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Unrevealing Voice Search Behaviors: Technology Acceptance Model Meets Anthropomorphism in Understanding Consumer Psychology in the U.S. Market

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Abstract: Voice search technology has surged in popularity in recent years, reshaping the way people interact with digital devices. This study investigates the multifaceted factors influencing voice search behaviors, considering the evolving landscape of online search methods. By integrating the technology acceptance model (TAM) and anthropomorphism theory, this research aims to offer valuable insights for developers, marketers, and policymakers interested in voice search technology. Through an online survey targeting experienced voice search consumers in the US, the study examines the impact of TAM factors (perceived usefulness, ease of use, quality satisfaction) and anthropomorphism traits (narcissism, Machiavellianism) on the intention to use voice search. Results from hierarchical regression analysis show that perceived usefulness, ease of use, and quality satisfaction positively affect the intention to use voice search. Additionally, narcissism and Machiavellianism positively affect the intention to use voice search. By merging TAM and anthropomorphism theory, this study enhances our understanding of voice search behavior and AI-driven technology adoption.

Keywords: voice search technology; AI-driven technology adoption; technology acceptance model; anthropomorphism; narcissism; Machiavellianism

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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 such as 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 diverse 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 US 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].

Voice search technology is frequently integrated into energy-efficient devices, such as smart speakers and smartphones, which have lower energy consumption, reducing their environmental impact. Furthermore, these devices function as central hubs for home automation, replacing various gadgets, including alarm clocks, radios, and thermostats. Their multi-functionality offers several sustainability benefits, including improved energy efficiency through the effective management of lighting, thermostats, and other devices, ultimately leading to reduced energy consumption. Additionally, voice search platforms can provide eco-friendly product recommendations, assisting users in making sustainable choices. Notably, recent studies have shown empirical evidence of how voice agents effectively support household decision-making processes regarding food and food waste reduction [8]. This highlights the potential for voice assistant devices to contribute to household waste reduction.

As such, while the role of voice recognition technology in today's society is crucial, the lack of attention to voice search trends in academia and industry has left companies unprepared to meet users' evolving expectations [9]. Most studies on voice search have emphasized the effects of features and usage contexts rather than delving into the psychological factors that influence voice search adoption. Therefore, the primary objective of this study is to focus on user characteristics involved in voice search and comprehensively investigate the individual differences shaping their usage patterns and information preferences. To accomplish this goal, the study employs two theoretical frameworks, the technology acceptance model (TAM) and the 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) [10]. Therefore, this 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. Technology Acceptance Model (TAM) and the Intention to Use Voice Search

This study employs TAM to predict the intention to use voice search. TAM has evolved as a foundational framework over the years, offering valuable insights into users' adoption of voice search technology. It has become the predominant model for predicting users' acceptance and behavioral intentions toward emerging technologies [11]. Originating from Fishbein and Ajzen's theory of reasoned action, TAM was initially developed by Davis in 1989 [12] to elucidate how individuals embrace and employ new technology, particularly in the workplace. Subsequently, Venkatesh and colleagues expanded the model, introducing TAM 2 in 2000 [13] and TAM 3 in 2008 [14]. Additionally, in 2003, they introduced an alternative model known as the Unified Theory of Acceptance and Use of Technology [15]. While TAM has seen the inclusion of additional constructs, the fundamental premise that a user's intention to adopt new technology is influenced by two core beliefs—perceived usefulness and perceived ease of use—has remained unchanged.

According to Davis, TAM consists of four major components: perceived usefulness (PU), perceived ease of use (PEU), attitude, and behavioral intentions [12]. The first two deal with application features, while the remainder are concerned with the application's impacts on users [16]. PU refers to the extent to which users believe that utilizing a particular system can enhance their work on individual tasks [12], while PEU refers to the belief that using technology should involve minimal effort and no special mental or physical difficulties [12]. As users perceive higher levels of ease of use and usefulness for a specific technology or service, their willingness to adopt new technologies and services also increases. Thus, PU and PEU have a significant impact on determining user attitudes and behaviors in the adoption of new technology [13]. These concepts are increasingly relevant in today's rapidly

advancing technological landscape, where efficiency and ease of obtaining information are ever more important [17].

TAM's robustness has been validated through previous studies demonstrating its wide-ranging adaptability across various technological domains. These domains include wireless internet [18], online banking [19,20], mobile applications [21], mobile commerce [22], e-learning [23], augmented reality (AR) [16], and chatbots [17,24]. Furthermore, researchers have employed 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 [20,23,25]. Given its adaptability, this study uses 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, 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. Previous studies exploring information systems indicate that PU significantly influences the intention to continue using them. For example, Venkatesh and Davis [13] observed that PU consistently impacts the intention to use information systems in the future. Seddon and Kiew [26] also emphasize PU as a central success factor in the information system adoption model, suggesting that perceptions of information system attributes are likely to shape users' understanding of PU.

Similarly, Horton et al. [11] suggested that PU significantly predicts the acceptance of intranet use among employees in the UK. Wu and Wang [22] 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 [16]. More importantly, previous studies on AI-driven context consistently found PU to be a strong determinant of behavioral intention to use AI technology [27]. Therefore, this study predicts that there is a positive relationship between PU and the intention to use voice search.

Hypothesis 1 (H1): *Perceived usefulness of voice search will have a positive effect on the intention to use 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. Individuals often exhibit favorable inclinations toward embracing technology when they believe they can swiftly and effortlessly grasp its usage. Likewise, previous research has established PEU as a critical variable in understanding acceptance in various technology domains [28]. Sakshi et al. [29] suggest that PEU is a crucial factor affecting technology acceptance, particularly in social media and travel-related contexts. They argued that the convenience factor, influenced by cognitive, physical, and emotional situations, is the most important predictor of behavioral intentions to use online platforms. Tao et al. [25] conducted a meta-analysis that demonstrated that PEU plays a significant role in individuals' desire to utilize consumer-oriented health information technologies. Similarly, studies on AR have consistently demonstrated that the PEU of AR positively impacts its acceptance [16].

Recent AI literature that applies TAM to study AI-driven technology adoption supports this positive link. Malik et al. [30] revealed that PEU positively influences intentions to use educational chatbots. Kao and Huang [31] suggested that PEU is critical in fostering the establishment of rapport between customers and service robots. 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 (H2): *Perceived ease of use of voice search will have a positive effect on the intention to use 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 [28,29]. One of these additional variables is perceived quality satisfaction (PQS). According to the expectation-confirmation theory (ECT), satisfaction plays a pivotal role in determining whether consumers continue or discontinue using a service [32]. Satisfied consumers are more likely to persist in using services, whereas dissatisfied ones may opt for alternatives or cease usage. This satisfaction is based on the evaluation of the initial experience with the service, leading to positive, indifferent, or negative feelings [33]. Studies in consumer psychology emphasize that individuals' intentions to use a service are influenced by satisfaction aligned with their expectations [34]. This reinforces the link between satisfaction and the intention to continue using services.

Notably, consistent with the contemporary trend of individual media consumption, especially for information-seeking purposes, PQS has gained increasing popularity. For example, research that integrates ECT and TAM has proposed that the intention to use a service is influenced not only by PU and PEU but also by satisfaction with quality [32]. Another study has indicated that a strong satisfaction level with mobile app quality signifies users' eagerness to utilize them [21]. 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 (H3): *Perceived quality satisfaction of voice search will have a positive effect on the intention to use voice search.*

2.2. Anthropomorphism and Voice Search

Fundamentally, TAM should help elucidate the factors that underlie the adoption of voice search within search engines. Nonetheless, research on TAM has consistently indicated that accurately predicting technology adoption requires consideration of how personality traits influence individual preferences [28,35]. It's important to note that one of the significant limitations of TAM is its assumption that human beings are rational when adopting new technology. However, it is now widely acknowledged that our decisions often rely on emotional perspectives rather than rational and logical reasoning [36]. This underscores the need to consider users' psychological states when exploring the adoption of new technology. To address this concern, this study integrates anthropomorphism theory as an additional theoretical framework to investigate 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 [37]. When users engage in voice-based conversations with machines, they tend to perceive the machines as social actors and try to understand them as if they are human interlocutors [38]. This perspective is encapsulated in the computers are social actors (CASA) model, which suggests that computers exhibit human-like social attributes [38]. As a result, humans unconsciously apply similar social heuristics in computer-human interactions as they do in human-human interactions [39].

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 products and offerings with human-like qualities extend beyond mere visual resemblance. For example, Amazon's Echo, which is referred to as Alexa and utilizes a female voice, mimics human intonations and exhibits several distinct personality traits [40]. 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 [41,42]. Specifically, individuals with high levels of self-confidence tend to exert control over others through their personal authority, leading them to respond more favorably to anthropomorphized devices [40]. Indeed, Awad and Youn demonstrated that narcissists hold more positive views of humanized brands [43]. 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 [44,45].

These traits can generate feelings of efficacy when interacting with nonhuman entities. Previous studies have suggested that people with high levels of self-confidence are likely to explore, take risks, and attempt to solve problems when engaging in information searches [10]. Furthermore, narcissistic individuals are also known to desire dominance so they can assert power and control [46]. 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 will probably prefer voice-command search.

Hypothesis 4 (H4): *Narcissism will have a positive effect on the intention to use 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 [47]. 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 [47]. Subsequent studies have delved further into the nuances of Machiavellianism, shedding light on associated traits [48].

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 [49]. They steadfastly pursue wealth and power and unhesitatingly leverage others to achieve their personal goals [48]. Meanwhile, recent research has shown that users who receive information from anthropomorphized devices have elevated expectations regarding the quality of the information provided [40], 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 [50]. Individuals who possess Machiavellian traits are more inclined to adopt and utilize voice search technology because it aligns with their predisposition toward 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 (H5): *Machiavellianism will have a positive effect on the intention to use voice search.*

3. Methods

3.1. Design, Participants, and Data Collection

To test the hypotheses, this study conducted an online survey targeting adults aged 18 and above in the United States with prior experience in voice search technology. Participant recruitment was facilitated through the Amazon Mechanical Turk (MTurk) platform, a well-known online crowdsourcing website. The survey link was made available on MTurk, enabling eligible and interested MTurk workers to select surveys that aligned with their qualifications.

The questionnaire started with basic inquiries about internet and voice search usage. Participants then progressed to the core survey, addressing variables pertinent to the hypotheses. Subsequently, demographic information was collected. Stringent measures were upheld to ensure data confidentiality and anonymity. In appreciation for their contributions, participants received a nominal fee of US $0.80. Following a thorough review that excluded incomplete or unreliable responses, the final analysis included 341 participants who successfully completed the survey via the MTurk platform.

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. [51] ($\alpha = 0.80$). A sample item is "Using voice search on search engines is useful in my life". PEU was measured using five items [51] ($\alpha = 0.76$), including "Learning to use voice search on search engines is easy for me". PQS was measured using three items [33] ($\alpha = 0.71$), including "I am satisfied with the quality of information generated from voice search on search engines".

Narcissism was measured using a four-item scale suggested by Jonason and Webster [52]. A sample item is "I tend to want others to pay attention to me" ($\alpha = 0.86$). Machiavellianism was measured using a four-item scale [52]. A sample item is "I tend to manipulate others to get my way" ($\alpha = 0.88$). Finally, the intention to use voice search was measured using four items adapted from previous literature [21]. A sample item is "I intend to use voice search on search engines in the future" ($\alpha = 0.75$). All items were measured on a 7-point Likert scale and exhibited Cronbach's alpha values higher than 0.70, 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, 0.9% 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 (0.6%). Table 1 summarizes the demographics of the 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	0.9%
Education	Some high school, no diploma	3	0.9%
	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 TAM and anthropomorphism theory on the intention to use voice search in a step-by-step manner. The independent variables were introduced in two stages, with the intention to use voice search as the dependent variable. Before conducting the main analysis, the tolerance and variance inflation factor (VIF) were checked to assess multicollinearity. The analysis indicated that the variables were orthogonal. Given that multicollinearity exists when the tolerance is less than 0.10, and VIF is greater than 5, multicollinearity was not an issue for any of the constructs [53,54]. Table 2 shows the multicollinearity test results.

Table 2. Multicollinearity analysis of factors.

Factors	Tolerance	VIF [1]
Perceived usefulness	0.313	3.196
Perceived ease of use	0.372	2.685
Perceived quality satisfaction	0.285	3.507
Narcissism	0.348	2.870
Machiavellianism	0.366	2.729

[1] VIF, variance inflation factor.

4.3. Hypothesis Testing

This study primarily aims to analyze the distinct effects of TAM-driven versus anthropomorphism-driven predictors. Therefore, hierarchical regression is appropriate as it offers a framework for model comparison and the assessment of whether the variables of interest significantly explain the variance in the dependent variable. 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 ($F = 218.651$, $p < 0.001$). PU ($\beta = 0.538$, $p < 0.001$), PEU ($\beta = 0.162$, $p < 0.01$), and PQS ($\beta = 0.176$, $p < 0.01$) were all significant predictors of the intention to use voice search. After adding narcissism and Machiavellianism in step two, $R^2 = 0.690$, accounting for a $\Delta R^2 = 0.034$ ($F = 152.232$, $p < 0.001$). Thus, adding two anthropomorphism-driven constructs increased the predictability of the intention to use voice search. As shown in Table 3, in step two, PU ($\beta = 0.427$, $p < 0.001$), PEU ($\beta = 0.207$, $p < 0.001$), PQS ($\beta = 0.186$, $p < 0.01$), narcissism ($\beta = 0.104$, $p < 0.05$), and Machiavellianism ($\beta = 0.107$, $p < 0.05$) were significant predictors of the intention to use voice search. Therefore, all the hypotheses were fully supported.

Table 3. Multiple regression stepwise analysis results for the intention to use voice search.

Factors	Step 1 β	Step 2 β
Perceived usefulness	0.538 ***	0.427 ***
Perceived ease of use	0.162 **	0.207 ***
Perceived quality satisfaction	0.176 **	0.186 **
Narcissism		0.104 *
Machiavellianism		0.107 *
	$R^2 = 0.658$	$\Delta R^2 = 0.034$
	$F = 218.651$	$F = 152.232$
	$p < 0.001$	$p < 0.001$

Note: Beta-weights marked with "*" are significant at $p < 0.05$. Beta-weights marked with "**" are significant at $p < 0.01$. Beta-weights marked with "***" are significant at $p < 0.001$.

5. Discussion

In our ever-evolving technological landscape, where voice recognition technology is rapidly advancing, further research is essential to expanding our 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 aims to enhance our understanding of voice search by investigating the factors that influence the intention to use voice search in search engines. Pioneering the simultaneous application of 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 TAM, this study underscores the importance of expanding the model by broadening its essential variables and adopting a multidimensional approach. The results of the current study affirm that the traditional core components of TAM—PU and PEU—positively influence the intention to use voice search. This finding indicates that perceptions of voice search as a valuable tool for real-life activities, such as academics or work, and its ease of use positively impact users' attitudes toward its usage.

Furthermore, the analysis conducted in this study suggests that users who are satisfied with the quality of voice-searched information are more likely to use voice commands when conducting searches. This study's findings establish that PQS has emerged as a valuable predictor of voice search adoption. Therefore, the successful use of an integrated model that combines PQS and TAM demonstrates the value of expanding TAM, thereby enhancing its theoretical significance in the field.

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 digital media due to its role in the popularity of the internet and social media [55]. Additionally, 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.

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 toward voice search, thus evaluating voice search's potential as an 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 the importance of improving PU and PEU 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 further uncovers the impact of user psychology, particularly traits such as narcissism and Machiavellianism, on voice search adoption, presenting a unique perspective distinct from previous research. This insight holds valuable implications for digital marketers. For instance, individuals with narcissistic tendencies may respond favorably to personalized, ego-driven marketing messages, while those with Machiavellian traits might appreciate content tailored to their desire for control and manipulation. Understanding these psychological responses can empower marketers to effectively engage users with voice-search-driven content. Leveraging user data and preferences is paramount for digital marketers, as personalizing voice search interactions allows for the delivery of tailored recommendations, product suggestions, and resonant content to individual users.

Finally, as voice search gains prominence, companies should invest in voice-assisted sustainability features in smart speakers. Smart speakers provide real-time advice on energy-efficient practices, eco-friendly product recommendations, and guidance on responsible recycling and disposal. Additionally, they offer educational content on sustainability topics and allow you to set voice-activated reminders for sustainable practices. These features make our home eco-friendly, enhancing our environmental consciousness and contributing to a greener future.

In summary, the findings of this study have several noteworthy implications, both in academic and practical areas. It reaffirms TAM's effectiveness in explaining user behavior within the domain of voice recognition technology and highlights its value as a theory capable of elucidating user actions, thereby contributing to ongoing discussions in TAM research. Nevertheless, while bolstering the theoretical soundness of 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. By merging TAM and anthropomorphism theory, this study offers a new perspective on the exploration of consumer 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 male participants with bachelor's degrees, limiting the study's examination of potential differences in voice search behavior across various gender and educational background groups. It is noteworthy that MTurk samples consist solely of individuals who voluntarily participate in MTurk, resulting in samples that may not accurately represent the broader U.S. population. While the present study demonstrates that gender had no statistically significant impact on the results ($\beta = 0.029$, $p = 0.343$) and MTurk has been validated as a reliable source of survey respondents [56], researchers aiming for a more comprehensive understanding of voice search behaviors should consider expanding their data collection. Including participants from diverse demographics enhances analysis, improving external validity.

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 such as a sense of power and materialism [40] may also shape our attitudes toward animated objects. The effects of anthropomorphism are also known to vary from one individual to another [57]. Therefore, future studies analyzing various individual differences in anthropomorphism can 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 [58]. Moreover, while this study uses established measurement scales, the validity of these scales may be limited, as perceptions of variables, including 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.

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