies tend to exhibit a strong desire to acquire wealth and power, often driven by a competitive spirit. They steadfastly pursue wealth and power and unhesitatingly leverage others to achieve their personal goals [37]. Meanwhile, recent research has shown that users who receive information from anthropomorphized devices have elevated expectations regarding the quality of the information provided [38], suggesting that Machiavellianism may be positively associated with intentions to use voice-activated, animated devices.

This positive relationship becomes apparent when considering the manipulative tendencies of individuals with high Machiavellianism. Studies have shown that those with high Machiavellianism tend to exploit various means to achieve their goals, and voice search technology presents a new avenue for them to exercise control and influence over information retrieval [39]. Individuals who possess Machiavellian traits would be more inclined to adopt and utilize voice search technology, because this technology aligns with their predisposition towards control, manipulation, and the pursuit of personal goals through any available means. Drawing on these research findings, this study formulates the following hypothesis:

Hypothesis 5: *Machiavellianism positively affects sustainable use intentions of voice search.*

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3. Methods

3.1. Design, Participatns, and Data Collection

To test the hypotheses, this study conducted an online survey targeting a sample of 400 adult men and women aged 18 and above in the United States, who had experience using voice search in search engines. After incomplete or unreliable responses were excluded, a total of 341 participants who completed the online survey conducted through the MTurk platform on Amazon.com were included in the final analysis. Each participant was paid a nominal fee of US$ .80 for participating in the study. Participants began the survey by answering questions about their Internet use. They then completed the survey regarding the variables in the hypotheses. Finally, they provided some demographic information.

3.2. Measures

Several existing scales were modified to fit the purpose of this study. PU was measured using a five-item scale developed by Natarajan et al. [40] (α = .80). A sample item is "Using voice search on search engines is useful in my life." PEU was measured using 5 items [40], including "Learning to use voice search on search engines is easy for me." (α = .76). PQS was measured using 3 items [41] (α = .71), including "I am satisfied with quality of information generated from voice search on search engines."

Narcissism was measured using a four-item scale suggested by Jonason and Webster [42] . A sample item is "I tend to want others to pay attention to me." (α = .86). Machiavellianism was measured using a four-item scale [42]. A sample item is "I tend to manipulate others to get my way." (α = .88). Finally, sustainable use intention of voice search was measured using 4 items adapted from previous literature [20]. A sample item is "I intend to use voice search on search engines in the future." (α = .75). All items were measured on a 7-point Likert scale and exhibited Cronbach's alpha values higher than.70, indicating that there was no issue with the reliability of the study's measurement tools.

4. Results

4.1. Demographics of Participants

Out of 341 participants, 218 were male (63.9%), and 123 were female (36.1%). The participants' ages ranged from 22 to 69, with an average age of 35.99 (SD = 10.17). The sample's racial/ethnic composition included 71.0% White, 17.9% African American, 6.2% Hispanic, and 4.1% Asian American/Pacific Islander. Additionally, .9% of the respondents identified as either multiracial or selected "other" as their ethnicity. Regarding educational background, 16 participants had completed high school or lower (4.7%), 8 held Associate's degrees (2.3%), 238 held Bachelor's degrees (69.8%), 77 possessed Master's degrees (22.6%), and 2 had doctoral degrees or higher (.6%). Table 1 summarizes the demographics of participants.

Table 1. Demographics of Participants.

Category		Frequency	Percentage
Gender	Male	218	63.9%
	Female	123	36.1%
Race	White	242	71.0%
	African American	61	17.9%
	Hispanic	21	6.2%
	Asian American/Pacific Islander	14	4.1%
	Other	3	.9%
Education	Some high school, no diploma	3	.9%
	High school graduate	13	3.8%

	Some college, Associate's degree	8	2.3%
	Bachelor's degree	238	69.8%
	Master's degree	77	22.6%
	Doctorate degree	2	0.6%
Total		341	100%

4.2. Multicollinearity Analysis

To test the hypotheses, a hierarchical multiple regression analysis was performed. This analysis systematically assessed the impact of the variables derived from both the TAM and anthropomorphism theory on intentions to use voice search in a step-by-step manner. The independent variables were introduced in two stages, sustainable use intention of voice search serving as the dependent variable. Before conducting the main analysis, tolerance and variance inflation factor (VIF) were checked to assess multicollinearity. The analysis indicated that the variables were orthogonal. Given multicollinearity exists when a tolerance is less than .10 and variance inflation factor (VIF) is greater than 5, multicollinearity was not an issue for any of the constructs [43,44]. Table 2 shows the multicollinearity test results.

Table 2. Multicollinearity analysis of factors.

Factors	Tolerance	VIF [1]
Perceived usefulness	.313	3.196
Perceived ease of use	.372	2.685
Perceived quality satisfaction	.285	3.507
Narcissism	.348	2.870
Machiavellianism	.366	2.729

[1] VIF, variance inflation factor.

4.2. Hypothesis Testing

A two-stage, stepwise regression analysis was performed to determine whether there was any additional variance within the constructs. The results of the analysis showed that the first-stage model explained 66% of the variance (F=218.651, p <.001). PU (β=.538, p <.001), PEU (β=.162, p <.01), and PQS (β=.176, p <.01) were all significant predictors of sustainable use intention of voice search. After adding narcissism and Machiavellianism in step two, R^2 = .690, accounting for a ΔR^2 = .034 (F=152.232, p <.001). Thus, adding two anthropomorphism-driven constructs increased the predictability of sustainable use intention of voice search. As shown in Table 3, in step two, PU (β=.427, p <.001), PEU (β=.207, p <.001), PQS (β=.186, p <.01), narcissism (β=.104, p <.05) and Machiavellianism (β=.107, p <.05) were significant predictors of sustainable use intention of voice search. Therefore, all the hypotheses were fully supported.

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Table 3. Multiple regression step-wise analysis results for intentions to use voice search.

Factors	Step 1 β	Step 2 β
Perceived usefulness	.538***	.427***
Perceived ease of use	.162**	.207***
Perceived quality satisfaction	.176**	.186**
Narcissism		.104*
Machiavellianism		.107*
	R^2 = .658	ΔR^2 =.034
	F = 218.651	F = 152.232
	p < .001	p < .001

Note: Beta-weights marked with "*" are significant at the p < .05. Beta-weights marked with "**"' are significant at the p < .01. Beta-weights marked with "***"' are significant at the p < .001.

5. Discussion

In our ever-evolving technological landscape where voice recognition technology is rapidly advancing, further research is essential to expanding scholarly and practical understanding of voice search. As users increasingly adapt to voice interactions, their willingness to use voice search is likely to change. To provide valuable guidance for marketers, developers, and policymakers aiming to optimize the voice search experience, researchers examining digital interactions must stay attuned to these shifting dynamics. Thus, this study aimed to enhance our understanding of voice search by investigating the factors that influence sustainable use intention of voice search in search engines. Pioneering the simultaneous application of the Technology Acceptance Model (TAM) and anthropomorphism theory in the context of digital interactions, this study makes several noteworthy contributions to the literature.

First, in addition to confirming the theoretical validity of the TAM, this study highlights the importance of expanding the model by broadening its essential variables and adopting a multidimensional approach. The results of the current study confirm that the traditional core components of the TAM—PU and PEU—positively influence intentions to use voice search. This finding indicates that perceptions that voice search is a valuable tool that assists with real-life activities such as academics or work and that requires little effort to use positively impact users' attitudes toward its usage. In addition, this study's analysis suggests that when search engine users are satisfied with the quality of voice-searched information, they are more likely to use voice commands when conducting searches. As this study's findings demonstrate, PQS has emerged as a valuable predictor of voice search adoption. In sum, the study's successful use of an integrated model that combines PQS and the TAM demonstrates the usefulness of expanding the TAM, bolstering its theoretical significance.

More importantly, this study identifies meaningful psychological factors related to our responses to animated things, specifically narcissism and Machiavellianism, as significant predictors along with the TAM-driven variables of voice search adoption. These findings align with the study's premise that individuals inclined toward control and high self-esteem are more likely to embrace voice search, viewing search engines as social actors. Narcissism, in particular, has garnered attention in the digital media due to its role in the popularity of the Internet and social media [45]. This study's finding regarding the influence of narcissism on voice search behaviors highlights the importance of these psychological variables and should motivate further research in digital communication.

Additionally, this study contributes to the field of digital marketing. Voice search is a leading paradigm in the growing digital platform market, undergoing significant growth and driving a surge in e-commerce. The data collected in this study confirms the influential role of voice search. In addition to analyzing voice search adoption behavior, this study explores the factors influencing attitudes towards voice search, thus evaluating voice search's potential as information-seeking behavior. The relationship between variables and voice search behavior can be extended to attitudes toward voice recognition technology in various applications, such as automatic driving systems, smart speakers, mobile apps, and chatbots. Since the psychological constructs identified in this study

have received limited attention from researchers in the past, the proposed model can provide a valuable framework for studying similar technologies.

Practically, this study underscores importance of improving perceived usefulness and ease of use in voice search interfaces. The findings should encourage digital marketers to invest in creating intuitive and efficient voice search experiences that meet users' needs. This will involve optimizing voice search in search engines and devices to provide useful and easy interactions. A positive user experience is likely to encourage continued usage and user satisfaction.

This study also reveals that user psychology, particularly traits like narcissism and Machiavellianism, impacts voice search adoption. Digital marketers can leverage this insight to tailor their marketing strategies. For instance, individuals with narcissistic tendencies may respond well to personalized, ego-driven marketing messages, while those with Machiavellian traits might appreciate content that appeals to their desire for control and manipulation. Understanding these psychological responses can help marketers more effectively elicit user engagement with voice search-driven content. Leveraging user data and preferences is crucial for digital marketers. By personalizing these voice search interactions, marketers can deliver tailored recommendations, product suggestions, and content that resonates with individual users.

Finally, as voice search gains prominence, companies should invest in Voice Engine Optimization (VEO) alongside traditional Search Engine Optimization (SEO). VEO involves optimizing content for voice search queries, which includes the integration of long-tail keywords and conversational phrases. Companies should adapt their digital marketing strategies to account for voice search's growing influence.

In summary, the findings of this study have several noteworthy implications, both in the academic and practical areas. It reaffirms the TAM's effectiveness in explaining user behavior within the domain of voice recognition technology and highlights the TAM's value as a theory capable of elucidating user actions, thereby contributing to ongoing discussions in TAM research. Nevertheless, while bolstering the theoretical soundness of the TAM, this study also draws attention to the need for comprehensive discussions concerning the clarity of the model's core variables and the importance of adopting a multidimensional approach. This research adopts a mixed model by incorporating PQS, aligning with recent trends in TAM research toward exploring the relationship between PU, PEU, and other factors. Furthermore, it introduces individual personality traits rooted in anthropomorphism theory as additional variables within the TAM framework. While the variables within the TAM framework are considered highly intuitive predictors, predicting user behavior based on anthropomorphism theory offers a new perspective in the exploration of users' intentions to engage in voice search in the context of search engine utilization.

6. Limitations and Future Study Direction

This study reveals promising avenues for future investigations. First, the fact that the study primarily focused on participants from the U.S. who had experience with voice search in search engines warrants emphasis. Given this geographic limitation, it may not fully explore or represent potential cultural and regional variations in voice search behavior and preferences. Additionally, the sample primarily consists of adult participants with Bachelor's degrees, which means the study does not thoroughly examine potential differences in voice search behavior across various age and educational background groups. Therefore, researchers aiming to provide a more comprehensive understanding of voice search behaviors online should broaden the scope of their data collection to include participants from different countries and demographic groups.

Second, while this study discusses the influence of narcissism and Machiavellianism on voice search preferences, it does not consider other potential factors related to anthropomorphism, which could impact user behavior. Anthropomorphic research indicates that variables like sense of power and materialism [29] may also shape our attitudes toward animated objects. The effects of anthropomorphism are also known to vary from one individual to another [46]. Future studies analyzing various individual differences in anthropomorphism could therefore enhance our understanding of the dynamics of voice-activated behaviors.

Third, the study relies on self-reported data collected through an online survey. Self-reported data are subject to response bias, where participants may provide socially desirable answers or inaccurately report their behaviors and attitudes [47]. Moreover, while this study uses established measurement scales, the validity of these scales may be limited, as perceptions of variables like narcissism and Machiavellianism may be influenced by self-reporting and social desirability biases.

In conclusion, the current status of voice recognition technology, the diverse landscape of user interactions, and the expanding scope of voice search applications highlight the need for ongoing research in this area. This study contributes to our knowledge of voice search, offering valuable insights that will assist in adapting to the ever-changing digital environment and maintaining the user-friendly nature and effectiveness of voice technology across various domains.

Institutional Review Board Statement: All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards.

Informed Consent Statement: Informed consent was obtained from all subjects involved in the study.

Data Availability Statement: Not applicable.

Conflicts of Interest: The authors declare no conflict of interest.

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